Effect of RFID on Organizational Performance: The Mediating Role of Supply Chain Performance

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Effect of RFID on Organizational Performance: The Mediating Role of Supply Chain Performance

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ABSTRACT

Purpose: The aim of this paper is to examine the influence of radio frequency identification (RFID) deployment on firms manufacturing effectiveness and efficiency, and ultimately its impact on organizational performance via supply chain performance.

Methodology: To test RFID deployment and supply chain and organizational performance model the questionnaire was developed. The data was collected from 104 middle level and front-line managerial employees of three (3) organizations. Structural Equation Modelling (SEM) technique was used to analyze the data in order to test the hypotheses.

Findings: Findings point out that deployment of RFID leads toward enhanced manufacturing effectiveness and efficiency, enhancement in effectiveness lead the organization toward better supply chain. Findings suggest that firms can adopt RFID technology to boost up their performance in terms of manufacturing effectiveness and efficiency and supply chain performance. According to the data provided by the respondents, the efficiency outcomes has not influence the organizational performance.

Research implication: Being the first research about RFID in Pakistan, and also this paper is dealing with so many variables that were not deal at the same ever in Pakistan. This research is also providing the guidelines to managers that how they can improve their efficiency.

Research contribution: This study initially focusing on RFID deployment in manufacturing organizations, and providing the directions to managers, that it should be use in all activities so that they can create better link with buyer and suppliers. This paper will provides evidence that RFID deployment is leading the organization toward improved organizational performance and supply chain performance.

Limitation and Future research: This paper is focusing only on manufacturing organization, but RFID technology can also be equally fruitful in service providing organizations. Secondly this data is collected on initial stage of this technology deployment, as it will be widely acceptable it will provide much better results.

Keywords: Organizational performance, Supply chain performance, Manufacturing effectiveness, Radio frequency identification (RFID) technology.

Article classification: Supply Chain Management

INTRODUCTION

Radio Frequency Identification (RFID) radio frequency transmission is describing a system that transforms the identity (in a serial number that is unique) of the object or a human being using a wireless media i.e. radio frequency. It comes under the broader category of the automatic system that consists of identification technology. It is used around all over the world now a day for the security purpose. Not like Universal Product Code (UPC) technology it does not need contact for communication. This data can easily be read by humans and by non metallic materials.

This system containing these three components:

1. A coil or antenna: That releases the signals to activate the tag.
2. A decoder: Reader catches the waves in a particular range regarding with its power.
3. An electrical program with information those are unique.

Purpose of this system is to transmit the data by a device that is portable and known as 'tag' which is read by the reader and it processed by the different applications according to their needs. It provides information about location or identification and about specifications such as colour, price, product tag and purchasing date. This technology is used for decades by many companies and it gained very quick attention due to its abilities of moving object, as this technology has been refined and invasive uses of RFID increases.

This technology can be used in different ways and for different purposes.

1. **Tracking the assets**
   RFID technology is mostly being used by the companies for tracking their assets, due to the fair of stolen and theft. Also be used for the incoming and outgoing assets so that they can keep the record.
2. **In manufacturing**
   It can use in the manufacturing process so that product can be safely moved from one department to another.
3. **Managing the supply chain**
   This technology is being used in supply chain that is close-loops, either in departments of the single organization or in total supply chain (from one end to another end).
4. **In retailing**
   RFID in now being used by Metro, Wall-Mart and best buy. It helps the retailers to manage the supply on the time when it needed.
5. **In payment systems**

   This technology is being used in payment systems for the safe transactions and convenient mechanism for payment. Tag system helps the organization to make a transaction more safe and convenient.

By adopting the RFID will lead the organization toward the improvement of the organizational performance and the performance of the supply chain as well, as it provides benefit to internal customer and being efficient and effective with the supplier and helps to reduce the production cost that will lead toward the low prices (**Green et al 2009**). If we see it from the supply chain ends, the utilization of this technology results to improve the partner satisfaction, accurating the logistics and by reducing the physical requirements and providing the facility of just in time order system and by reducing the uncertainty of flow of material **(Cannonetal.2008).**

