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HARNESSING IOT STRATEGY FOR SUPPLY MANAGEMENT FOR THE MIDDLE AND SMALL-SIZED BUSINESSES

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1. Introduction

Supply-chain-management in businesses today have an important place as it involves the movement of goods physically from one point to another point thereby sometimes even having work-in-process inventory.

A supply-chain depends upon the product which is to manage in the business (Zhou, Chong, & Ngai, 2015). For example, it could sometimes be manufactured sub-parts like those of cars which are supposed to be assembled and then shipped further to the market or could also be the shipping of fruits and vegetables from a location where they are produced to the marketplace.

With the advent of IOT (Internet of Things), it is possible to now have a knowledge of all the items from the point they were raw materials to the point they arrived as products in the market. IOT basically helps us to tap information at every point of the supply chain process to increase the quality and the operational efficiencies of the product.

Using IOT in the supply chain management can positively make an impact on the following criteria to increase the operational efficiency and thereby increase the revenue of the business.

- Judging quality of the products

The quality of the products can be judged by the data collected through smart sensors. The RFID and GPS tags help in taking decisions related to the product quality by knowing the time of its arrival. If products have a shelf life, it can automate the decision to filter out those products whose quality is compromised.

- Fleet Management

The fleet management can be done by having shipping containers, delivery trucks, and even individual products connected so that there can be constant communication of information from the fleet about the products.

- Asset Management

The assets can be managed by IoT. Granular data like floor-from-store strategy can be obtained where data about products such as the temperature of storage, time on the shelf, dispatch date and location while dispatching is all done by IOT for better catering to the supply chain needs.

- Scheduling maintenance

By the advent of tracking the product and also having the minute details of each product, it is now easy to schedule maintenance at the warehouses, connecting hubs or storage centers. IOT enables a business to atomize the decision-making capabilities by considering a number of variables such as current storage temperature, product shelf life, time of dispatch and other details related to the warehouses. Thus, scheduling maintenance becomes an easy task due to the automated decision provided by IOT for a business.

The above-mentioned tasks have to be performed to fully automate the current supply chains so that they can sense and respond using the incoming IOT technologies.

However, there are concerns regarding the IOS device utility, like the constant versioning of RFID tags has caused the previously used tags to be useless (Rekik, 2011). Thus, businesses wanting to reap benefits of the IOT technology need to constantly invest in forth-coming technology.

Furthermore, only large-scale businesses are capable of bearing such high costs. The solution should be for the small and the medium scale businesses who can spend comparatively less amount of money and can still have the cutting-edge IOT solutions for their business.

The concept of collaborating warehouses has been around in business ecosystems (Jakšič & Fransoo, 2015; Qiu, Luo, Xu, Zhong, & Huang, 2015b). But, to host the IOT services and device better automated supply chains, the smart assets are also to be handled along with handling the technical problems related to integration of IOT devices having multiple different versions.

Hence, a model can be formulated with collaborative smart assets, husband warehouses to support the businesses of the similar ecosystem.

The research essay would firstly discuss about the strategies constructed to support IOT driven businesses such as: The bottom-up strategy (Reaidy, Gunasekaran, & Spalanzani, 2015) 6C framework strategy(Rong, Hu, Lin, Shi, & Guo, 2015) and Physical Asset and Service Sharing strategy(Qiu et al., 2015).

These strategies are discussed holistically from the point of view of small and medium-scale businesses. They guide to better understand and formulate the conceptual framework to address the problems faced by small and medium-sized businesses have in incorporating IOT strategies. Secondly, the conceptual framework and the semantic model is described. The conceptual framework is created on the drawbacks of strategies, so that it is totally accepted in the small and medium scale businesses.

Finally, the other factors affecting the schematic model are discussed to holistically understand the adaptability, use and the feasibility of the schematic model.

