# Exploring the Process of an Inventory Forecasting System to Ascertain Capital Investment in Cloud Computing Application for a SME

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**Abstract**

Forecasting commands power to control resources, monitor competition, staying ahead of the competitive curve with the help of insight into business analytics. It is a powerful statistical tool to visualize demand better to allow business decision makers to specifically use their experience to work with cloud computing applications. Vertical integration principles like agility, aggressiveness and ability to change has been linked to the cloud computing. The paper aims to find a workflow model which helps to provide a better foresight into SME cloud computing solution investments for the future.
**Keywords:** SME, POS, ERP, cloud services, inventory forecasting.

## 1. Introduction

The Point of Sale (POS) for a small or medium enterprise (SME) plays an important part in demand visibility [14]. It not only provides a point of the decoupling of information between the SME management and its customers, it also acts as a system through which value generation takes place at various levels of its operational stages. These stages can either be approached horizontally within an organization or vertically by combining resources of other organizations to ensure better demand visibility and to safeguard its competitive advantage and mitigating risks like information leaks.

Managing resources, especially Information Technology, is a difficult task because the rate of change and the speed of information transfer is ever changing. Therefore using specialized partners to do specialized tasks is necessary for ensuring safe and smooth flow of large amounts of information between various other corporate partners with lesser time lags and more accuracy. However, there are issues pertaining to proper representation of data that need to be answered. Through this better demand visibility [4] and eventually tighter forecasts can be attained.

The integration of the concepts of demand visibility and forecasting with the cloud technology might give efficient outputs because of the similarities [12] between them. This is the main purpose of the approach proposed in this paper. Access of resources is an important factor for an organization to consider. Cost of acquiring these resources becomes a major issue especially at this point. This can be better done by the earlier introduced vertical integration concept. Such integration will not only help attain the required economy of scale, it will also

help understand future investment prospects better. Also, it has to be noted that the size of the SME usually restricts it to have the ability to gather a large amount of data autonomously because of the cost factors involved in the process. Also it is evident in practice that the use of Enterprise Resources Planning (ERP) systems has become a handy tool to make work more efficient. The major disadvantage of using ERP systems is their cost and questions regarding their investment of return in the future. The cost of investment of stand-alone ERP software is huge compared to the spending budget that a SME has. Furthermore, such a huge investment limits the SME to further invest in anything else thereby limiting business operations. However cloud computing based systems may provide flexibility and facilities at fraction of the price.

The cloud computing technology can be useful and very effective, however, it is complex and it involves necessity of understanding of its architecture before any idea can be implemented. The reason why cloud computing can be integrated with an ERP software is because their operating principles are similar. The other side of the argument suggests that cloud computing is a black box for the business decision makers. The proposed model aims at creating a working model and simplifying the interactions between the SME management and the programming of cloud computing architecture [24] to implement it at a management level as a strategy.

This paper tries to find a simplified process for a SME company to select an ERP system for the future through the use of business analytics by looking at cost-benefit analysis of a company's projected value. As the paper proceeds more information is provided regarding Inventory Forecasting and Cloud Computing that enables SME decision makers to choose ERP software on the cloud computing platform. In Section 1.1 the literature review on the principles of forecasting is presented. Section 1.2 provides the review of the software as a service (SaaS) layer within the architecture of cloud computing. Section 2 presents the approach that can be used to choose an ERP system. Section 2.1 presents the model for selecting ERP systems with minimum IT knowledge. Section 2.2 elaborates on how goodwill of a company can be derived from the investment. Section 2.3 illustrates historical data and net present value (NPV) which is, as presented in Section 2.3 and Section 2.4, a partial proof of applicability of the proposed model within a SME context. In Section 3 the discussion based on the business roadmap is provided. At the end, the conclusion and future work are described in Section 4.

## 1. Literature Review

In the literature review we briefly touch on issues of demand forecasting for the future so that it can be used to model an investment forecast workflow for a SME to follow. It also touches on the SaaS component of the cloud architecture in the workflow. Links between the cloud marketplace and the physical market place are explored, too.