RFID has ability that it can influence the efficiency as well as the effectiveness of supply chain, production and manufacturing operations. Also defining and describing the outcomes of efficiency and effectiveness and the role they have play in utilization of this technology. The mode is antecedent to the efficiency of the outcomes and the supply chain as well. Simply supply chain is involving end consumer purchasing the things (like goods and services) from the store of a retailer or from the website. Retailers buy the goods normally from distributors of the particular company. And distributor purchases goods in bulk quantities from the producer or from manufacturer and he purchase the material from supplier. Organizations and the businesses always strive to make the supply chains

more effective by improving the system of information, all parties has share their forecasting on constant basis. To improve the information system all parties are trying to apply the technologies that are new coming, one of the technology is RFID. This technology impact on the different nodes of the supply chain and it can be benefited for all the nodes.

In this modern era RFID technology is capturing the attention of many companies that are leading and spending a significant amount of time and money so that this technology is feasible with their operations. The main goal is the leverage their internal structure of this technology so that they can capture real time information of their entire business and with their trading partners. RFID is deploying on the basis of open and standardized engineering, procurement and construction interfaces that are enabling implementation in multivendor in data sharing globally. Electronic product code (EPC) and RFID are being used by department of defence US government, and Wall Mart to gain the improvements in operations visibility of inventory, to reduce the lose and depreciation, tracking the lots and expiry dates of that lots, managing the data relating to work in process, giving the serial numbers that are unique to all the items and sharing the data about EPC with partners of supply chain. This system was design to tag and manage the assets effectively. EPC is structure of data developed an ID which is auto, and it is capable to adopt other standards or coding scheme in it. RFID and EPC are only applicable and beneficial for those whose whole supply chain has adopt this system if the nodes of the supply chains are not collaborated with each other, then it this technology can not provide any benefit. Due to its cost efficiency most of the market has been attracted by this system and they are going to adopt this. RFID is promising greater efficiency in supply chain. New advancements in this technology gave it a great prominence and the adaptation at high level, tags not required anything like bar code and this help to eliminate the additional cost of scanners. Broad range of tags makes the communication easier and it helps to good decision making, it can also be attached with the sensor so that the temperature and movement in other conditions of movement can be recorded tags are more durable and can be use in any kind of environment, it also helps the organization that where the assets are and in how much quantity is available. Because the superior quality and great features most of the companies are adopting this system, the results benefited are as follows, automation of process, security of assets, monitoring of the environment, reduction in labour cost, managing the inventory smartly, automatic arrangements of docks, automatically replenish the inventory, automatic payment authorization and automatic control of goods returned from the customers.

LITERATURE REVIEW

A system consists of subsystems that interact with each others to achieve the common goals, and research tells us any action takes place in one part of a system affects other subsystems and the whole system as well. In this way, the supply chain is also influenced by the actions of the members of the supply chain that are sharing the resources and information so that they can achieve their common goals (**Green et al. 2009).**

In this study, we will discuss the efficiency of manufacturing and effectiveness outcomes, and in addition we will discuss the performance of supply chain and performance of the organization also.

RFID utilization:

Study conducted by (**Vijay araman and Osyka 2006)** and (**Reyes et al. 2007**) it enables us to understand in better way that why this technology has to be used along the challenges that an organisation will face.

In studies that are prior mentioned, most of the respondent are not considering the implementation of this technology with the reason that it is not applicable to our business, because there are the benefits of this technology that are not much unforeseeable and the cost as well.

This also takes into consideration that all the programmes that are previously designed to enhance the effectiveness and efficiency of the organization, just like total quality management, has some short falls might be due to not taking interest or lacking behind from the side of higher management in the

sense of commitment or might be due to limitation of applied resources and might be due to work overload **(Soltani et al. 2005).**

These previously described reasons might also affect the decision of the organization that weather they have to implement this technology or not and the degree to which this technology implementation is being successful or not. Studies that are above mention are discussing the reasons that why this technology has to be deployed, (**Vijay araman and Osyk,2006**)and how fastly organization are planning to implement this technology **(Reyes et al., 2007)** so that products and inventory becomes more visible and it will help to automatically replenishment of the inventory.

These studies founded the top reasons of the cost saving, one of them is to reduce the situation of being out of stock, secondly by minimizing losses in case of inventory handling and also help to reduce the labour cost because they have to handle less material. In another study (**Reyes et al. 2007**) improvements were realized just like availability and most important the accuracy of information, level that how much the process is atomized and customer services level and cost of labour.