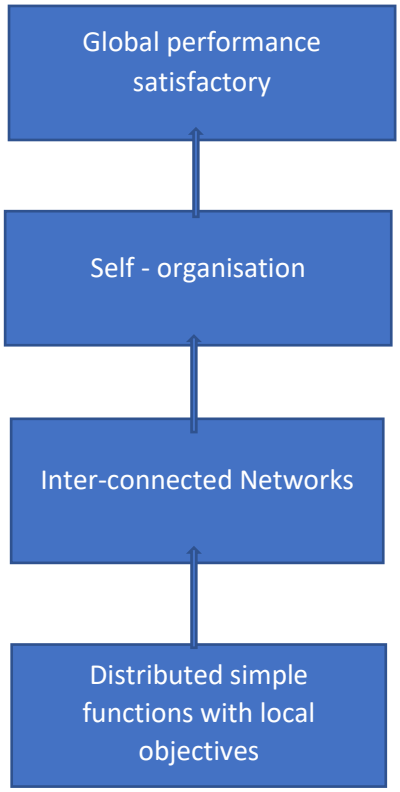
2. Strategies:

As stated in the introduction, with the advent of IoT, there are various ways to tap its usability in terms of using it for the business to procure its benefits into revenue equivalents.

The following strategies were created by researchers in order to help businesses adapt to the technology IOT brings to benefit their respective business ecosystem. To better define the strategic framework for building collaborative cost-effective supply chains, I came across the following key strategies developed by researchers to better define sustainable automated chains. They help in understanding and defining the key criteria to be considered while developing the conceptual framework and further the schematic model.

I. **The bottom-up strategy** (Reaidy et al., 2015)

The bottom-up strategy, states that the warehouses can be consolidated by the management of the ambient intelligence IOT provides (Reaidy et al., 2015). It states that instead of having highly structured procedure-oriented processes, we can have dynamic local processes driven by the information sensors, RFID tags, GPRS provide to have automated decisions taken.



(fig 1.1 Basic approaches involved in a production system. Derived from Reaidy. (2003))

The heart of the bottom-up strategy has self-organization, which means that there have to be processed which can work out the data holistically given by the inter-connected networks. It should be adaptive enough to make the entire process automated. The inter-connected networks give a common interface to the self-organization. However, there need to be complex algorithms driving the data to valuable insights at this level. In the business ecosystem, there would be occurrences of faults and failures within the system. The heart of the system, self-the organization would hence, not be a fault tolerant, as if it fails, the entire system would crash.

II. **6C framework strategy**(Rong et al., 2015)

In the 6C framework strategy, the researchers have argued that businesses should not simply create and customize the supply chain but create and define an entire business ecosystem. This business ecosystem would be governed by the perspective of 6Cs for the entire elimination of risk and uncertainty created by the use of IOT (Rong et al., 2015).

- Context- To consider the different barriers, drivers, mission, and life-stages of the business process
- Cooperation- Co-ordination or governing mechanism through which partners might want to communicate with each other

- Configuration- To consider the pattern or the external relationship
- Change- Reflecting the pattern renewal or the co-evolution of the business ecosystem
- Construct- The structure as well as the infrastructure to govern the processing mechanism of the system
- Capability-Ability of communication, learning, adaptability, and integration decide the capability of the business for the technology.

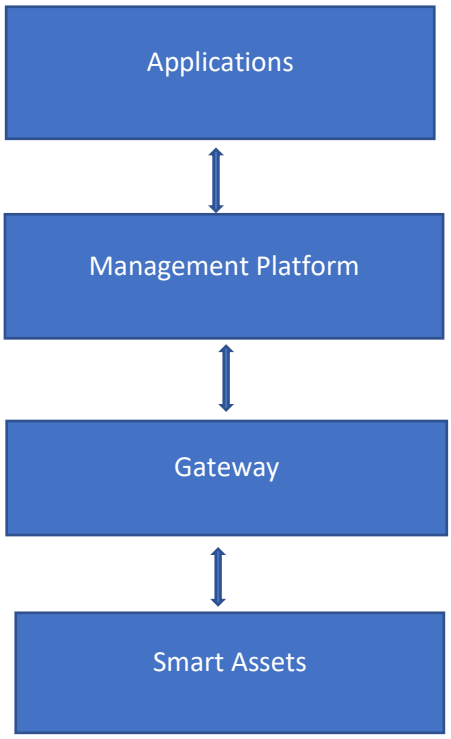
The 6C framework strategy is quite lucrative in terms of the quality an IOT enabled system should be like. However, there is no description given to incorporate the 6Cs for small or middle-sized businesses. The cost is an important factor to be considered while implementing any framework or strategy.