### 1.1 Forecasting

Researchers and practitioners exhaustively discuss different methods by which forecasting can be done. It is important to understand these methods because current algorithms used in the cloud market place are derived from them. In [26] a very simplified definition of demand is presented, however the variable cost of inventory is ignored there before approaching the equilibrium point. This smoothens the trend lines, but provides a good overview, on the basis of which the enterprise plans can be formulated. The overview can be made specific with the algorithms that are provided by author in [9] by considering the relationships between linear costs, continuous state of demand for lumpy and dense forecasting instances. In [15] the model is presented to calculate marginal cost by including the variability and surges in demand through Markov processes. In [13] auto regression of moving averages is used to look at issues at detail. In [18] and [19], the different parameters are worked out that would be needed to do the forecasting through the use of Markov chain. Authors of [28] have encompassed all above issues in their approach where stochastic lead times and fixed costs were incorporated. However, these models do not provide the users the comfort and the reliability that SMEs need the most; as exponential smoothing models cannot compensate for lumpy demand surges or

dips within stock flow and inventory management [11]. All of these models provide the building blocks on which the paper is based. Wastage and redundancy cannot be eliminated but reduced. The smoothing algorithms can be used as buffer lines to act as a backup in case the error in variability of forecasting happens, but they cannot be used as an absolute forecast to suggest the exact numbers. Therefore also management methods have to be used and implemented to manually look into forecasting.

### 1.2 Cloud Computing

Cloud Computing is a type of computing service which is based on internet and provides facilities to store, manage and process data remotely using remote servers or machines rather than using local machines or a server. Cloud computing is defined in many ways, one of the best definition was provided in [24] where the author define cloud computing as a model to create an omnipresent system of configurable attributes which has the facility of sharing various computing resources autonomously, thereby aiding quick provisioning with minimal supervision of an administrator. It is also stated that the cloud computing is related to the paradigm of a market that is based on the internet using IT systems to fulfill its operations [12].

The cloud computing architecture is based on three main service layers which are infrastructure as a service or IaaS, platform as a service or PaaS and software as a service or SaaS. PaaS constitutes the data center and hardware, IaaS contains software frameworks like java, db and .net. The top layer, the SaaS layer, is mainly used by end users and is the application layer.

Symmetrical transfer of information is very important [27]. It is accurate and convenient because of its characteristics like self service, on demand broad network access, rapid elastic resource pooling and service to measure and track. This paper aims to understand investment forecasting within a supply chain context. Further we look into the specific principles that are used to construct cloud architectures within a SME context, housing the ERP software on the cloud using the SaaS infrastructure. The three main components of the cloud architecture are Cloud Application Architecture layer or CAA, the interface layer and the Cloud Platform Architecture or CPA on which these applications would be based [2], [24]. SaaS exhibits POS features according to [24] with virtual appliance being the product and cloud application programming interfaces (API) being the service provided; all of which are governed by the law of demand and supply [10].

