Literature Survey

Inventory Cloud Service for Local SME : A Scenario Study for Ice Cream Factory

This paper presented the inventory cloud service framework for the local SME. This framework will help the ice-cream factory eliminate or reducing the current problems by reducing the cost of system implementing, and maintaining, and increasing the effectiveness of using the inventory system.

The quality attributes of this framework are reliability,scalability and usability.

The features of the system include,

· The app must support multi-tenancy.By which SMEs can share and can utilize the max capacity of the computing resource.

· The cloud application and IT resource are scalable as business needing.

· The server provider manages IT resource and maintains system.

· User authentication and identification mechanisms are required as it supports various SMEs or multi-tenancy.

· It must allow for customization and adding application services or modules.

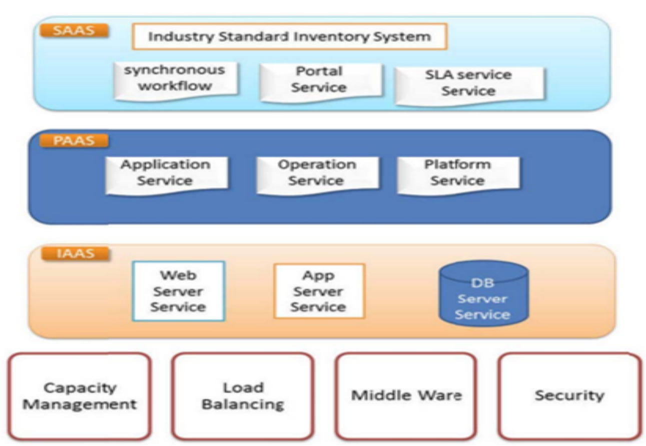

Figure 1 Inventory Cloud Service Framework

The proposed framework consists of 3 layers ,Saas,Paas,Iaas.Each of these layers are managed by 4 main services as follows.

- Capacity management – monitors the volume of the tasks of each instance and decides to increase or decrease the capacity.
- Load balancing – distributes incoming application traffic to the good traffic root and instance.
- Security – needed to secure not only the data but the infrastructure, virtualization, etc.

SaaS layer: Using the SaaS is simple for the users; it is not required software installation and configuration. SaaS layer is accessed by the thin client via the internet. Each tenant will be able to use all the software function and IT resources as needed. Users interact with the user interface in the form of web clients tier and then it triggers the synchronous workflow. Therefore, this layer supports the security issue and stability of data transmission over the internet, for example authentication, data security and load balancing. The application and database are located on the service provider site, which enables the cost saving for infrastructures and maintenance cost. The Portal Service controls the transport process and security. The private virtual network service will ensure the data security during transferring data which clients need to pay more service fees to these services. However the Service Level Agreement (SLA) needs to be understood by the tenants, in order to get the best service and control the budget for the service.

There are 5 modules for the industry standard inventory system, which are categorized by the task characteristic. These modules were design from the ice-cream factory requirement.

1. Master Data Module: This module manages the primary data that needed to operate the plant, such as product, customer, transportation zone, freezer and system data.

2. Inventory Module: This module stores the inventory data for the main inventory and the sub-inventory. The unit level of each product will be managed automatically relating to sale transaction and production. In additionally, this module also allows user importing and exporting product to inventory manually.

3. Sale Module: The sale module manages all the transaction for every point of sales. The module allows user to manage the product receipt and invoice, and the sale reports.

4. Expense Module: This module manages all the expense in the plant such as production cost, general cost and it also provides the expense reports.

5. System User Module: This module will manage the system users and authentication.

Paas layer: PaaS layer provides the development cloud platform. The PaaS is the programing interface to the cloud application developers. The cloud developers can control the deployment application and application hosting environment. The database management system (DBMS) and the web server are deployed for the implementation environment. The PaaS enables the development more agile. The PaaS works like an outsourcing of core business process application development, hence PaaS will make the SaaS more responsive to the user requirements. Furthermore, since the business requirements are various, this layer allows the developers customizing modules and creating the additional service for the inventory cloud service efficiently.