Also, the quality of any IOT driven system is determined by the business ecosystem in which it is introduced. That means that some business ecosystems like engine parts of a car may not have criteria like shelf life, the temperature to be judged for deciding. The business ecosystem primarily defines the amount of granularity, the devices should sense.

III. **Physical Assets and Service Sharing** (Qiu, Luo, Xu, Zhong, & Huang, 2015a)

In order to address the problems of unreliability in Supply Hub in Industrial Park (SHIP), the strategy of Physical assets and service sharing is introduced by researchers(Qiu et al., 2015).

It primarily contains the following sub-strategies:



(Fig1.2 Strategy for Physical Assets and Service sharing, Derived from (Rong, Hu, Lin, Shi, & Guo, 2015))

I. Smart Assets: They are the assets which can be enabled with auto-ID devices such as RFID tags, GPRS, sensors. They are essentially only those devices which can sense and communicate data.
II. Gateway: Gateway is that part of the system which collects data from the other interfaces of the system. Data from smart assets is gathered and sent to the gateway. It has the ability to temporarily store data and perform actions on it.
III. Management Platform: The management platform is responsible for projecting the data to various applications via the internet. It has decision support management, service management, data management features as well to help project data sensibly
IV. Application: The applications are primarily pertaining to the service sharing operations and asset support. They are devised to manage the service or assets of SHIP.

The SHIP has managed to provide a well-conceptualized strategy for addressing the problems of the uncertainty of IOT based supply chains. By Physical Asset and Service Sharing, collaboration can be obtained. However, the management platform has to handle varied applications such as:

I. Decision support for the asset and the services provided by the connected warehouse or hub.
II. Data management and storage for the support of automated decisions.
III. Creating interface with the application interface so that the interface can query the data.
IV. Emergency control mechanisms to support the shared assets and services
V. Automated processes to control the asset and services at the hub or warehouse when no precise input is given through the application
VI. Fleet control by supporting automated processes

The number of tasks and their complexity might create an overload in practical as a lot of decisions about the entire IOT enabled-service are to be taken up here. The whole point of bringing up IOT technology is to automate the entire chain with little or no human intervention. The automation of the entire system, in this case, is conceptually according to the researchers conducted at the management platform. However, the practical implementation of this platform might need to have tiers to decrease the load. Also, the failure in the management platform may cause the entire automated system to collapse.

I believe that there has to be the distribution of tasks in order to make the system fault tolerant and more automated.

3. Conceptual framework and semantic model:

I. Conceptual framework

As seen from earlier strategies, the supply change management strategies need to be optimized in order to

- Reduce the uncertainty caused by the use of IOT devices.
- It should have the ability to integrate with the existing interfaces
- Should be capable of supporting automated decisions.

Small-scale and medium scale businesses, in reality, are not able to use IOT for optimizing their supply chains as they cannot invest in IOT technology and fund its's service requirements (Rekik, 2011). Thus, the question is to make IOT available to the small scale and medium scale businesses to optimize their supply chains by

- Customizing them according to the needs of their businesses
- Collaborating the supply chain so that the IOT set-up costs for all the businesses are reduced in totality

The conceptual framework for the schematic model developed further is as follows:

- Seamless integration of all the IOT devices

With the advent of new IOT technologies, RFID tags are continuously being modified and new being introduced to the market. Thus, the previous ones become useless(Huang, Qu, Fang, & Bramley, 2011). The need for integration is felt at this level, where multiple versions can collaborate for an entire system to function, thereby reducing the costs of investing in the new technologies.

- Automated decision system with distinct processes

The need for automated decision is an important factor in judging the quality of the IOT powered systems. There are two kinds of strategies defined for implementing IOT into a system. They are platform strategy and tailoring strategy (Ng, Scharf, Pogrebna, & Maull, 2015). Platform strategy is where the tasks are generalized for an IOT driven business ecosystem whereas tailoring strategy is the process of catering tailored processes to each of businesses.