Now a day's firms are going to adopt this technology and having expectations that this technology will help them to improve the productivity of supply chain and the financial performance of an organization **(Green et al. 2009).** Organization, i.e., airbus and Boeing are considering this technology as a value addition because it has a potential in their supply chain **(Ryes and Frazier, 2007**) It is founded by (**Co and Barro2009)** if this technology is forcedly implemented so that the organization can improve their performance, but the supply chain partners compelling to go will traditional method and not showing the urgency it would leads to effectiveness. Another model that is analytically assessing the benefits and the cost of application of this technology in a particular segment of fast moving consuming goods (**Miragliotta et al. 2009).Visich et al. 2009)** investigates impact or this technology on performance of supply chain. The benefits investigated are divided into three parts: informational, transformational and automation.

Automation relating to value driven by most efficient processes as reduction in labour cost improving the replenishment of inventory, time reduction in processes of shipping and receiving.

Informational is relevant to ability that technology must have to gather, process, store and to distribution of information which leads to high responsiveness, reduction in wastage and defiantly improved assets utilization.

Transformational effect leads towards totally new direction or process innovation or redesigning of process.

Effectiveness and efficiency out comes:

Primary purpose of supply chain is to generate worth and to construct a competitive infrastructure providing the leverage to worldwide system of logistic, synchronizing the supply and demand and measure the performance at worldwide level. **(Blackstone, 2008,)**

Company's competitive edge is always influenced by the effectiveness and efficiency (**Hunt and Duhan 2002).**

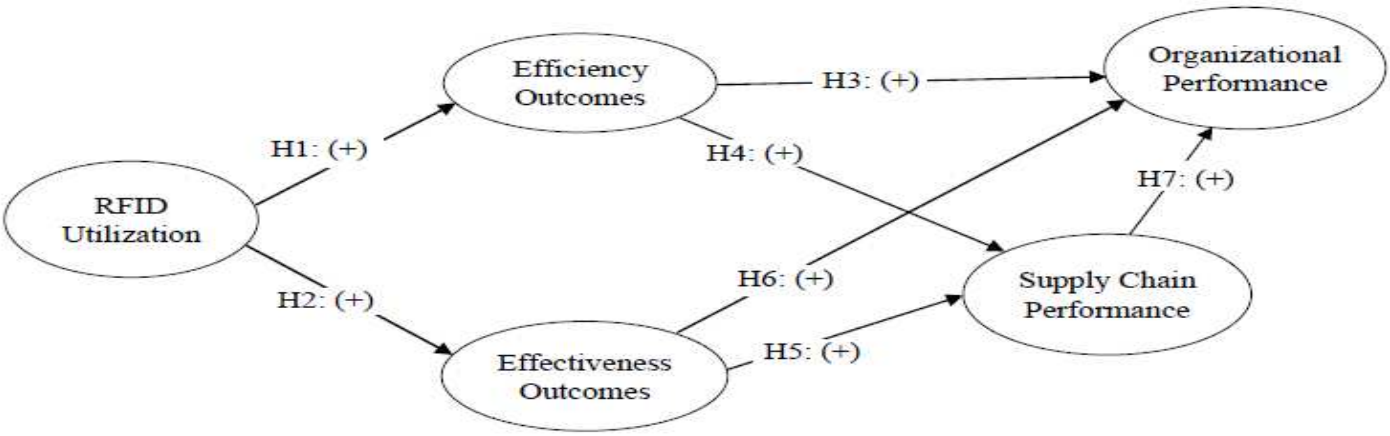
Supply chain can never be effective and efficient and the same time, firstly it will go for effectiveness (customer satisfaction) and then it will move toward efficiency in performance (**Vokurka and Lummus, 2000 ;)**

Theoretical frame work:

We have proposed RFID deployment and outcomes of performance model focusing on efficiency and effectiveness, this model has been design by taking a manufacturing firm under consideration, that RFID utilization within the manufacturing organization precursor to efficiency and effectiveness and that both will precursor to the performance of supply chain and performance of the organization.