IaaS layer: IaaS layer leverage the virtualization in order to provide the computing resource to the tenants. The computing resource includes virtualizing computing resource, storage, and network. This layer allows the cloud developer self-access to the cloud resource in order to deploy and run software, such as operating systems, application platforms and the database by themselves.

Scenarios List

Scalability

s1 New tenant requests using the service, this process can be done efficiency.

s2 Users use the system 24 hours.

s3 The users requires low latency when massive incoming application traffic

Reliability

s4 The application server crashes. The application server will automatic restart or switch to another instance.

s5 The server outage, and when it backs online, all the update master data, and transaction data are also recovered.

s6 There are no IT personnel in the factory, they are all end user. Hence they required automatic the maintenance task, and overhead infrastructure management.

Usability

s7 User requires to backup database offsite every month.

s8 The company wants rapid updating the system, or adding new functions to meet the business operation and requirements.

s9 When the office administrators want to reviews these data or query the transaction history, the system should manipulate theses action effectively and quickly.

1)Scalability: The scenario 1, 2, and 3 are grouped together. The sources of stimulus of these scenarios are the users. The stimulus is the request of using the system increasing by the existing and new users. The cloud service framework has the capacity management and load balancing service to ensure that the increasing volume of users and tenants will not affect on the system performance. Furthermore the VM will allow to add new tenants using the inventory cloud service.

2.) Reliability: The scenario 4, 5, and 6 are grouped together. The sources of stimulus these scenarios are the service providers. The architecture approach responds to this stimulus depending on the SLA which should be flexible and cost-effective for the factory. The cloud service framework provides the backup and recovery process for example the replication service for storage centre, load balancing and the security service. Some providers guarantee the 99.95 availability if the user has at least 2 VM in stall in the data center. The maintenance tasks will be automatically managed by the service provider. The ice cream factory employee who are end users and have less IT still will focus on the operational work for the plant. As the SaaS layer, user will access the application via the internet and some users may have role to manage and monitor the IT resource using at the period of time. The cloud service has the backup and recovery method to ensure availability for the user. Monitoring and self-access to manage the IaaS service will be done by the application developer team.

3.) Usability: The scenarios are grouped to 7, 8, and 9. The source of stimulus are the service providers. In this case, tenants need to be ensure that they can access their application and database. It is possible by the agreement that allow user to access their VM and database via the web service API from the provider service. The companies will utilize the cloud strategy for the inventory cloud service which is suitable for the business needs. The update cloud strategy will be automatically done by the PaaP service layer. The PaaS developer team can focus on the requirement form each business type, so they can be fast provisioning, flexible building to meets business needs. However adding more cloud service affects on the cost. So it is essential that the company must have a good understanding about the service value, in order to balance the costs and the benefits.

Conclusion

This paper proposes the inventory cloud service framework for the SMEs in rural area in Thailand. There are 3 quality attributes to achieve in this paper including scalability, reliability and usability. This paper has found that the most important attribute is the scalability because SMEs are generally lack of budgets and technical personnel to maintain the systems. However, the governance for deploying new applications needs to be considered, in order to prevent too many small applications which can lead to the application management problems. The reliability and usability have lower priority in order. Therefore having the cloud service can solve the cost and the technical issue. However, the risks derived from service providers still under cover. The further study should be focusing on how asset the risks from service providers.

2. Cloud-Based Inventory System for Effective Management of Under and Over-stock Hazards

The paper tells us about the effective management of inventory system (One stop centre) using cloud computing .

One-Stop Centre (OSCent) is a student-handled shop located at Kuliyyah of Engineering (KOE) that sells a variety of item needed by the students such as safety boots,workshop jackets, stationery and textbook.As a well-established shop, it has the stock-in and stock-out that need to be continuously monitored. However, the inventory management at the shop is not convenient and successful enough to handle all the stock in the inventory because they are still using the manual inventory system which as a result leads to lots of problems with one of the problems being that the members of OSCent always need to gather and calculate their stock manually at the beginning of each semester.In order to improve the inventory management in OSCent, the cloud-based computerised inventory system is proposed with the integration of a barcode scanner to replace the usage of the manual and paper-based system.