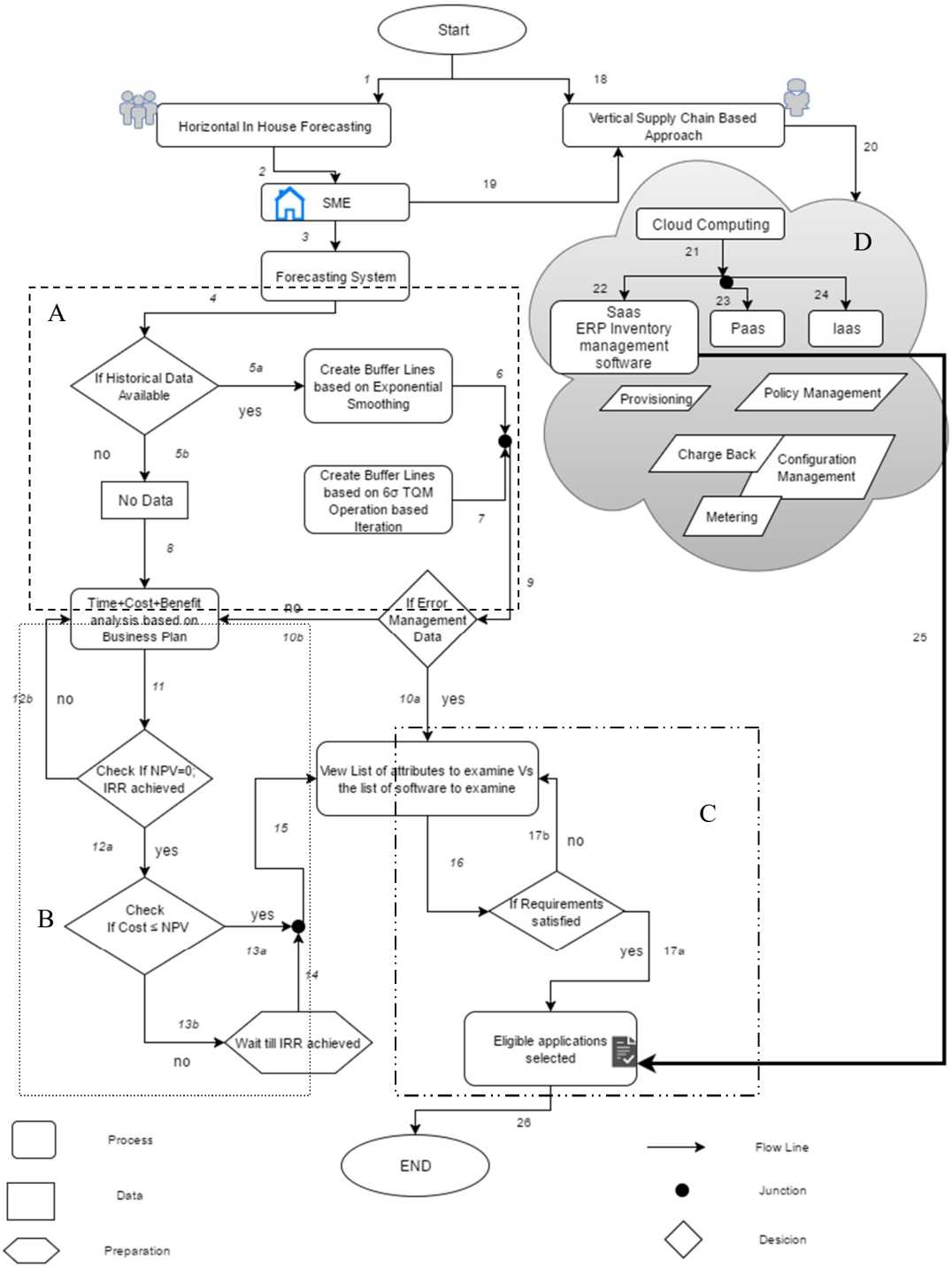
Creation of value traditionally took a horizontal approach with the integration of company's activities like in the value chain [23] and turned to a more vertical integration of companies [4] that specialize in a particular activity and better demand visibility. Despite the disadvantages with these systems kindled the advancement of cloud computing architectures they were capable to transfer and interpret information trans-borders. Also, cloud computing enabled multiple professionals to collaborate in real time. This has reduced variability and human induced errors greatly. On the other hand, inventory forecasting has helped to regulate quality, lead times and quantity better with fewer redundancy and better efficacy [29].

## 2. Proposed Model

An ideal mapping of cloud computing system would be the one which creates a clutter free easily understandable system. Also, as the change is always evident hence short response-times to counter change are desirable to be supported by the mapping.. The proposed model is a map that shows how the forecasting could be done for selecting a particular ERP system (see Figure 1). Hence the mapping can be viewed as the front end component that is designed based on management principles and manager experience tools. The back end would be designed based on the cloud computing architectural modules and principles. The link between the two would be introduced through the proposed mapping utilizing the following steps.

- Step 1: Establish Historic Data. Using NPV's relation with Investment in this case as the primary concern here is to forecast cost of investment in the future.

- Step 2: Create Graphical view for Step1 to understand better correlation between different elements.
- Step 3: Depending on the classification of forecasting choose the best method




Section A: Establishing Historical data
Section B: Business analysis of the situation
Section C: The section on which the selection algorithm will be based.
Section D: Cloud computing infrastructure as a black box for SME.

**Fig 1**: Proposed model (modified flow chart style used for graphical representation).

The represented process expands the front end processes so that business concepts can only be used to select eligible ERP applications using cloud computing concepts; which is a back end system and a black box for managers. Provisioning, policy making, charge back or back dating of resources facilities and metering are the features that cloud computing offers [29]. These are the principles on which even forecasting based on demand visibility [4] relies upon.