To support the concept of collaborative warehouses and assets in order to reduce the costs sprouts from both the ideas. Assets and the warehouses should be managed in such a way that they can house the needs of individual ecosystems as a whole.

- Collaboration to bring down the setup cost

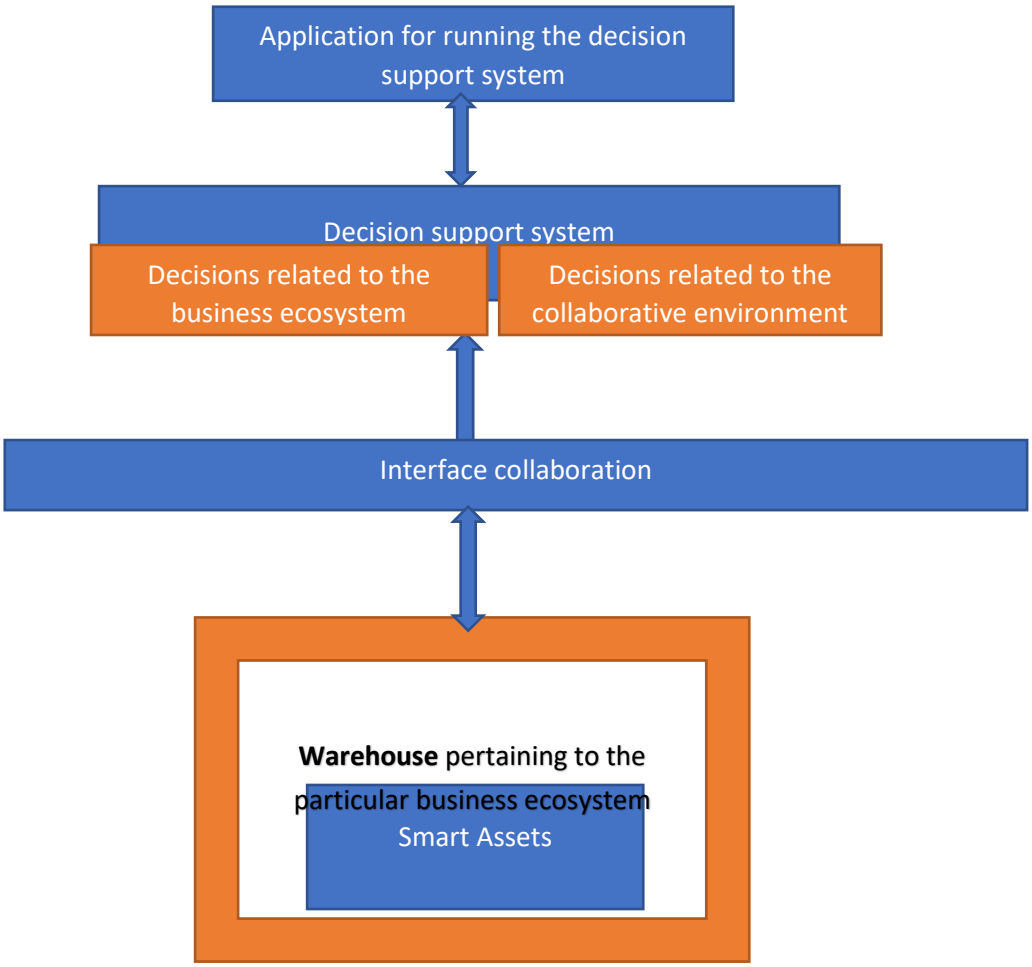
The initial and continual investment in RFID technology has become a heavy fiscal burden (Rekik, 2011). Integration of the setup lowers the cost. Housing similar chains in a particular hose or warehouse may help further in reducing the costs. The market pull which refers to the new market needs and technology push which refers to harnessing new technological approach is the needs of businesses with similar ecosystems (Li, Hou, Liu, & Liu, 2012). For example, dairy and grocery businesses would require the warehouses with similar functionality. Hence, they can be clubbed together to bring down the setup costs.