Methodology:

A. Baseline Study: To further understand the current situation and problem at OSCent, a baseline study is required. The study population is on the heads of each unit in OSCent.An interview session is conducted to gather data for the research. In conducting the interview, the research instrument which is interview questions consists of three questions. The question is about the procedure to place an order for each unit, the problem faced, and the documentation of each transaction. The result from the interview is analyzed and used for the next section. A root cause analysis is conducted to find the actual root cause to the stated problem.After comparing the root cause diagram with the result from the interview, no record of transactions has been identified as the main root cause of the occurring problems. As such, the computerized system is designed to overcome the loss that occurred due to the current manual system.So, the iterative model is selected.This model consists of making planning, collecting requirements, developing a design, implementing the design, verifying the implementation, and getting the evaluation from the client.

Requirement:

The plan and timeline to develop the system took one calendar year. Based on the interview, three functional requirements have been derived.In addition, multiple non-functional requirements have been set.

Design:

Multiple diagrams are used to give a clearer view to the developer on the actors, roles, actions and classes. The Use Case diagram shows the interaction between the actors and the system. The general content of the system can be viewed through the class diagram that shows the database class that is connected directly to the user. Should changes happened in the order, sale, item and user, it is updated directly to the database. The Sale class and Order class depend on the Item and User class to get the data. Member user can only access the Sale and Order class after they log on to the system. In addition to that, the class ends with the logout.

Implementation:

PHP has been selected as the main programming language. For the database, MySQL is used and the relational schema for the database.

Verification and Evaluation:

After the software development, it is tested on a one-tailed test to ensure that the performance of the computerised inventory system is better than the manual inventory system. This project was released and put under observation after the release for bugs and error to be fixed. After the system released at OSCent, a feedback form was given to OSCent members, comments on the features to added, removed or improved was entertained. Each feedback is analysed and brought into the discussion. The evaluation process keeps running until the system completion.

Result:

The system is named as One Stop Centre Inventory System (OSCenTIS), and the interface is designed to fulfil the function that is highlighted in the early section to ensure the problems can be solved.

Performance Evaluation:

The one tailed test was selected as the scientific method to show the relevance of having OSCenTIS instead of a manual system. From the comparison between manual and cloud based system, The mean time for manual system is higher compared to OSCenTIS with difference more than 100 sec. Using the significance level, $\alpha = 0.5$, the result shows that the most important value, which is the probability for one tail, $P(T<=t)$ one-tail = 0.001839363. Since the significance level is 0.5 and having the probability value P less than the significance level proves that there is statistically significant difference between the two variables that are being tested. Hence, we can reject the null hypothesis, $H0$ which claims that there is no difference between OSCenTIS and manual system as the OSCenTIS is 95% more efficient than manual by looking at the probability P=0.001.

Conclusion:

It is undeniable that the manual inventory system needs to be changed to an automated inventory system that can reduce the time taken, reduce human error, and improve the efficiency of the inventory. The software chosen is also capable of achieving the targeted requirements aimed at solving the problem. In future work, the system can be improved by adding the section to store receipts and create receipts for each transaction. In addition to that, a profile section for each user can be developed to store more info on the users, finally, there is a feature that can give an alert when an item is approaching expiry date.

3.Construction and optimization of inventory management system via cloud-edge collaborative computing in supply chain environment

The present work aims to strengthen the core competitiveness of industrial enterprises in the supply chain environment, and enhance the efficiency of inventory management and the utilization rate of inventory resources. First, an analysis is performed on the supply and demand relationship between suppliers and manufacturers in the supply chain environment and the production mode of intelligent plant based on cloud manufacturing. It is found that the efficient management of spare parts inventory can effectively reduce costs and improve service levels. On this basis, different prediction methods are proposed for different data types of spare parts demand, which are all verified. Finally, the inventory management system based on cloud-edge collaborative computing is constructed, and the genetic algorithm is selected as a comparison to validate the performance of the system reported here. The experimental results indicate that prediction method based on weighted summation of eigenvalues and fitting proposed here has the smallest error and the best fitting effect in the demand prediction of machine spare parts, and the minimum error after fitting is only 2.2%. Moreover, the inventory management system based on cloud-edge collaborative computing has shorter processing time, higher efficiency, better stability, and better overall performance than genetic algorithms. The research results provide reference and ideas for the application of edge computing in inventory management, which have certain reference significance and application value.

