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ASSESSMENT OF ELECTRONIC INVENTORY MANAGEMENT SYSTEMS AND UTILISATION IN THE HEALTHCARE SYSTEM IN ABUJA, FCT NIGERIA

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ABSTRACT: *It has been argued that integrating electronic inventory management system (EIMS) into business operations improves competitiveness, productivity, efficiency and profitability. This study set out to explore the level of implementation and utilization of EIMS in hospitals of the FCT Abuja Nigeria. Three hypotheses were formulated and guided the analysis of the assessment. A cross-sectional questionnaire based study design was adopted and the study was focused on a population of about 122 hospitals in Abuja FCT Nigeria. Data collected was analysed by SigmaXL software and statistical significance at P < 0.05. A total of 98 hospitals were surveyed and 84 responded (91% response rate). Majority were private hospitals 68 (81%). The implementation and utilization of partially electronic inventory system in which some manual register/card exist (39, 46%). Chi-square test revealed that factors such as age, variety of services and type of hospital did not influence the implementation of EMIS, but indicate that a significant (P < 0.00), proportion (37, 78%) of the hospital implementing EIMS are using software developed and managed by Nigerians. For this setting under study, the implementation and utilization of EIMS in the hospitals is at a commendable level and that the contribution of indigenous software development and management has considerable facilitated this. Notwithstanding this achievement, there is a great gap of implementation and utilization of EIMS in the government healthcare sector and huge business opportunities for entrepreneurs of software exist. Further studies were suggested that will improve on the huge entrepreneurial opportunities that exist in EIMS in hospitals in Nigeria.*

KEYWORDS: *assessment; electronic; inventory management systems; utilisation; healthcare industry*

INTRODUCTION

Electronic inventory management system (EIMS) is the computerization and automation of the processes of inventory control and management in any business concern. Computerized automation can dramatically impact all phases of inventory management, including counting and monitoring of inventory items; recording and retrieval of item storage location; recording changes to inventory; and anticipating inventory needs, including inventory handling requirements. Hence EIMS has become a major investment in most companies integrating into their businesses (Awaya, et al., 2005; De Vries, 2011). An inventory control and management

system is a system that encompasses all aspects of managing a company's inventories; purchasing, shipping, receiving, tracking, warehousing and storage, turnover, and reordering. In different firms the activities associated with each of these areas may not be strictly contained within separate subsystems, but these functions must be performed in sequence in order to have a well-run inventory control system. Computerized inventory systems make it possible to integrate the various functional subsystems that are a part of the inventory management into a single cohesive system (Awaya, et al., 2005; Butler, 1993; Bonney, 1994; Kleywegt, et al., 2002).

In today's business environment, even small and mid-sized businesses have come to rely on computerized inventory management systems. Although there are plenty of small retail outlets, manufacturers, and other businesses that continue to rely on manual means of inventory tracking. Moreover, the recent development of powerful computer programs capable of addressing a wide variety of record keeping needs—including inventory management—in one integrated system have also contributed to the growing popularity of electronic inventory control options. They are also easily accessible and affordable.

EIMS have been adopted in various fields of human endeavour. They include space inventory management systems in schools and academia such as the university (Aziz, et al., 2013), in bottling industries (Unam, 2012; Ogbo & Ukpere, 2014), finance and accounting (Wu & Chen, 2010), supermarket (van Donselaar, et al, 2006), in warehouses, supply chain and logistics management (Williams & Tokar, 2008; Pala & Vennix, 2005), the healthcare industry, specifically in pharmacies (Awaya, et al., 2005; Priyan & Uthayakumar, 2014), dentistry (Levin, 2004), and blood banks (Stanger, et al., 2012) and Hospital activities have been reported to be greatly improved and challenges drastically reduced through the implementations EIMS (Awaya, et al., 2005).

There is a huge gap in the implementation and utilization of EIMS in Nigeria hospitals. Yet it is known that hospital activities, especially the pharmacy section have challenging inventory problems because of the volume of transactions, the large number of line items, the high stockout cost, and the limited shelf life (Butler, 1993). Other challenges associated with manual approach to the routine operations in the hospital ranges from poor handling of material data, lack of good storage information system for drugs and drug dispensary, delays, to the difficulty in retrieving information on material/item usage. Thus integrating EMIS into hospital activities have been known to drastically reduce these challenges (Awaya, et al., 2005; Butler, 1993).

There are very little or no reports on inventory management systems in the hospital business in Nigeria. In the more recent study by Sylvester et al. (2016) that acknowledges this challenges, but focused on the pharmacy section of a Nigerian hospital also corroborated the earlier findings of USAID (USAID, 2012) with regards the poor preparedness of Nigeria to integrating EIMS in the healthcare system.