II. Semantic model

The schematic model is hence described to device collaboration of assets, management systems, and applications at all the levels by standing by the 6C framework strategy(Rong et al., 2015) and making use of the multi-agent system for better decision support. However, when talking about a collaborative environment for all the business ecosystems it becomes restrictive in the types of supply chains it can support. For example, there can be collaborative warehouses built for dairy, vegetable and fruit industry. The collaborative warehouses would share common necessities such as:

- Sensors for detecting the temperature of the warehouse
- RFID Tags for each container
- Smart Cameras
- Smart locks
- A fleet with RFID tags or GPRS with temperature control facility

The schematic model for the stated objective is as follows:



(Fig 1.3 Schematic Model devising collaboration)

The schematic model given above is constructed with the idea of eliminating the uncertainty of the IOT devices, as well as to bring down the individual costs of installation related to the designing and service of each model.

The essence of this schematic model is to derive processes which are capable of controlling the environment of the shared hub or the warehouse as whole and then to cater individual business ecosystem needs which can be accommodated by the warehouse or shared hub.

I. Smart Assets

Smart Assets at all times would be common to all the business ecosystems, thus bringing down the costs of the chains.

Smart Assets can be among the following:

- Fleet management – RFID and GPRS enabled tags to track down assets at all times, for example, the time they would reach at the intended location, the shelf life of the asset, the time needed for the transportation
- Warehouse monitoring - Smart locks, temperature sensors in the warehouse needs to be temperature controlled, container tags attached so that there is an all-time record of the asset which is present inside the warehouse.
- Tags on the Assets – In some cases, individual assets need to be tagged.

II. Interface collaboration

- Interface collaboration is essentially a separately defined part of the system as it is responsible for integrating all the information from IOT devices sensing information from the assets and the warehouse. It is also responsible for upgrading the system as and when new assets are added. Interface collaboration is responsible for the durability of the system and hence is also making the system fault-tolerant. As stated by the 6C framework strategy, it is responsible for the following (Rong et al., 2015)
- Cooperation – the cooperation of the interfaces
- Change - change when introduced by the new devices for enhancement of IOT technology
- Capability- the ability to learn and communicate seamlessly
- Construct- the ability to construct new patterns to further deliver insights to the decision support system

III. Decision-support system

The decision support system is more devised upon making the system processes customizable to the business ecosystems and also maintaining the standards of the collaborative warehouse. The distinct customizable processes are according to the business ecosystem, are designed to address specific business needs such as:

- To control the dispatch time of the assets
- The data related to the quantity assets have at a particular time in the warehouse
- The quantity dispatched and arriving through the fleet.

- The time is taken to travel while assets are in transportation

The decisions related to the collaborative warehouse, especially in terms of controlling the assets are of a higher priority. That is, for example, if the smart lock is broken and there is an alert sensed regarding security, all the other customized process related to fleet and transport have to be stopped in order to not make any more damage in an emergency situation like this. It should, in turn, send alerts to the police and make the RFID tags attached to the assets in an active state so that the assets can be tracked later on.

Thus, it should be able to control tasks such as:

- The temperature of the warehouse or the hub through temperature sensors
- The smart locks installed
- Emergency events at the warehouse
- Track of all the assets that come and go to judge the free capacity at any time

IV. Application

The application running for the decision support system may have two categories:

- Warehouse administrator:

The warehouse administrator can feed in the data needed to control the warehouse holistically.

- All general warehouse alerts can be seen through this application.
- The general repair and maintenance alerts should be visible.
- General information about the list of businesses scheduling their assets with the quantity via the collaborative warehouse.