Introduction

The industrial production data is investigated here based on the analysis of the related concepts and production modes of supply chain and cloud manufacturing. Then, the demand prediction method for different types of industrial spare parts and the inventory management system are proposed via cloud-edge collaborative computing. The purpose of this work is to optimize inventory management and utilization efficiency by predicting the demand for vulnerable spare parts, and improve the performance of inventory management systems with the advantage of cloud-edge collaboration computing. Moreover, cloud computing and IoT technology are utilized to explore the implementation method of refining the traditional inventory management of the supply chain. The innovation of this study is that corresponding demand prediction methods are studied separately according to three demand modes of vulnerable spare parts, namely periodic demand, stationary demand, and trend demand. Specifically, the simple exponential smoothing method is used to predict demand for stationary spare parts. The quadratic exponential smoothing method is selected to predict the linear demand, and the feature synthesis method is proposed for forecasting the spare parts with periodic demand mode. On this basis, edge computing is employed to develop a cloud-edge collaborative computing architecture, to optimize the spare parts prediction algorithm and improve inventory management efficiency and pertinence

Introduction to concepts related to cloud-edge collaboration for logistics management

Cloud manufacturing includes cloud-edge collaboration technology, AI service technology, container-based platform service technology, digital twins service technology, data security, and other related technologies. It is a novel type of digital, intelligent, and smart networked manufacturing with Chinese characteristics.

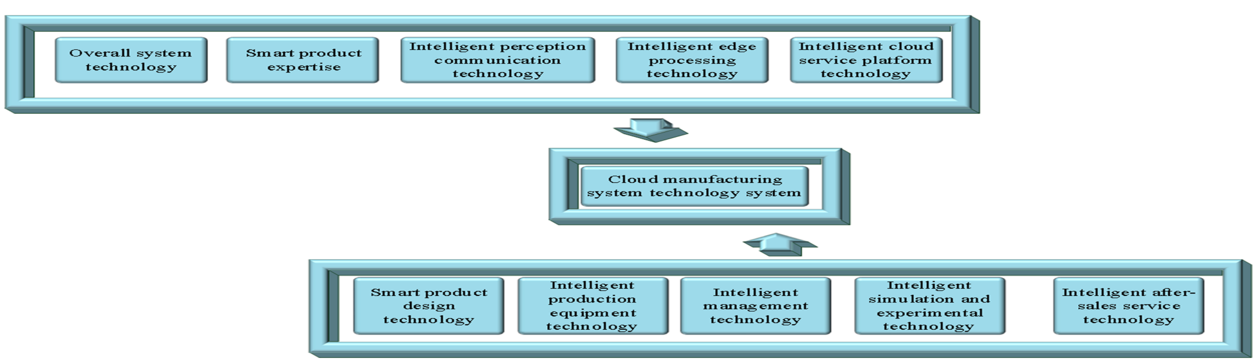

Fig. Overall system of cloud manufacturing technology

The foundation of intelligent cloud manufacturing is a ubiquitous and human-centered network, which integrates digital technology such as information manufacturing technology and intelligent technology comprehensively. The cloud manufacturing system enables users to obtain manufacturing resources and capabilities according to their own needs anytime and anywhere through cloud-based manufacturing.