There are two ways to approach the forecasting. A company could either apply the horizontal management using activities within the organization to create the value. The company could also apply a more vertical approach to find a forecasting process for the entire supply chain, using specialized technologies and partners. A SME decides which approach to take. Duplication of services and processes cannot be allowed as resources are very limited and proper control needs to be rigid and pre-determined. Secondly, the supply chain route could be followed where all or some processes are handled by specialized companies or technologies, like cloud computing in the above model. Vertical integration not only helps manage processes with effectiveness, efficiency and efficacy; it also increases the value of the company. The explanation to the model presented in Figure 1 is given below (see the numbers of the links in the figure):

1) Traditional management methods are used to target the problems.
2) Top down or bottom up yet integrated approaches are used. Usually a company is not equipped to handle planning beyond a particular level because of the lack of tools. These tools are like a black box for them to understand.
3) The SME needs to assess its ability to invest in future and, if it is feasible, to invest in an expensive ERP system in the future. Hence, Forecasting Systems are used.
4) Historical data needs to be analysed and its availability checked in detail (Section 3.1).
5) 5a. If data is available then buffer lines can be created to do better risk assessment for forecasting. 5b. If data is not present, then alternative steps are followed.
6) In continuation of step 5a buffer lines are created based on exponential smoothing methods (Section 2.1).
7) To make it robust, 6σ TQM methods would be used to establish the spread of these buffer lines.
8) Now in continuation of 5b, when no data is present in the company, the Time+cost +benefit would need to be analyzed as per business plan to look for alternate forecasting methods.
9) Based on step 6 and step 7, errors in forecasting need to be checked and found out. 10a. If risk assessment is established then requirements, attribute list and software information can be checked using existing databases. 10b. If the company fails to forecast then it goes to step 8 where time+cost+benefit analysis is done.
10) Analysing the time+cost+benefit factor the NPV is introduced to know the value of the company at that instance. The investment trend line can be deduced from this (Section 3.3).
11) 12a. If NPV=0, it means that internal rate of return (IRR) is achieved and the risk of investing in the future drops.12b. If NPV≠0 then return back to step 8 to do the cost benefit analysis.
12) 13a. On achieving IRR or if cost ≤ NPV, the examination of the data base to compare ERP systems can be done. Then go to step 10a. 13b. If cost >NPV, then iteration takes place until step 12a is achieved.
13) IRR is achieved.
14) ERP applications can be selected.
15) Now all requirements are analyzed and examined in this stage.
16) 17a. If all requirements are satisfied then selection of software is done. 17b. If requirements are not satisfied then go back to step 10a.
17) This is the black box element of the model that managers do not need to know. To get the software details experts have to be inquired so to achieve that vertical supply chain approached is chosen where one expert can work only on his/her domain.
18) SME is a part of Vertical Supply Chain Approach.
19) Now we can consider that the expert is working on Cloud Computing.
20) Cloud Computing is vast branch so in this we have different categories of cloud.
21) SaaS is the structure which is the main category here as for SME case all software applications are placed on this layer which represents the front end application (Section 2).

22) PaaS: platform as a service (middle layer) mainly supports with runtime environment for applications created and provides deployment and development tools.
23) IaaS: infrastructure as a service is the first main layer where virtual and physical machines, storage devices and other tools are provided.
24) After viewing the whole insight of how software application is formed in cloud, the SME can choose the best ERP software application based on above checks done.
25) Once the SME chooses the eligible software then the process ends.