The figure 1 will more clarify you about this statement

Figure 1:



This model having seven independent hypotheses and several individual relationships has been investigated, previously no comprehensive study is being investigated and we are sure that this investigation will contribute significantly in the literature.
This model is supporting the integrated investigation of RFID technology's capability that either it is enhancing the effectiveness and efficiency or not, and resulting this improvements in performance of supply chain and organizational performance will be there, this also clarifies that the RFID has an impact on both supply chain and organizational performance.

Theory also suggests us that if there will be any change in one part of the system it will bring the change in other parts of the system. It also tells that RFID is being adopted for control of inventory at organizational level will improve the efficiency of operations and also helpful in reducing cost. Efficiency increases in sense of better customer satisfaction as the quality, quantity and provide good according to fashion timely, it also help an organization to provide the products at cheaper price that will also lead toward customer gaining and satisfaction.
The decision to adopt RFID is not only impact on manufacturing but organizations marketing and supply chain functions as well, also help to satisfy the downstream of the supply chain and final to end consumer.

Hypothesis:
H1: efficiency outcomes are positively influenced by the deployment of RFID technology.

it proposes that utility theory is the explanation of increase efficiency associating RFID, (**Angeles' (2007),** theory suggested that organization has to use these type of tools so that their efficiency can be increase, use of RFID is going to lead decrease in stock level because the capabilities of tracking and automatic identification system of RFID reduce the number of misplacements of items, also increase efficiency in process of shipping **(Stambaugh and (Carpenter, 2009).**
H 2: effectiveness outcomes are positively influenced by the deployment of RFID technology.

(Vijay araman and Osyka's 2006) provides that firms are expecting that RFID will improve the efficiency, their expectations are being supported by the visibility and availability of product and information allows quick response to change.
By investing in deployment of this technology in the processes of organization it will enhance the availability and reliability of information so that organization can respond more quickly and in effective manners to the upcoming changes **(Vijay araman 2008).**
H 3: performance of the organizations positively influenced by efficiency outcomes.

Performance of organization is always calculated in the form of sales, net profit and ROI (return on investment). Efficiency enhancement always help to produce goods at cheaper cost, and as the goods produce at low cost it will provides to customers at cheaper prices and this will leads an organization towards greater profit making organization **(Hunt and Duhan 2002).** It has been founded by **(green 2009)** there is a positive relation exists between utilization of RFID and performance of the organizations.

H 4: performance of supply chain is positively influence by the efficiency outcomes.

Performance of supply chain is always calculated on the basis of abilities of the partners of supply chain that how they can satisfy the end consumer and final consumer can only be satisfied if he is provided with low price than our competitor is offering (**Hardgrave 2006).**

Organization has need to invest in infrastructure of RFID, so that partners of supply chain can easily access the accurate information and when they have proper access to information they can easily solve any kind of problem (**Herrera and Lora2005).**

H 5: Performance of the supply chain is positively influence by effectiveness outcomes.

Organizations have to be more effective to satisfy the immediate customer. This emphasis on immediate consumer with believes that if immediate consumer is satisfied then the final customer will also be satisfied. RFID technology can also be helpful in forecasting, effectiveness outcomes can be derived by seeking the market access and strategic assets **(Bernard 1968)**, **(hoofer and schendel 1978).** By forecasting and information system, organizations ability can be increase to deliver the products on right time and logistics cost can also be saved by delivering the supplies of precise quantities and it will leads an organization toward more effectiveness via eliminating the late, incomplete orders **(McFarlane and sheffi 2003).**

H 6: performance of the organizations is positively influenced by effectiveness outcomes.

Ability of the organizations to respond quickly to the changes in consumers demand can be calculated by outcomes of effectiveness. Performance of the organization can also be judge through its capabilities and values that it is providing to the consumers (**Eden 2002).**

Consumers that are highly satisfied will become loyal and suggest to others as well, this will lead an organization toward more profit making that results better financial performance of an organization (**Lim and koh, 2009).**

H 7: Performance of the organizations is positively influenced by performance of supply chain.