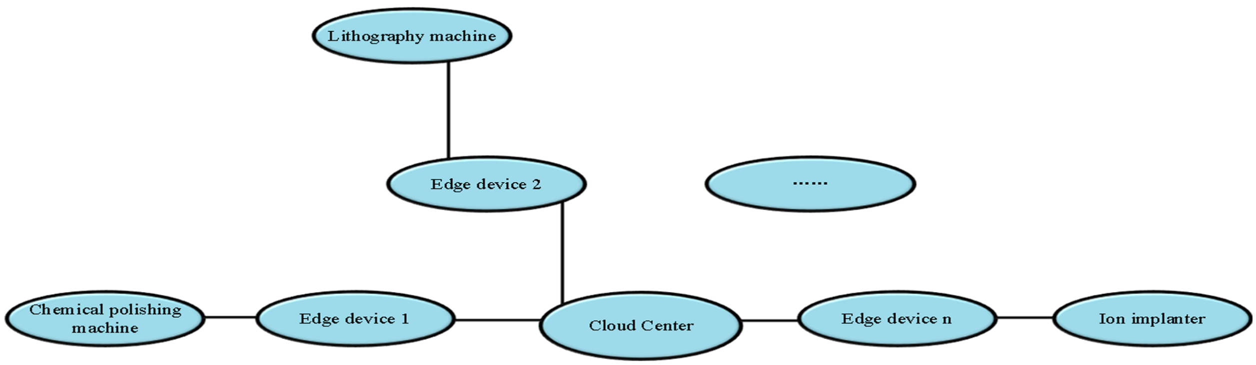

Fig. The manufacturing factory based on cloud-edge collaborative computing architecture.

Many problems such as single-point faults may occur in industrial applications. In addition to the unified control of the cloud, the edge nodes have the computing ability to independently make decisions and solve problems, which can improve factory productivity, while avoiding equipment failure. In IoT scenarios, edge computing focuses on solving problems of lightweight data size closer to the user's by transferring computing operation. Therefore, it cannot completely replace cloud computing, but assists cloud computing to improve work efficiency. With the deepening of industry research and academic research, cloud collaboration is widely used in numerous fields such as medical treatment, industry, and finance. Cloud-edge collaborative architecture can balance the load and reduce the hardware requirements of edge devices, making the peripheral equipment more convenient while maintaining the capacity. Fig provides a manufacturing factory example based on cloud-edge collaborative computing architecture.

Inventory management system based on cloud-edge collaboration

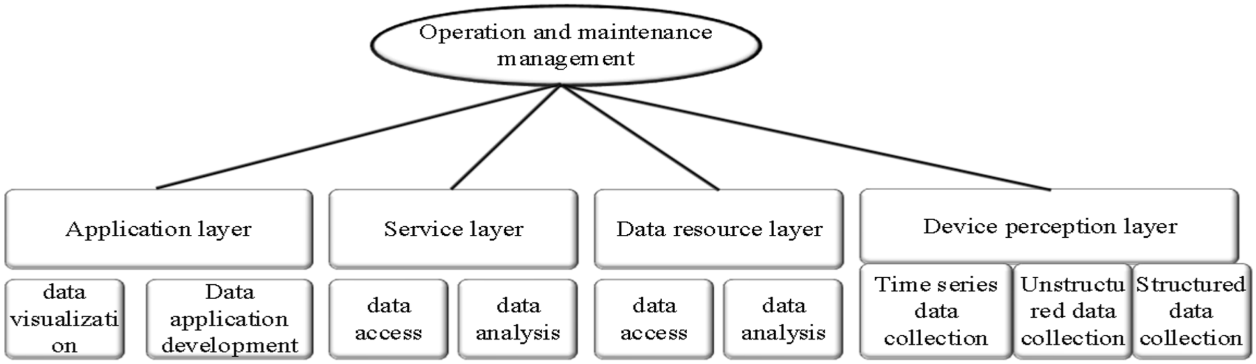

Fig. Architecture of cloud-edge collaborative computing.

The deployment of industrial IoT in an intelligent manufacturing environment mainly contains the equipment perception layer, data resource layer, service application layer, and operation and maintenance management layer, which work together to maintain all data links. From the specific business point of view, the cloud components are mainly responsible for the formation of the model of the collected data, and the peripheral components are basically responsible for obtaining the model from the data dictionary, providing timely services for factory equipment in real time. Reducing the training time of models and networks can shorten the response time of the closed-loop system and improve the overall production quality of the plant equipment. OpenStpack and Starling X enable companies to build their own cloud- edge collaborative computing services using the most advanced open-source cloud computing platform and the latest distributed cloud computing platform, respectively.