## 2.2 Calculating the Investment Curve Equation

Cost benefit analysis or value benefit analysis helps finding the niche and insights into historical data. The bottom line for a company is to maintain a healthy profit for operation [14]; hence, it is important to establish the source and sustainability of the cash flow within the company. Since the investment is of a crucial concern to a SME, the investment graph needs to be created. The following approach applied to partly test the model proposed in Section 2.1 uses NPV to explain what is good will if NPV ≥ 0; then investment can be done in the project. The paper looks at the flow of cash implications on the decision making process within the management of the SME, we can state the (1):

$$\text{Investment} = NPV_t - \text{Total cost} \quad (1)$$

Where,

Total cost= Ordering costs + holding costs + shortage costs + Purchase cost

Where, $T_c$ = Total Cost

$$T_c = nc_o + c_h \sum_{i=1}^{n} \int_{t_i}^{s_i} (t - t_i) f(t) dt + c_s \sum_{i=1}^{n} \int_{s_{i-1}}^{t_i} (t_i - t) f(t) dt + \sum_{i=1}^{n} c(t_i) \int_{s_{i-1}}^{s_i} f(t) dt \quad (2)$$

Where n is the quantity, $c_0$ is ordering cost, $c_h$ is holding cost, $c_s$ shortage or cost due to lack of enough supply, t is total time, $t_i$ is time at instance i, $s_i$ is shortage at instance i, $s_{i-1}$ is shortage at instance i-1, t is total time, c is the costs.

Net present value is the present value of cash inflows and cash out flows [16]. Cash inflows is nothing but the injection of cash into a company, hence investment and cash inflow can be inter changed.

$$NPV_t = \text{Investment} - \text{cost}_t \quad (3)$$

Also,

$$NPV = \sum_{t=1}^{T} \left( C_t \frac{1}{(1+r)^t} - C_0 \right) \quad (4)$$

Where: $C_t$=net cash inflow during the period t; $C_o$= total initial investment costs; r=discount rate, and t=number of time periods

There following conditions would arise at different stages of the operation:

a) If investment in an operation is less than the expense or cost of the project at time t then:

$$\text{If Investment} < \text{Total Cost; } NPV_t \text{ is negative} \quad (5)$$

b) If investment in an operation is more than the expense or cost of the project at time t, then:

$$\text{Investment} > \text{Total Cost; } NPV_t \text{ is positive} \quad (6)$$

c) if total investment at time t is equal to the total cost at time t; internal rate of return is reached and can be defined as the point where the project has recovered the amount of money spent. This is important to understand as investments beyond this time t will create profits for the company provided (a) or (b) is not met. If (7) is achieved, a sense of confidence in the operation can be inferred when NPV is zero.

$$NPV = \text{Total Cost; Investment is zero and IRR is reached} \quad (7)$$

From Formula (1) it can be deduced that

$$\text{Investment}_t = \text{NPV}_t + \text{cost}_t \quad (8)$$

where t is the instance of time where the above readings are taken.

When NPV is plotted against the cost, we get the investment into the project because NPV has a cost component in it. Replacing NPV as goodwill if regular profits are made; by definition value of the product will increase over time n. This is important because goodwill generates investment capital and hence needs to be accounted for. Therefore,

$$\text{NPV}_n = \text{goodwill}_n \quad (9)$$

From Formula (1),

$$I_n = \sum_{t=1}^{T} \left( C_t \frac{1}{(1+r)^t} - C_0 \right) + nc_o + c_h \sum_{i=1}^{n} \int_{t_i}^{s_i} (t - t_i) f(t) dt + c_s \sum_{i=1}^{n} \int_{s_{i-1}}^{t_i} (t_i - t) f(t) dt + \\ + \sum_{i=1}^{n} c(t_i) \int_{s_{i-1}}^{s_i} f(t) dt \} \quad (10)$$

## 2.3. Graphical Example of the Above Equation

The following issues have to be considered here:

- It is important to note the scale on the y-axis. If the company does well over time, the NPV will add over time becoming goodwill to the company. This goodwill will attract more partners, e.g., in case of SaaS or supply chain vertical integration context.
- The strength or the weakness of the company can be analysed. The health of the company could be accertained better by looking at the speed in which internal rate of return or IRR was achieved. When NPV is zero, IRR is achieved. i.e., the total investments vs. the expenditure is zero. The SME will make profit beyond this point.
- Based on the above data, an initial upper and lower buffer line could be created.

The following experiment, illustrated in Figures 2 and 3 and Table 1, was conducted at Rocque's Ad & Edit Ltd by a totally hypothetical random data. The cash flow was plotted against a particular time interval. The same data was used to plot NPV vs. time. The graphical view is useful to visually analyze the patterns of cash flow. It can be deduced that the below graph represents a cyclical pattern.