Mangers are directly responsible for improving the organizational performance and they are supposed to be accountable for that. Manager has to consider the influence of strategies on partner of the supply chain, that his organization has build. Performance of the organization can never be directly improve or enhance until its supply chain is not fully supporting, any problem in supply chain can also influence the competitive advantage and performance of the whole organization as well **(Meredith and Shafer 2002).** Performance of the organization can only be optimized when all the partner of supply chain are adopting the strategic approach **(chopra and meindle 2004).**

Capabilities of the organization to fulfilled the requirement of the final consumer and to remove all the problems like delay, unfilled order or any other, will lead the organization toward better performance of the organization, and it will not possible without the capabilities of the supply chain **(Green et al 2009).**

METHODOLOGY

Process of data collection:

The data was collected through questionnaires during the month of May 2012. Approximately 150 questionnaires were distributed to the front line managers (operations, engineering, purchase and plant manager) and supervisors (operational and production) in 3 organization of Faisalabad using RFID technology, out of which 104 respondents participated actively in the survey. Intention of this survey was to study that how the RFID works in manufacturing process of the organization with a believe that the persons that are working on the plants have a great

knowledge about their jobs and about the manufacturing plant and its process, so that they can provide us a detail about how deployment of RFID enhancing the effectiveness and efficiency, and how do these both lead the performance of supply chain and performance of the organization. Management of corporate levels is only making the policies and strategies, but the individuals who are working on that can provide a better 'know how' about that technology, so that's why we chose this method of conducting a survey.

Scales of measurement:

Outcomes of efficiency are Operationalized on the basis of stock level, total cost of supply chain and cost of claiming the warranties, times taken by the completion of cycle of cash and how much time it will take to refill the inventory **(Cohen and roussel 2005).**

Outcomes of the Effectiveness are Operationalized on the basis of delivery speed, accessibility and correctness of information, client's facilitation level and how urgently organization is fulfilling the customer's order **(Fynes 2005).**

Performance of the organization is operationalized on the basis of net profit, returns from investment, growth in profit and returns on sales, Efficiency is always linked with activities that are costing low in input process **(Hanvey 2003).**

Performance of the supply chain are Operationalized on the basis that how much an organization is able to resolve the problem of late delivery, unfulfilled orders and how quick an organization is capable to resolve the problems **(Green 2007).**

RESULTS

Assessment of measurement scale:

In order to test the reliability and consistency we used exploratory factor analysis and Cronbach's Alpha test. The results indicated that the instrument is consistent and reliable.

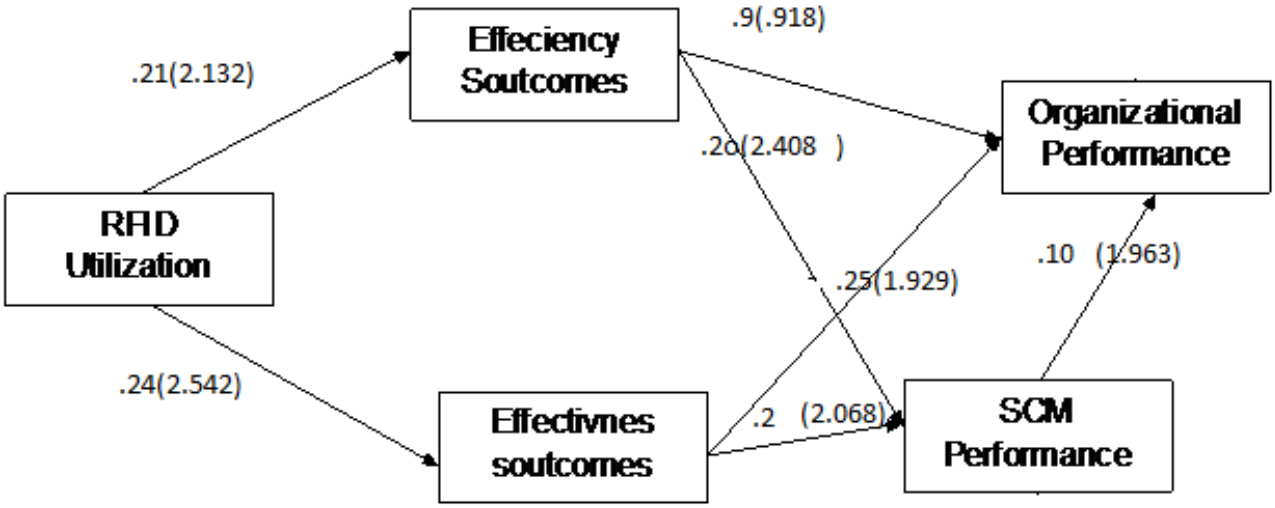
In order to test the hypotheses, structural equation modelling technique was used. Any goodness of fit test can be apply to test these result, commonly used measures and guidelines are goodness-of-fit index (GFI) value must be larger than 0.90 **(Ahire 1996),** non-norm-fit index (NNFI) and comparative-fit index (CFI) values must be larger than 0.90 **(Graver and Mentzer 1999)** and Cronbach's coefficient alpha must be greater than .70.