The overall objective of this study is to explore the level of implementation and utilization of EIMS in hospitals of the FCT Abuja Nigeria. The specific objectives are to:

1. determine the proportion of hospitals that have implemented EIMS

2. evaluate indigenous features of EIMS in correlation with number of implementing hospitals
3. determine the reasons for non-implementation of EIMS differ between private and government hospitals.

The following hypotheses were formulated and tested in this study:

H_1: The number of hospitals implementing EIMS is significantly higher than those not implementing.

H_2: Indigenous features of EIMS correlate with number of implementing hospitals.

H_3: Reasons for non-implementation of EIMS differ between private and government hospitals.

Conceptual Framework

Concept of Inventory and Electronic Inventory Management Systems

Historically, inventory was first recorded in 1601 and has created a great impact on the profitability of the manufacturing firm (Lancioni & Howard, 1978). In traditional settings, inventories of raw materials, work-in-progress components and finished goods were kept as a buffer against the possibility of running out of needed items. However, large buffer inventories consume valuable resources and generate hidden costs. Consequently, many companies have changed their approach to production and inventory management. Since at least the early 1980s, inventory management leading to inventory reduction has become the primary target, as is often the case in just-in-time (JIT) systems, where raw materials and parts are purchased or produced just in time to be used at each stage of the production process. This approach to inventory management brings considerable cost savings from reduced inventory levels (Mogere, et al., 2013; Kros, et al., 2006).

Materials management concepts enhance communication and coordination by bringing together all functions which are interrelated (Ogbo & Ukpere, 2014). They outline that sophisticated techniques have been applied to this reduction such as genetic algorithms to determine optimal ordering at each echelon. It was also suggested that application of the vendor managed inventory system leads to higher service levels to customers and improvements in key supply chain variables such as decreasing stock-outs and elimination of the bullwhip effect (Unam, 2012). It also identified the various inventory control systems that have been implemented by various industries as such as vendor managed inventory and forecasting and replenishment.

According to Hardgrave, Langford, Waller & Miller (2008) firms have to acquire the right technology of inventory control systems for managing their supply chain inventories. Williams, Roh, Tokar and Swink, (2013), examined inventory control systems through collaborative models. They further discussed the integration of traditional logistics decisions with inventory management decisions using traditional control models. Inventory control systems would integrate the farmers, tea factories and customers of the tea products (Mogere, et al., 2013).

Changes to recording methods include the use of different methods of information collection and processing, e.g. bar coding in retailing and manufacture and electronic exchange of information. Control methods are more computer-based and are becoming part of increasingly

integrated systems. Procedures are needed to bring one-off analyses of inventory to become part of routine systems, work needs to be done to produce performance measures which are consistent between different levels of the organisations and the modeling of dynamic performance needs to become part of the design of inventory systems (Bonney, 1994).

Cachon & Fisher (2000) described the advantages of computerization of inventory system. They explained that in traditional supply chain inventory management, orders are the only information firms' exchange, but information technology now allows firms to share demand and inventory data quickly and inexpensively. In their study the value of sharing these data in a model with one supplier, N identical retailers, and stationary stochastic consumer demand. There are inventory holding costs and back-order penalty costs. They compared a traditional information policy that does not use shared information with a full information policy that does exploit shared information. Their study revealed that supply chain costs are 2.2% lower on average with the full information policy than with the traditional information policy, and the maximum difference is 12.1%.

Due to small rate of stock loss undetected by the information system can lead to inventory inaccuracy that disrupts the replenishment process and creates severe out-of-stock situations, methods of compensating for the inventory inaccuracy have also been developed by Kang & Gershwin (2005) as inventory record inaccuracy has also been queried (Kök & Shang, 2007) as well as the impact of shrinkage errors and the value of taking into account the inventory inaccuracy (Rekik & Sahin, 2012).

Materials are the lifeblood and heart of any system and no organization can operate without them. They must be made available at the right price, at the right quantity, in the right quality in the right place and at the right time in order to co-ordinate and schedule the production activity in an integrative way for an industrial undertaking. A manufacturing firm will remain shaky if materials are under stocked, overstocked, or in any way poorly managed (Jeruto, Keitany et al., 2014).

Empirical Reviews

Several authors/scholars have written on the inventory management systems but few had conducted studies on the assessment of electronic inventory management systems utilisation in the healthcare industry especially in Nigeria. Thus the section exploited various researches on inventory management.