**Table 1**. Sample Used

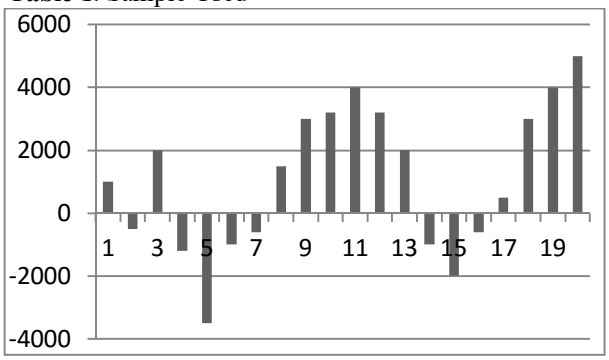



**Fig.2.** Cash Flow vs. Time

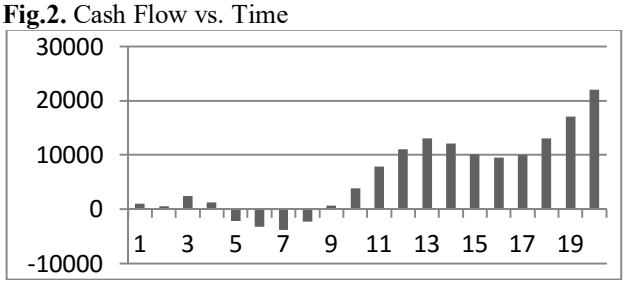



**Fig.3.** NPV vs. Time

| Time | Cash Flow | NPV |
|---|---|---|
| 1 | 1000 | 1000 |
| 2 | -500 | 500 |
| 3 | 2000 | 2500 |
| 4 | -1200 | 1300 |
| 5 | -3500 | -2200 |
| 6 | -1000 | -3200 |
| 7 | -600 | -3800 |
| 8 | 1500 | -2300 |
| 9 | 3000 | 700 |
| 10 | 3200 | 3900 |
| 11 | 4000 | 7900 |
| 12 | 3200 | 11100 |
| 13 | 2000 | 13100 |
| 14 | -1000 | 12100 |
| 15 | -2000 | 10100 |
| 16 | -600 | 9500 |
| 17 | 500 | 10000 |
| 18 | 3000 | 13000 |
| 19 | 4000 | 17000 |
| 20 | 5000 | 22000 |

The interpretation of Figure 2 and Figure 3, and Table 3 is given in the next section.

## 2.4. Creating Projections

In Table 1 an overview data of forecasting methods is exposed. It has been created by amalgamating information from [12] and [5]. See also Figure 3. When historical data has been established, further projections can be done based on Six Sigma TQM [16] and other methods as described in Table 2.

1

**Table 2.** Projections of Forecasting and Cloud Computing [25]

| *CATEGORY* | *SUBCATAGORY* | *DESCRIPTION OF CATAGORY IN FOCUS* |
|---|---|---|
| *Time based* | Short term | Less than one year |
| | Medium term | Between 1 and 2 years |
| | Long term | More than a 2 years |
| *Method based* | Quantitative | Using Statistical Methods |
| | Qualitative | Using Judgement Methods |
| | Historical | Aggregation of past data to figure out trends |
| | Causal | Systems thinking |
| *Based on concentration of demand* | Lumpy | Grouped appearance of instances |
| | Trend | A continuous linear or non linear forecast line |
| | Seasonal | Patterns in the line |
| | Random | No patterns in the line |
| *Based on the scenario* | Life-cycle, Teleology, Dialectical, Evolutionary approach. | Trends matching the life cycle of the firm |
| *Rule based* | Equally weighted | Standard deviation covers distribution of error symmetrically. |
| | Unequally weighted | Concentration of errors is un symmetrical |
| *Based on Cloud Computing Architecture principle* | Enablement | Concentration on 'Strategic enabler' rather than outsourcing |
| | Cost | Evaluation of cost by comparing cloud or other technologies |
| | Enterprise Risk | Adopt cloud and manage with help of Enterprise risk management |