- Warehouse user (from the business):

The business official who wants to use the collaborative warehouse should have information such as:

- Assets in the warehouse
- Their shelf life and alerts if nearing to the expiry of the asset
- Fleet management details, such as when were the assets transported, where were they transported, the next scheduled dispatch
- The costs incurred upon using the warehouse

4. Other factors affecting the schematic model

I. Strategic Decisions

In order to support the decision related to the automated supply chains, get-ahead strategy and catch-up strategic decisions would make an impact on the schematic model as a whole (Li et al., 2012). The get-ahead strategy in business is to make use of IOT devices in such a way that it supports innovation. It is the formulation of new techniques to better automate and integrate chains. This would primarily affect the decision system of the schematic model. The trends of the markets dictate the future needs of a particular cluster of the business ecosystem. Understanding them would help in bringing out the most of the collaborative warehouse and smart assets.

Also, the get-ahead and catch-up decision in terms of technology are to be addressed by the interface collaboration of the schematic model. A good degree of integration and the optimal replacement of IOT devices would facilitate these strategic decisions.

II. E-commerce triad

The buyer, seller, and the service provider, all have relationships with each other. The buyer would buy goods which are more innovative from the market or the e-store, the seller would produce goods by selecting the most efficient service provider (YU, Subramanian, Ning, & Edwards, 2015). Thus, the schematic model should consider what services the sellers would like for facilitating their intended products through the service provider. At the application level of the schematic interface, the kind of features provided are to be designed with respect to the granularity and diversity they provide for helping out sellers take better-optimized decisions.

III. From Global Supply Chain point-of-view

For effective solutions through the automized supply chain, full integration with the internet and also integration across many allied business entities (Ghiassi & Spera, 2003). The interface collaboration in the schematic model are hence supposed to be web-centric, cloud-based systems. Also, the tasks handled by the interface collaboration and the decision system built in a heterogeneous computing environment are well worthy of sensing and responding to tasks better. Also, with the advent of the e-marketplaces, there is a huge capital investment done in the B-2-B, that is, business to business transactions (Ghiassi & Spera, 2003).

The design of such automated supply chains for business ecosystems have e-marketplaces to incur important revenue gains in the near future. (Ghiassi & Spera, 2003).

5. Conclusion

In this research essay, I have proposed a schematic model for collaborative use of smart assets (RFID tags, GPRS, actuators, sensors, smart locks), collaborative warehouses and hubs for small-scale and medium-scale businesses to reap the benefits of automating supply chains using cutting edge IOT technologies.

To better understand the requirements of sustainable IOT automated supply chain, the strategies previously developed by researchers are indicative of the innovative ways to define solutions for businesses. After interpreting the distinct strategies, I have concluded that the researchers are discussing the features (6C Framework Strategy, Bottom-up strategy) without any consideration of the collaboration done to minimize to technology costs(Reaidy et al., 2015; Rong et al., 2015). The strategies making use of collaborative technologies on the other hand (Physical Assets and Service System) did not consider the load created on the layer where the automated response was to be generated for all the processed information (Qiu et al., 2015). After assessing the strategies at the first stage, the foundation for the conceptual framework is clarified. For creating cost-effective solutions, the conceptual framework revolves around the three most important concepts: integration, automized decision support and collaboration for designing a simplified system.

Thus, a schematic model is proposed which collaborates smart assets and warehouse. The decision-making processes have been simplified to only those customizable to businesses and the warehouse as a whole. Thus, giving better control through the application interface to the warehouse administrator.

The ability to customize in a collaborated environment is the most beneficial outcome of this schematic model. The tailoring of IOT enabled processes has always been preferred over the generalized processes (Ng et al., 2015). This has caused more expenditure and given only a niche market for IOT technologies to operate. By collaborating IOT driven technologies for common business ecosystems, we can have a customized yet collaborative approach for automating supply chains.

Further, the schematic model can have the strategies of the 6C framework adopted easily due to the simplicity in each layer. Though, the business ecosystems which the warehouse is housing would holistically determine the needs and the granularity of each need.

Also, the schematic model is affected by other factors as described in the research essay as strategic decisions, e-commerce triads and global-supply chain which are to be considered when designing the model as well as selecting the cluster of business ecosystem it would host(Ghiassi & Spera, 2003; Huang et al., 2011; Li et al., 2012) .

Thus, by adopting the simplistic approach, the schematic model can customize and at the same time collaborate to lower down costs of a cutting-edge IOT technology and make them a popular utility for small and medium-sized businesses.

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