Shardeo, (2015) examined the relationship between the inventory management and financial performance of the firm. The study measured the manager's perceptions of the inventory management practices and financial performance of the firm. Inventory and the influence management of the working capital on the profitability of Indian cement industry in India. The result of their analysis depicted that the inventory turnover ratio, debtor turnover ratio and working capital turnover ratio were positively related with the return on investment, a variable used for the measurement of the firm's profitability (Panigrahi, 2013).

Ramanathan (2006) investigated the association between inventory management policies and the financial performance of a firm. The purpose of the study was to assess the impact of inventory management practice on financial performances across the period 1992-2002.

According to Beier, (1995), health care supply chain management may be considered more complex than typical industrial applications. Each item may be considered critical and there is a perceived need to supply very high levels of service. On the other hand, there is a high product value and, in many cases, a need for special handling to combat spoilage or obsolescence. This observation has been directed toward manufacturers and wholesalers of healthcare products, who have been able to reduce inventory to sales ratios by approximately 30% between 1979 and 1987. A similar study involved perusal of records maintained at General stores and interview of staff in general stores, Nursing staff and Inventory control team was carried out (Mavaji Seetharam et al. 2015)

Hospital inventory management faces a continually increasing challenge to ensure the availability of medical and surgical supplies at the lowest inventory cost. For overcoming the drawbacks of existing re-order point approaches commonly applied in hospital materials replenishment management, this research presents an innovative demand-pull replenishment approach named the dynamic drum-buffer-rope (DDBR) replenishment model. The DDBR model is implemented using a system dynamics approach in which two essential mechanisms – the demand-pull characteristics and dynamic buffer-adjustment activities – are simulated and experimented on. To determine appropriate buffer sizes and replenishment quantities, this research adopted Powell search algorithm to achieve the objective of no stock-out occurrence and low inventory cost. The evaluation of the proposed DDBR model in a real hospital case through a series of comparisons shows that the DDBR model can determine optimal replenishment timing and quantity for total inventory cost with no stock-out occurrence (Wang, et al., 2015).

Wallin, et al (2006) discussed the appropriateness of four choices to adopt for a given purchased item in a particular context: inventory speculation, inventory postponement, inventory consignment, and reverse inventory consignment. They explained that decision is influenced by three factors -- customer demand or usage requirements, nature of the supply line and bargaining power of a firm relative to the supplier.

Automation in the drug distribution processes is helpful to pharmacists in creating new clinical services. Awaya, et al (2005) in their study ameliorated the drug inventory control system seamlessly connected with the physician order-entry system. This control system application, named Artima, allows inventory functions to be faster and more efficient in real time. The medicines used in the hospital are automatically fixed and arranged to sold-packages, and are ordered from each wholesaler by a fax-modem every day. Artima can search the lot number and expiration date of drug in the purchase and delivery records. These functions are powerful and useful in patient's safety and cost containment. Their survey of the inventory amount stored in the computer database, and evaluated time required for inventory management by tabulating working records of employees during past decades. Inventory decreased by 70% along with the continuous improvement of the system during the past decade. The workload in the inventory management in each section of the Pharmacy Department as well as in clinical units was dramatically reduced after the implementation of this system. Similar automation system in the drug inventory management that allows creating new clinical positions have been studied (Findlay et al., 2015; Gebicki et al., 2014; Uthayakumar & Priyan, 2013; Rachmania & Basri, 2013).

Zepeda, et al (2016) studied the effects of horizontal inter-organizational arrangements on inventory costs for hospitals facing two key environmental conditions, namely the logistics services infrastructure where the hospital is located and the demand uncertainty for clinical requirements that a hospital experiences. Utilizing detailed data from hospitals in the State of California, they investigated the potential mitigating effects of affiliation with multi-hospital systems while controlling for service performance. They argued that these arrangements potentially influence managers' confidence in their supply chains, which in turn impacts inventory accumulation. Results suggest that while affiliation with local, regional, and national systems has mitigating effects under weak logistics services infrastructure, the mitigating effect is greatest for affiliation in local systems. The results also point to potential for improved operating efficiency with system affiliation, a factor that is often not considered in policy discussions regarding hospital system formation.

In another study by Esptein and Dexter (2000) material management information systems in operating room (OR) was found to decrease perioperative labor costs. They used computer simulation to investigate whether using the OR schedule to trigger purchasing of perioperative supplies is likely to further decrease perioperative inventory costs, as compared with using sophisticated, stand-alone material management inventory control. They conclude that, in a hospital with a sophisticated material management information system, OR managers will probably achieve greater cost reductions from focusing on negotiating less expensive purchase prices for items than on trying to link the OR information system with the hospital's material management information system to achieve just-in-time inventory control.