Correlation matrix

	Mean	SD	RFID utilization	Efficiency outcomes	Effectiveness outcomes	SCM performance
RFID utilization	4.1207	.22602				
Efficiency outcomes	4.0827	.31235	.206(*)			
Effectiveness outcomes	4.1651	.27528	.243(*)	.167		
SCM performance	4.1135	.28796	.248(*)	.257(**)	.231(*)	
ORG performance	4.1106	.33017	.206(*)	.146	.225(*)	.163*

Notes: *p<0.05, **p<0.01, *N*=104

Figure 2:



Note: Chi-square =6.14, DF=3, CMIN/DF=2.137, P<0.05, GFI=.976, NFI=.821, CFI=.967

Six out of seven hypotheses are supported by the standardized estimates. The relationship between RFID utilization and efficiency outcomes (H1) is significant at level 0.05 with an estimate 0.21. The relationship between RFID utilization and effectiveness outcomes (H2) is significant at level 0.05 with an estimate of 0.24. The relationship between efficiency outcomes and organizational performance (H3) is not significant at level 0.05 with an estimate of 0.95. The relationship between efficiency outcomes and supply chain performance (H4) is significant at level 0.05 with an estimate of 0.207. The relationship between effectiveness outcome and supply chain performance (H5) is significant at level 0.05 with an estimate of 0.202. The relationship between effectiveness outcomes and organizational performance (H6) is significant at level 0.05 with an estimate of 0.225. The relationship between supply chain performance and organizational performance (H7) is significant at level 0.05 with an estimate of 0.111.

Discussion:

As it has been previously written that it is the prediction of theory that if we take an action in any function of the organization it will lead toward change in whole system. Main purpose of this study is to check that how much RFID deployment affecting the outcomes of efficiency and outcomes of effectiveness as well. Taking literature as base a model was constructed and hypotheses were tested. RFID deployment on the basis of flow of stock, raw substance, finished goods and stock level have significant impact on both outcomes of efficiency and outcomes of effectiveness. Performance of the organization is not been effected by efficiency outcomes (H3) but performance of supply chain is directly being influenced by outcomes of effectiveness (H5). Organizational performance is being influenced by effectiveness outcomes (H6) and performance of supply chain is being influenced by outcomes of efficiency (H4). Performance of organization is influenced by performance of supply chain (H7). Performance of organization however being influenced by the outcomes of efficiency indirectly through performance of supply chain. Outcomes of efficiency directly lead an organization toward improvement but according to our research result are unexpected. And it is important the unexpected results that performance of the organization is not directly influenced but it works indirectly through performance of supply chain. Managers are to be held responsible for this kind of problem because they are liable for the performance of organization, because theory is telling us that

wherever RFID was implemented outcomes of efficiency leads the organization toward improvements.

Conclusion:

Study contribution:

This study initially focusing on RFID deployment in manufacturing organizations, and providing the directions to managers, that it should be use in all activities so that they can create better link with buyer and suppliers. This paper provides evidence that RFID deployment is leading the organization toward improved organizational performance through improved performance of supply chain. This paper has provides the scales that are valid and reliable and can be used in further study. Study has also provided RFID deployment model that can be used as base if anyone wants to study more about this technology.

Limitations and future research:

This study also has some limitations because data was collected from only three organizations as RFID deployment is at initial stage in Pakistani industry.

This paper is focusing only on manufacturing organization, but RFID technology can also be equally fruitful if used in other processes. Secondly this data is collected on initial stage of this technology deployment, as it will be widely acceptable it will provide much better results. And the data is collected from front line managers and supervisors, corporate level management might be much able to provide feedback about performance or the organization and performance or the supply chain.

In future research can be conducted in non manufacturing like supply chain partner and the international supply chain partner can also be under consideration while study.

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