| | | |
|---|---|---|
| | Capability | Integration of capabilities between cloud providers and company internal resource. |
| | Accountability | List out responsibility for cloud providers and internal resources who work hand in hand. |
| | Trust | Define clearly integrity, business process, requirements, confidentiality for whole system. |
| Based on Service Models | IaaS | Mainly provides Interoperability ,Flexibility ,portability with application program |
| | PaaS | Mainly provides less administrative responsibility, less ownership cost and scalable solution |
| | SaaS | Provides scalability ,efficiency ,performance, multiple solutions and various resources which are user friendly. |
| Based on ERP Application | Single Attribute | Applications that only specialise only on one component |
| | Multiple Attribute | Applications host integrated or third party components. This is the advantage of cloud computing. Costs to develop these software are less compared to individual desktop licences. Examples include companies like SAP, Sage, ERPNEXT,DOLIBARR, IBM |

Cost cutting and being Lean is the key as proposed by Henry Ford and Kaizan or continuous improvement [1] while maintaining the value. ERP is at the forefront of complex business activities today [21]. Economy of scale, the process of globalization, the competition [6] and the law of diminishing returns [30] play an important role in the production of trend lines.

Various forecasting methods [1] provide different solutions for different assumptions. They have been categorized as above in Table 2. For the purpose of creating a work flow for understanding requirements judgmental and statistical methods with extrapolation models, qualitative analogies and rule based forecasting has to be used along with the soft system causal methods such as indexing, regression analysis and segmentation of problems issues and outputs.

## 3. Discussion

In this section we provide main concerns related to the proposed model and the road map for the organization to introduce improvements with the cloud based technologies. It is a sustainability model emphasizing on regular updates at the end of each cycle as indicated by trend lines in Figure 4.