THEORETICAL FRAMEWORK

This research is based on the Theory of Inventory Control, which is explained using two models, the deterministic models or stochastic models according to the predictability of the demand involved. In inventory, the demand for a product refers to the number of units that will need to be withdrawn from inventory for some use during some specific time, for example, sales. Deterministic inventory models are used in cases where the demand is known, that is, in cases where future periods can be forecast with considerable precision and where it is assumed that all forecasts will always be completely accurate (Eunice, Robert & Juma, 2013).

In the deterministic inventory models, the demand function may either be estimated or approximated. These inventory models are based on the assumptions that both the demand volume and procurement cycle are predetermined. Knowing the exact volume of needs to be met out of inventories, even notwithstanding the random variations in deliveries from suppliers, it is pointless to create any safety stock. Therefore, all of the deterministic models only optimize certain inventory turnover ratio and a cost optimum is searched only by means of storage costs and one-off costs to replenish inventory (Jablonský 2007, Lukáš 2005, Kořenář 2002, Lysina 2000 as cited in Polanecký & Lukoszová, 2016)

Stochastic models on the other hand are used when demand cannot be predicted very well, that is, where the demand in any period is a random variable rather than a known constant. These models can also be classified by the way the inventory is reviewed, either continuously or periodic. In a continuous model, an order is placed as soon as the stock level falls below the

prescribed reorder point. In a periodic review, the inventory level is checked at discrete intervals and ordering decisions are made only at these times even if inventory dips below the reorder point between review times (Stevenson 2007).

The stochastic modeling focuses on the impossibility of further inventory replenishment. Therefore, these are situations, where over a certain period it is necessary to satisfy the needs from the stock that can be created only once. If the generated stock is lower than the actual need, certain costs from a shortage of stock will emerge. On the contrary, provided that the generated stock is higher than the actual need, some additional costs will be incurred again, for after the end of the period, the stock will not be usable (e.g. a Christmas tree retailer).

RESEARCH METHODOLOGY

This study adopted a cross-sectional survey design using a questionnaire as data collection instrument. Although cross-sectional studies are known to have some limitations such as the weakness of the snapshot of time span of the study which does not guaranteed representativeness (Sedgwick, 2014), but it was found suitable for this study due to the cost minimization and the constraints of time allocated to collect data.

The study was conducted within the Abuja municipal area council (AMAC) in the Federal Capital Territory (FCT) of Abuja. This is located on latitude 8° 25” and 9° 25” North of the Equator and longitude 6° 45” and 7° 45” East of the Greenwich (AGIS, 2015). Abuja was created in 1991 with a land mass of approximately 8000sq km (Ujoh, et al, 2010; Adeyemi, 2011).

AMAC has 6 districts and comprise of Garki, Wuse II, Wuse Zone 5 and 6, Maitama and Gwarinpa. These have a population of 778,567 people (NPC & ICF International, 2014). Abuja is generally a well-planned city with all the necessary amenities including the various healthcare infrastructures (PHL, 2012; Ujoh, et al., 2010).

Data Analysis

Data collected was inputted into Microsoft Excel spreadsheet and analysis was performed using SigmaXL® version 6.1 (SigmaXL 2016) statistical software for Microsoft Excel.

Table 4.1: Sample Characteristics

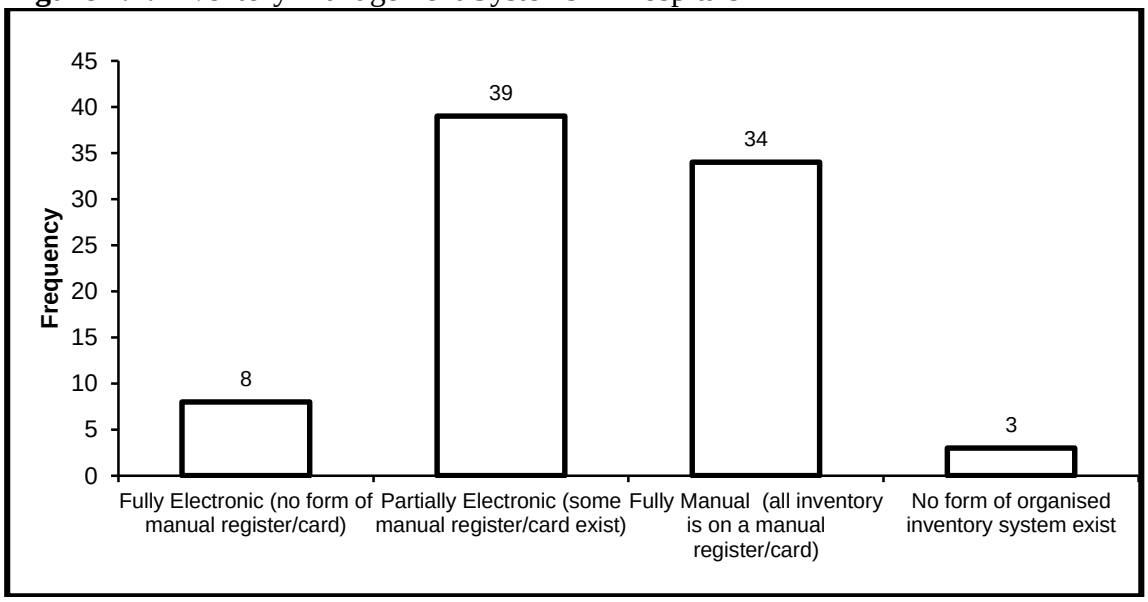
Characteristics	Frequency	Percentage
Type of Hospital		
Government Hospital	13	15
Private Hospital	68	81
NGO, Others	3	4
Age of Hospital (Years)		
0-4	9	11
5-9	28	33
10-14	15	18
15 and above	32	38
Services Delivered by Hospitals		
Outpatient	84	100
In-patient	70	83
Radiology	76	90
Laboratory	41	49
Pharmacy	76	90
Specialty	50	60