The solution of traditional cloud computing architecture is to upload all kinds of sensor data from factory equipment, such as vibration, pressure, and temperature, to the cloud remote server through data acquisition module. Besides, it utilizes the popular big data analysis technology to establish the mathematical model of index data and factory equipment performance, to enhance the production quality, work efficiency, and market competitiveness of factory equipment. Taking the coal industry as an example, the mine is generally located in a remote location where it is difficult to implement network communication. Due to the characteristics of large scale, numerous varieties, low value density, and fast update and processing requirements of coal mine data, the traditional cloud computing architecture is inadequate, because it is easy to produce problems of single point faults and slow closed-loop response. Based on the above analysis, the cloud-edge collaborative computing architecture is selected for the industrial IoT to cope with the problems of fast real-time control response and fast data calculation in large manufacturing workshops. Fig illustrates the workflow of cloud-edge collaborative computing architecture, where various data acquisition devices and user requests are collectively referred to as collectors. The smart endpoint simply pre-processes information from the collectors and sends it to the computing node in the edge server cluster. Then, the I/O intensive virtual machine on the computing node receives the information and stores it in the database on the storage node.

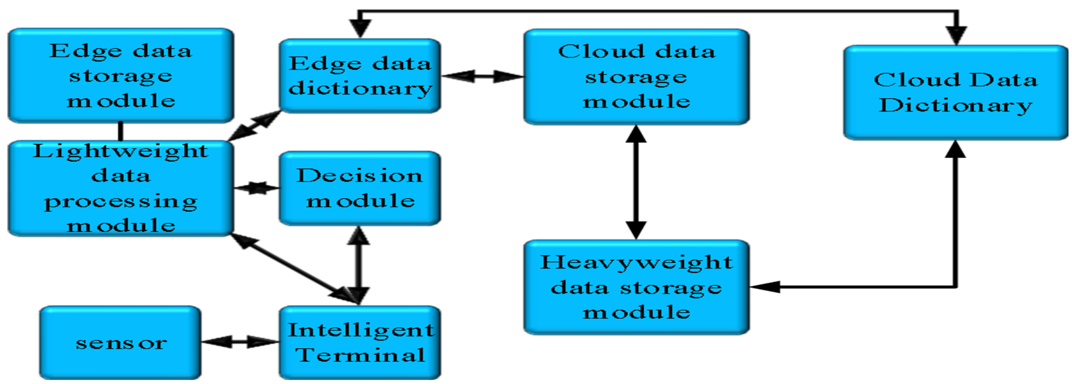

Fig. Workflow of cloud-edge collaborative computing.

The following is the specific processing of the edge server:

1. the intelligent terminal sends the collected data to the edge data storage module;
2. data processing module retrieves the corresponding data from the edge data storage module according to the user's request;
3. data processing module carries out lightweight big data analysis according to the model parameters provided by the data dictionary module. Besides, the edge data dictionary module is analyzed and synchronized;
4. The decision module outputs the processing results of the data processing module to the intelligent equipment and checks them accordingly.

The procedure of the remote centralized server is as follows:

1. the edge server and remote centralized data storage module synchronize incremental data;
2. data processing module retrieves data from the remote centralized data storage module according to user needs;
3. The data processing module conducts large-scale big data analysis according to the model parameters provided by the data dictionary module.

The analysis and synchronization of the remote data dictionary module are presented as follows:

1. edge server synchronizes incremental data with the remote centralized data storage module;

2. the data processing module retrieves data from remote centralized data storage module according to user needs;
3. The data processing module conducts large-scale big data analysis according to the model parameters provided by the data dictionary module. Meanwhile, analysis and synchronization are performed on the remote data dictionary module;
4. The remote data dictionary module synchronizes data processing with edge data dictionary modules according to specific requirements.

Edge servers and remote centralized servers regularly analyze and use stored data, and the data dictionary is updated to ensure the correctness of the decision message.

Conclusions

Finally, an inventory management system based on cloud-edge collaborative computing is proposed to reasonably allocate inventory resources and improve the utilization of inventory resources. The prediction method based on weighted fitting of eigenvalues proposed here has the smallest error and the best fitting effect in the demand prediction of machine spare parts, and the lowest error after fitting is only 2.2%. Exponential smoothing method and quadratic exponential smoothing method are used for spare parts with non-periodic linear demands and spare parts with nonlinear demands, respectively, and the prediction results are close to the actual values. In terms of completion time, the virtual machine performance algorithm reported here realizes shorter processing time and higher efficiency than genetic algorithm. In terms of stability, this research algorithm is much more stable than the genetic algorithm.