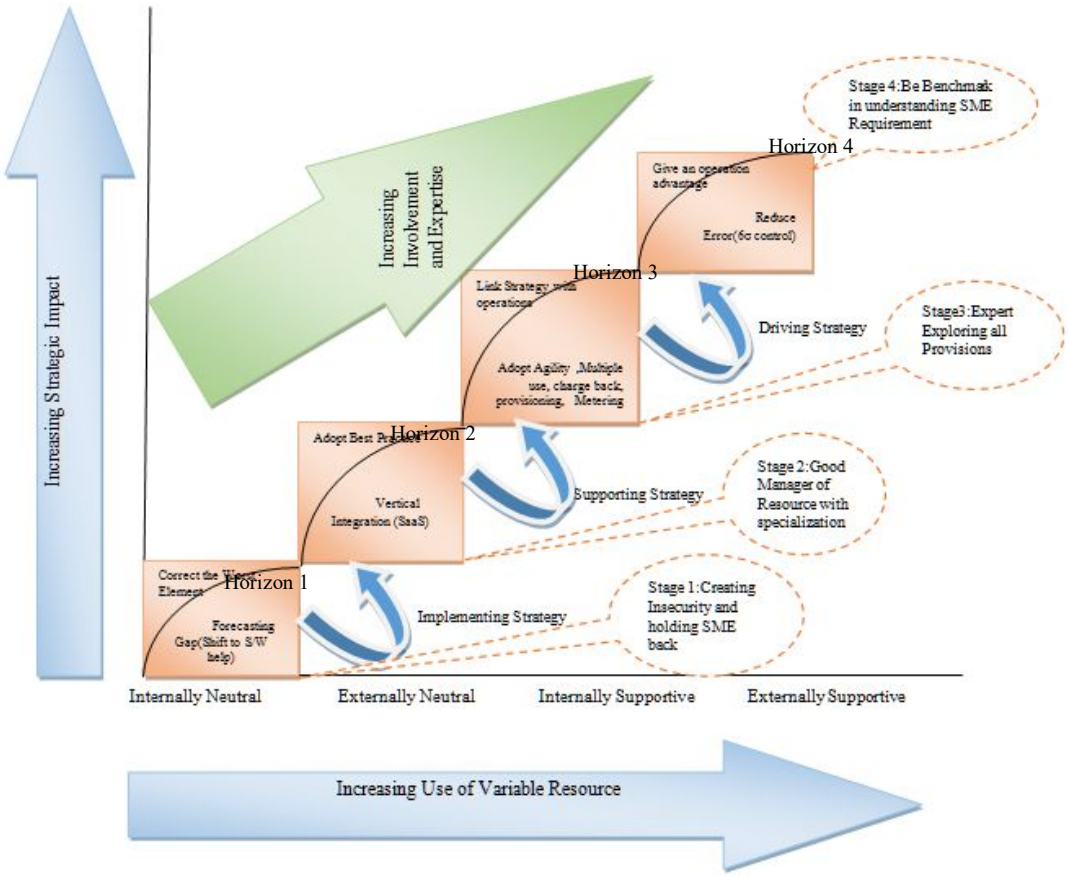



**Fig.4.** Business roadmap for SME, integrated from [10] and Product life cycle [17] and 6σ TQM [16]

On the basis of the integrated views represented in Figure 4 and according to the arguments stated above in the paper, we can recommend that the SME follows the four horizons strategy [4] making its way to handling complexity. Each horizon level needs to be reached before pursuing the next horizon level. At the end of the fourth and final horizon, the SME is supposed to become robust and reduce variance and increase productivity through better efficiency, efficacy and effectiveness. A horizon is based on the product life cycle. A new horizon is created where the tipping point of the previous horizon takes place. This is also the stage where the project matures and is about to decline. The next horizon must start before the project starts declining.

From the area A in Figure 1, the following recommendation of stages to follow to ensure sustainability can be stated:

1) Stage 1: Creating Insecurity and holding SME back. The SME has to look for problems within the current system and look at the past data to search for loop holes within the expense and investment system through the use of the cost benefit analysis, expert judgment and variance analysis.
2) Stage 2: Good management of resources with specialization. Forecasting and reduction of variance done through regression of the proposed work flow to forecast future capital requirements of a SME and then using this information to select a cloud computing SaaS. The SaaS is a black box at this stage and is only connected to the model through business analysis aiding the SME management to have better demand visibility and control over its future strategically decisions.
3) Stage 3: The Expert exploring all provisions. The SME needs to manage resources efficiently with accuracy. This could be achieved by integrating the proposed goodwill formula to the selection process. Furthermore, horizontal integration of SME departments and activities could be replaced by a more specialized vertical system where specialized resources and partners could deliver value. Cloud SaaS with better

database management systems and file retrieval using platforms such as Cloud Foundry could be used to collect and analyze huge amounts of data.

4) Stage 4: Benchmark in understanding SME requirements.

CTQ or Critical to Quality tree concepts have to be used to create a hierarchy within TQM through the use of 6σ DMAIC (Define, Measure, Analyze, Improve and Control) to access sustainability and maintain quality for further iterations of cloud computing infrastructure models. This will also help in the reduction of wastes as forecasting errors and decision errors will be minimized. Also, since specialized data mining activities of the SME can be outsourced, quality could be a driving force to create value and better visibility of investment demand hence after. Cloud computing practices could provide redundancy for the above and add further value in the quick selection process by creation of algorithms based on Gale-Shapley algorithm. This would not only help finding the best possible ERP software based on the proposed workflow, it would also provide the user with alternatives in case the user wishes to customize the final output.

Forecasting through applications should not be done on its own. Combination with expert judgmental methods is recommended by most of researchers and professionals.

## 4. Conclusions and Future Work

Economy of scale has proved better cost value efficiency of the system, enabling SMEs with small budgets to invest into applications. The authors provided the model to select a SaaS based ERP application. Various forecasting systems were analyzed based on which the workflow model was created. Example forecasting was done by establishing the historical data, based on which trend lines were created. Error management system was incorporated in the model and, finally, how to select the ERP application based on cloud computing principles was shown. The concepts of the Net Present Value or NPV and Internal Rate of Return or IRR were explained and used to deduce goodwill of the company. Automation tools within cloud computing can help managers to intuitively take decisions. We have partly verified the model for selecting ERP system within the context of Rocque's Ad and Edit Ltd. Further development of algorithms and decision trees are needed to make the proposed workflow more robust.

One disadvantage with these cloud computing systems is that there is very little variability within the applications. Further research within this domain would involve going into deeper consideration of IaaS, PaaS and SaaS layers to resolve security risk factors that are ongoing issues in the cloud computing. The aim would be to achieve a risk free and cost effective and relatively easy to choose ERP application for SMEs

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