Source: Field Survey, 2018

Inventory Management Systems in Hospitals

Figure 4.2 shows that majority of the hospital use implement and utilise partially electronic inventory system in which some manual register/card exist (39, 46%), but very few (3, 4%) indicated no form of organised inventory system exist.

Figure 4.1: Inventory Management Systems in Hospitals



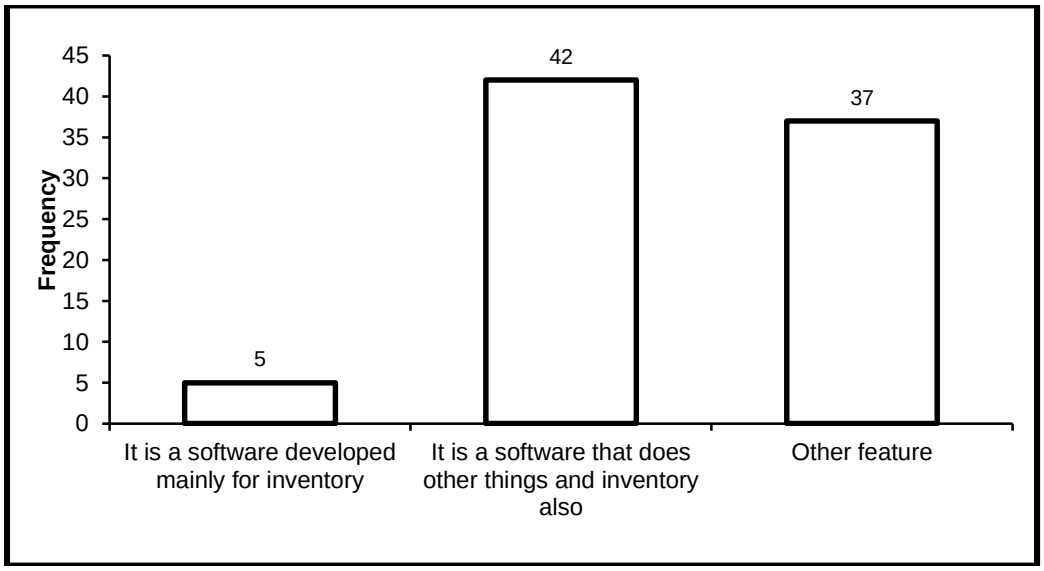
Source: Field Survey, 2018

Electronic Inventory Software Description

The results of the features of the software being implemented in the hospitals are presented on Figures 4.3 and 4.4.