Supply Chain Efficient Inventory Management as a Service Offered by a Cloud-based Platform

The main objective of [1] is to propose a cloud-centric based optimization for inventory management in the supply chain. This proposed inventory management system collects all the data and stores it starting from manufacture till its retail. The proposed system aims at providing efficient and real-time inventory management in a cloud platform. The suggested system differs from the conventional Discovery services(DS) and Object Naming Services(ONS) in two ways. First difference is that conventional services did not include the end consumer whereas the proposed system included the end consumer's feedback and their retail history. Secondly, whereas standard lookup services, such as ONS and services for discovery only provide exact traceability in supply chain of product products, the suggested platform provides effective real-time inventory management services to supply chain participants.

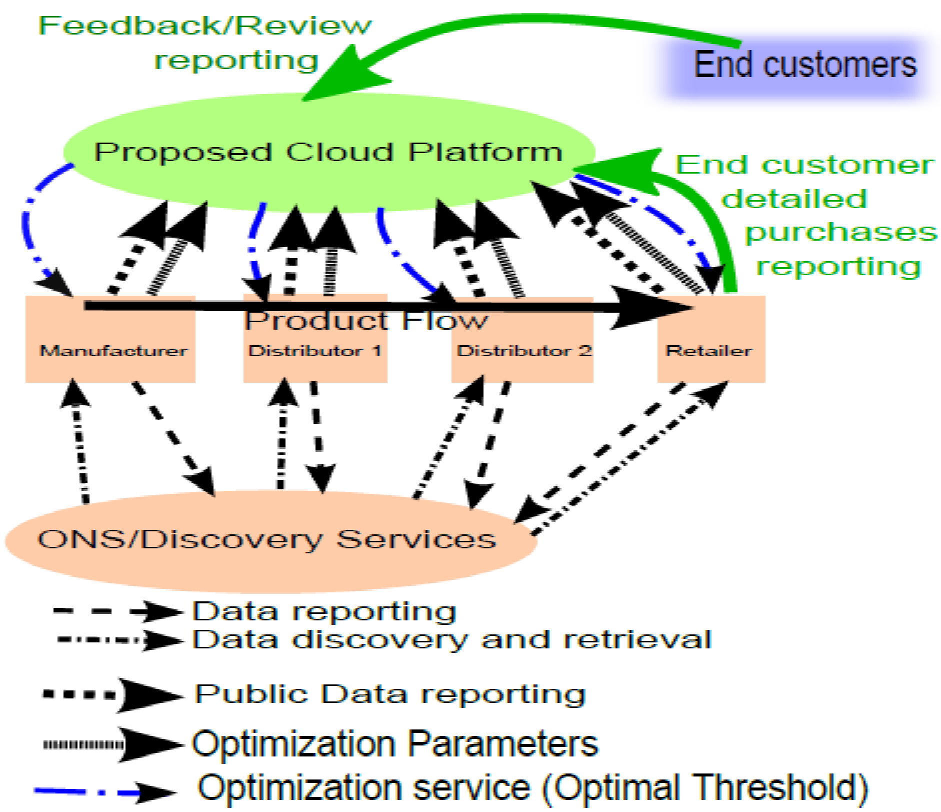

Fig 1. Proposed model vs Conventional model

The proposed model focuses on optimization.Optimization here refers that stakeholders attempt to balance two opposing goals; in particular, to prevent circumstances in which a commodity runs out of stock and reducing inventory in the event that a product runs out of stock prompting a purchase of such a thing.Realization of the information flow using a platform that is hosted in the cloud, where all data, relating to everything transactions in all supply chains, including retail transactions, is recorded and assembled. Additionally, customers can provide their opinions/comments on a specific product, which would aid in anticipating improvement model.

As system architecture depicted in Fig. 2, collaboration among three authorities to put the platform in use. Government agencies exclusively identifies each user before connecting them to a distinct household with a distinct address. Financial Authorities link each user to their respective debit, both prepaid and credit cards. Create an account on behalf of the company by using each organization's unique company prefix as identification,in order to make public EPC information on the product items reported on the site as they are traded via a supply chain.