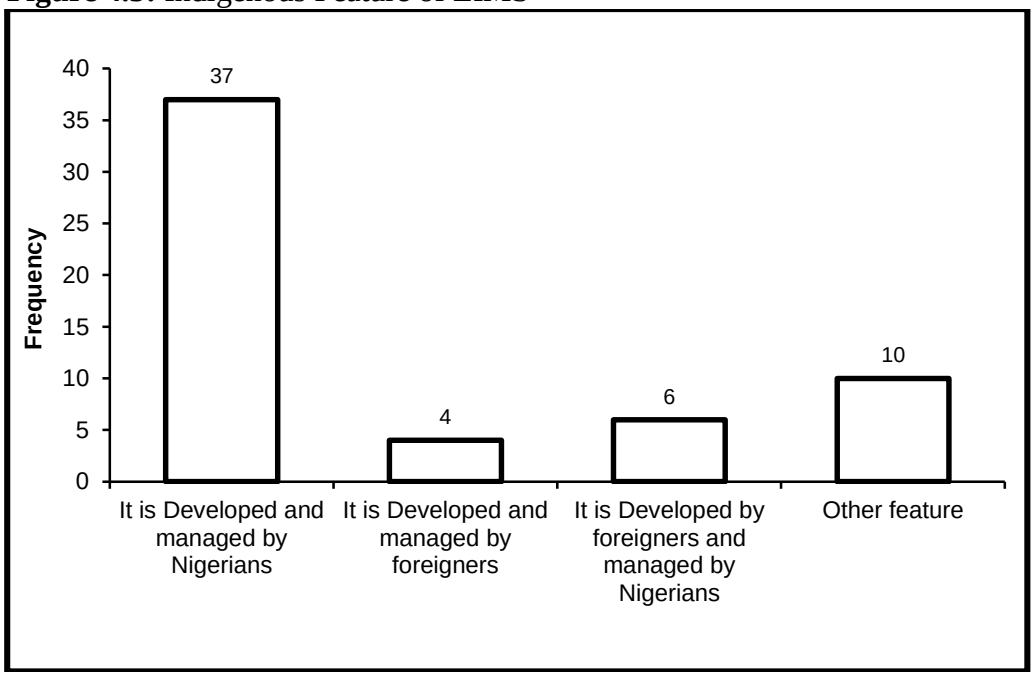
Figure 4.3 shows that half (42, 50%) of the hospitals use software that perform other functions other than inventory and very few use the stand-alone software. Majority (37, 65%) of the software have indigenous features (Figure 4.4).

Figure 4.2: EIMS Software Feature



Source: Field Survey, 2018

Figure 4.3: Indigenous Feature of EIMS

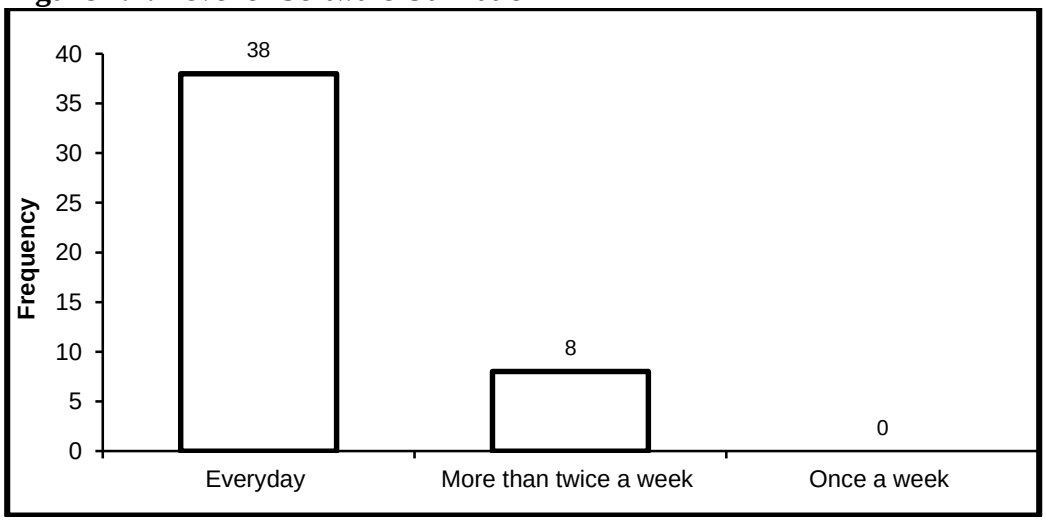


Source: Field Survey, 2018

Level of Software Utilisation

Figure 4.5 shows the level of EIMS software utilisation and revealed that majority (38, 82%) of the hospitals utilise the EIMS on a daily basis.

Figure 4.4: Level of Software Utilization

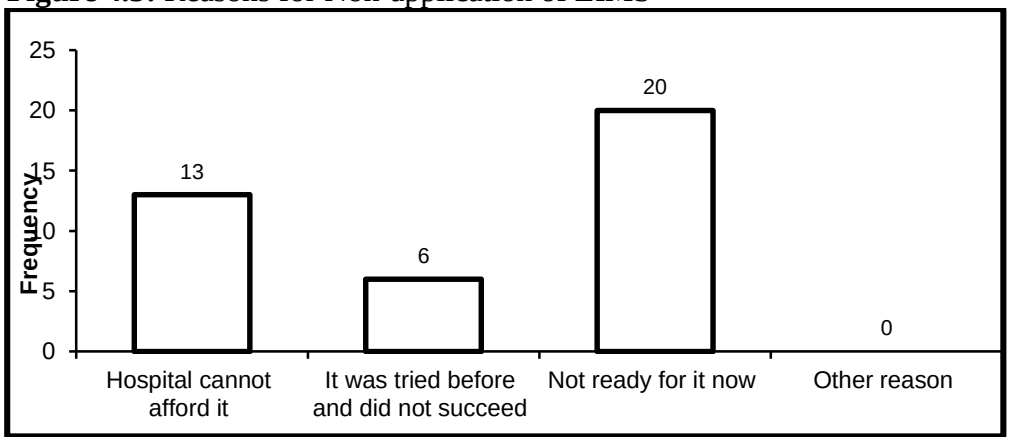


Source: Field Survey, 2018

Reasons for Non-application of EIMS

Figure 4.6 revealed that majority (20) of the hospital that do not have EIMS were unable to do so because they are not ready for it. This is followed by those that perceived that the Hospital cannot afford it.

Figure 4.5: Reasons for Non-application of EIMS



Source: Field Survey, 2018

Recommended EIMS and Proficiency

Table 4.2 present the recommended EIMS software by respondents from some the hospitals surveyed. Majority of the respondents recommended the use of Odoo (15, 32%) as EIMS, while very few mentioned Sage software.

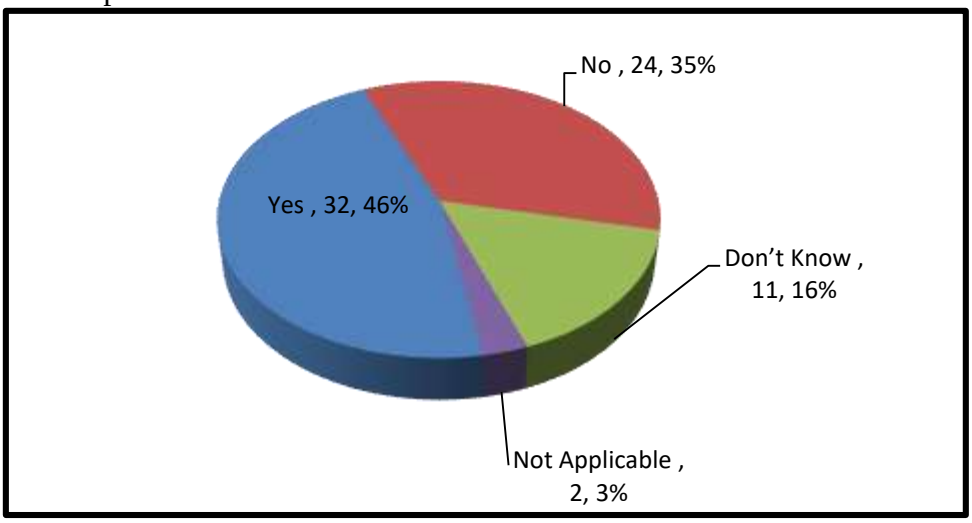
Table 4.3 further present responses of the comparison of the recommended software with what is in use at the hospitals. The result shows that majority 32 (46%) indicated that what they recommended is better than what is currently in use.

Table 4.2: Recommended EIMS

Recommended Software	Frequency	Percentage
Odoo	15	32
e-clinic pro	10	21
EMR software	10	21
Other customized	5	11
Atrex software	3	6
SoftClinic	2	4
Sage	2	4

Source: Field Survey, 2018

Figure 4.6: Comparison of Recommended Software



Source: Field Survey, 2018

Hypotheses Testing

Three hypotheses were formulated in this study and tested. The results are presented in the following sub-sections.

Number of Hospitals Implementing EIMS

Binomial test was performed to test H_1: "*The number of hospitals implementing EIMS is significantly higher than those not implementing.*"

Table 4.3 present the result of the test and indicate that 56% of the hospital have implemented and re utilizing EIMS, but this was not significantly (P =0.163) higher than the number of those hospitals not implementing EIMS.

Therefore H_1 is rejected and the alternative accepted that the number of hospitals implementing EIMS is **not** significantly higher than those not implementing.

Table 4.3: Results of Binomial Test for Proportion of Hospitals Implementing EIMS

n	84		
	Implementation		
	Yes	No	Total
Total	47	37	84
Hypothesised proportion	0.500		
Proportion	0.560		
95% CI	0.464	to 1.000	(exact)
1-tailed p	0.1631	(exact)	

Source: Field Survey, 2018

Features of EIMS Implemented in Hospitals

The test for H_2: *"Indigenous features of EIMS significantly relates with number of implementing hospitals,"* was performed by Chi-squared test.