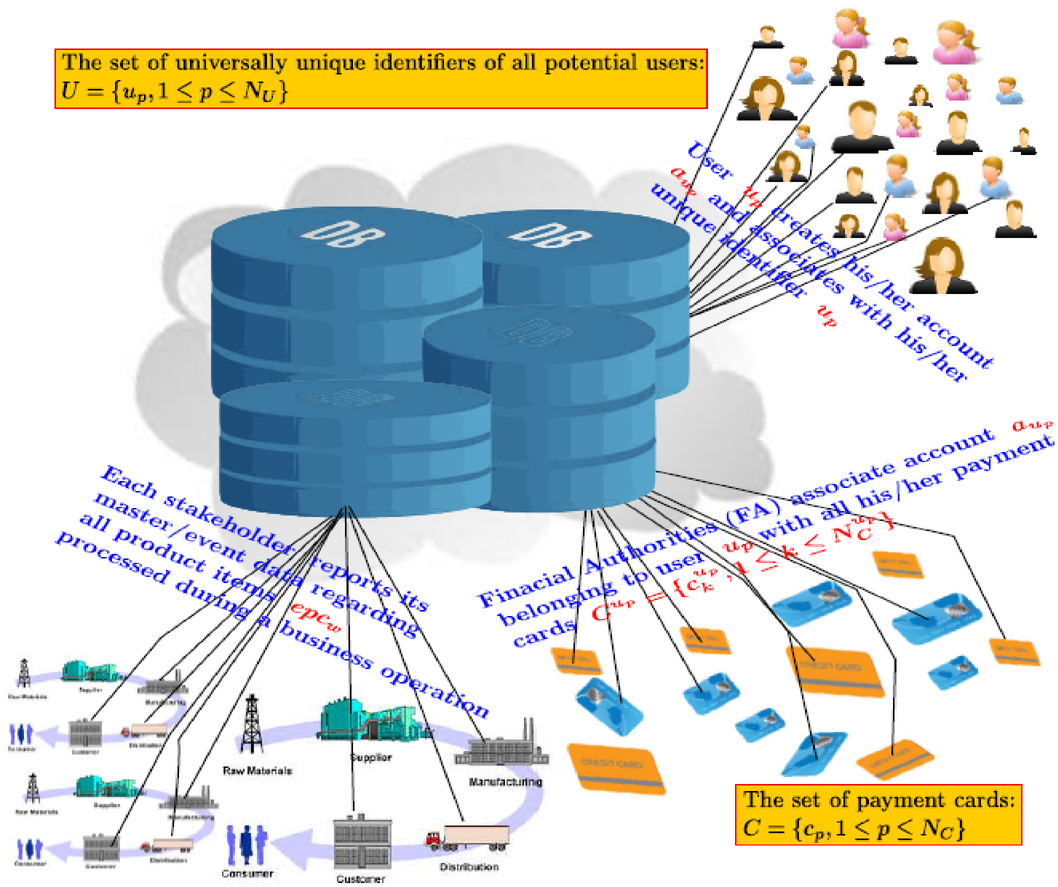

Fig 2 . System architecture of proposed system

The optimization model requires two types of input information;

1) Real-time Statistical Computation of Parameters: Once all the data is gathered in the proposed cloud-based platform described in section III-A, delivery rates i are computed real-time for each stakeholder Si, based on the purchase rate at the level of the last stakeholder in the supply chain;which is the retailer. Retailer is computed with regards to a given category y, purchased by end users within a time frame [t1, t2], in a location l1.

2)Real-time Probabilistic Computation of the Inventory Threshold: The up-to-date optimal inventory threshold conveyed by the cloud platform to stakeholder Si, in order to update its parameters. This real-time update of the inventory threshold would enable stakeholder Si to avoid a potential stock-out.

Conclusion:

In this paper, we have proposed an integrated Cloud platform offering real-time and accurate inventory management as a service for supply chain stakeholders. Using the parameters loaded by each stakeholder into the platform, and using the data collected by the platform, the optimization service computes, via a probabilistic model, the optimal ”inventory threshold”, to be considered by supply chain stakeholders in their replenishment policy. By optimal we mean that it minimizes the stock disruption likelihood, while minimizing the allocated resources. Analytical results have illustrated the efficiency of the inventory optimization service offered by our proposed cloud-centric platform.

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