Table 4.4 present the result of the test and indicate that more than half (37, 78%) of the hospital implementing EIMS are using software developed and managed by Nigerians. There is a significant ($P < 0.00$) higher than the number of those hospitals not implementing EIMS.

Therefore H_2 is accepted that the indigenous features of EIMS significantly relate with number of implementing hospitals EIMS in Abuja.

Table 4.4: Results of X^2 Statistic Test for Indigenous Features of EIMS

n	47		
	Indigenous		
Indigenous features	No	Yes	Total
It is Developed and managed by Nigerians	0	37	37
	(7.9)	(29.1)	
It is Developed and managed by foreigners	4	0	4
	(0.9)	(3.1)	
It is Developed by foreigners and managed by Nigerians	6	0	6
	(1.3)	(4.7)	
Total	10	37	47
Pearson's X^2 statistic	47.00		
DF	2		
p	<0.0001		

Source: Field Survey, 2018

Reasons Influencing the Non-implementation of EIMS

Table 4.5 shows the result of the test of H_3: *Reasons for non-implementation of EIMS differ between private and government hospitals*, performed by Chi-squared test. The result shows that there were varying reasons between private and government hospitals for non-implementation of EIMS. Although there was no significant association (P = 0.11) between the reasons and the type of hospitals.

Thus H_3: Reasons for non-implementation of EIMS differ between private and government hospitals, but significantly so. However, it can be seen that for the government hospitals, there was no attempt made before in implementing EIMS. It was tried before and did not succeed

Table 4.5: Results of X^2 Statistic Test of Reasons Influencing the Non-implementation of EIMS

n	35		
	Type of hospital		
Reasons for non-implementation	Government Hospital	Private Hospital	Total
Hospital cannot afford it	5 (2.7)	7 (9.3)	12
It was tried before and did not succeed	0 (1.1)	5 (3.9)	5
Not ready for it now	3 (4.1)	15 (13.9)	18
Total	8	27	35
Pearson's X^2 statistic	4.28		
DF	2		
p	0.1176		

Source: Field Survey, 2018

DISCUSSION OF FINDINGS

Traditionally healthcare systems have paid little attention to the management of inventories. But recent trend of outsourcing to distribute non-critical medical supplies directly to the hospital departments using them (i.e., the two-echelon network) results not only in inventory cost savings but also does not compromise the quality of care as reflected in service levels (Nicholson et al., 2004).

The process of designing and implementing inventory management systems in other words, is not only a technical process but also a process subjected to perceptions and attitudes related to the power and interests of the stakeholders. It is important for project management to be aware of the different perceptions stakeholders may have of the potential effects of the system in order to guide the behaviour of the stakeholders (De Vries, 2013).

Odoo is a suite of enterprise management applications. Targeting companies of all sizes, the application suite includes billing, accounting, manufacturing, etc. e-clinic Pro is our flagship clinic management software which allows clinics and practitioners to cut costs, increase revenue and drive competitiveness. Atrex is an inventory control/point-of-sale (POS) package for the business that desires complete control over stock levels and inventory tracking. Sage Live, our unique cloud accounting solution, leverages the power of Salesforce CRM with the ability to give you real-time access to your financial data; instantly, simply, seamlessly, effortlessly. SoftClinic Hospital management software (HMS) is all you needs in computerizing your Hospital & clinic.

CONCLUSION AND RECOMMENDATIONS

This study set out to explore the level of implementation and utilization of EIMS in hospitals of the FCT Abuja Nigeria. The primary question of this study is: what extent are the hospitals in Abuja implementing and utilizing EIMS? However, to attain this, a cross-sectional structured questionnaire based survey was conducted that aided the measures of the implementation and utilization of EIMS in hospitals in Abuja FCT.

The general conclusion that can be drawn from this study is that for the setting under assessment shows that implementation and utilization of EIMS in the hospitals is at a commendable level and that the contribution of indigenous software development and management has considerable facilitated this. Notwithstanding this achievement, there is a great gap of implementation and utilization of EIMS in the government healthcare sector and huge business opportunities for entrepreneurs of software exist.

The following recommendations are therefore offered:

1. It is recommended that indigenous software developers are empowered to facilitate the widespread implementation and utilization of EIMS in hospitals
2. In this study, it was guessed why many hospitals are not ready to implement EIMS, thus further studies are required to provide details that will help improve on the gap.
3. That project management should be aware of the different perceptions stakeholders may have of the potential effects of the system in order to guide the behaviour of the stakeholders.

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