e-VacciIMS: A Web-Based Vaccine Inventory Management In The Health Office Entrenching Forecasting Algorithm

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Abstract— The motivation of Expanded Programme on Immunization (EPI) of the World Health Organization was basic and direct which is to deliver various vaccines to all children through a basic timetable of child visits to the health centers to control and destroy vaccine-preventable diseases. Accuracy in forecasting vaccine demand is necessary to ensure normal operation during immunization. It is essential to often keep an inventory to guarantee continuous, accurate and timely delivery of the supply of vaccine so that quality standards are observed. However, in the City Health Office of Panabo City, Davao del Norte Philippines lacks the efficient and systematic way of managing inventory such as recording vaccine stocks and dispensing. It is time consuming in recording the incoming stocks manually and dispensing of the vaccine and record keeping of transactions are tedious. These processes are needed to guarantee accuracy in forecasting vaccine demand. Traditional way is prone to errors and inaccuracy. Thus, the development of a web-based inventory management for efficient transactions in receiving and dispensing of vaccine is conceptualized. The evaluation of the processes during the pilot testing of the said system achieves very good performance rating in monitoring the supply, ensuring consistency of the vaccine vial records and furnishing of report for efficient planning and control of vaccine. This means that the system met the objective and conforms to the user requirements. Furthermore, embedding the system to a vaccine demand forecasting algorithm is the future plan of this study.

Index Terms—City health IMS, Health office inventory, Inventory management system, Procurement decision support, Vaccine demand forecasting, Web-based inventory management, Vaccine inventory system.

1 INTRODUCTION

The Expanded Programme on Immunization (EPI) was propelled by the World Health Organization (WHO) way back 1974. Its motivation was to deliver various vaccines to all children through a basic timetable of child visits to the health centers [1], [2], [3] established through routine immunization (RI) across nations that gives admittance to life sparing immunizations, prevents and abridged untimely death or a lifetime of disability [4], [5]. Immunization is acknowledged as one of the most successful public health interferences ever conceived [6] that helps control and destroy vaccine-preventable diseases [7], [8]. Inventory management of vaccine in the cold rooms and in the shelves will guarantee availability and accessibility for on-time immunization administration to infants and children [9]. Vaccines are temperature-sensitive [10], [3] products where shelf life is affected directly by temperature conditions. It is imported into the country to the national vaccine store, and then distributed until they reach health facilities. It is where vaccines are stored until they are used for immunization [6]. Outreach conveyance and health center visit are the two most applied immunization arrangement [11]. Careful attention is needed to ensure optimal potency of vaccines since cold chains is time-critical, complex and dynamic [12]. Storage and transport of vaccines are the important activity in the cold chain from the manufacturer through the primary vaccine store down to the outreach sites commonly at health centers. To ensure normal operation, it is essential to often keep an inventory to guarantee continuous and timely delivery of the supply of vaccine and quality standards are observed, otherwise, insufficient inventory causes shortage and disruption [13]. Managing inventory is the part of supply chain management that plans, implements and controls the efficient, effective, forward, and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet consumer’s requirements [14] which in turn, if not given attention may results to instability of vaccines and inadequacy of supply in the routine and supplementary immunization schedules and the level of inventory should be optimized. In the Philippines, the lead of Routine Immunization (RI) for infants and children is through the “Reaching Every Barangay (REB)” approach, a fine-tuning from the “Reaching Every District (RED)” methodology of “WHO-UNICEF”, which expects to enhance the entrance of routine immunization and diminishing drop-outs. There are five (5) parts of the approach, to be specific: study of facts for action, re-create outreach services, fortifies connections amid groups and administrations, strong management and augmenting supplies. Additionally, the exactness of the estimates is vital - underestimating the supplies results in vaccine shortages, overestimating results in excess stock - increases the cost. Its significance relies upon the exactness - nulling over the kind of immunization, the presentation (vial size), the amount and the planning of delivery of the vaccine. Poor forecasting may bring about delays or shortages in delivery, extra expenses, and diminishes validity. Besides, keeping up vaccines at appropriate temperatures has turned out to be more perplexing on the grounds that some new vaccines loss its potency by freezing while others are harmed by heat exposure. Poor management of vaccines practices has huge financial consequences too [9]. The City Health Office (CHO) of Panabo City in particular is one of the most important entities who took charge of the vaccine cold chain and delivering immunization program and schedules to each of the forty (40) member barangays. CHO manages the receiving, dispensing and monitoring of each of the EPI vaccine. Insufficient inventory may cause shortages and result in the interruption of the program and delays immunization of affected infants/children. The inventory management of vaccine in CHO specifically the receiving and dispensing of vaccine stocks (i.e BCG, DPT, DPT-HepB-Hib, HepB, Measles, MMR, Polio, Pneumococcal (PCV), Rotavirus and TT) are done manually. The current way of recording in the issuances ledger and the receiving of supply recorded in the stock card
provided for each vaccine makes it tough in monitoring the overstocking and under stocking of supply as well as losses through deterioration, pilferage, wastages and damages. Moreover, the file of papers is increasing as the daily operation goes on and the ordering, receiving and dispensing of vaccine becomes tedious and time consuming. Furthermore, reordering of vaccine using the order form is done in traditional way where data entry is prone to errors. This will lead to inaccuracy of the number of different vaccine vial to be requested and later affects the stock levels and reorder time of supply. These limitations if not given much attention, may result to insufficiency of supply. Moreover, there is a need to give focus on the accuracy of vaccine supply to every recipient barangay to avoid circumstances which may lead to potential risk against vaccine preventable-diseases. Also, lack of automated systems, stock outs are experienced often and replenishment is done hurriedly leading to costly inventory management and likewise low performance standards. Hence, there is a need to enhance the inventory management of vaccine in the City Health Office (CHO) of Panabo City and aim to expedite convenience in furnishing of reports for efficient planning in procurement decision, control of inventory and higher accuracy in forecasting vaccine demand. The following parts of the paper are structured as follows: Section II looks into the idea of monitoring supplies, ensuring consistency and furnishing of reports for efficient planning, inventory control and policy. Section III outlines the suggested system as a procurement decision support strategy. Section IV outlines the well as the outcomes and discussion of results and finally, suggestions and conclusions are offered in Section V.

2 Review of related literature

2.1 Monitor Supply of Vaccines

As immunization programs prospers, better and productive inventories set expanded weights to make exact estimates for item requests, allocate supplies more effectively, settle on the correct speculation choices, and improve delivery of supply. Managing all these requires exact and helpful data to sustain supply and equipment needs, substantiate scope rates, perceive temperature in the cold rooms, and characterize ineffective associations in the supply chain. While vaccines are rolled out worldwide, cold chain systems struggle to support the national immunization program or other known as EPI which resulted in risks of reduced potency of vaccine due to improper temperature control, poor availability of immunization supply due to inadequate storage capacity, disrupted service delivery, vaccine stock outs and losses from vaccine wastage [15]. Obsolescence and/or deterioration is also emphasized in the inventory management of perishable items in all operations and cited that demand is the main characteristic of inventory system [16]. The Markov Decision Model (MDP) is built for the optimal ordering policy and expected to minimize the cost of inventory and avoids shortages and deterioration but needs improvement because the model does not consider individual expiration dates for each item in the inventory. First-in-First-out stock management practices when vaccine stock exceeds in the cold rooms and alleviate issues concerning storage volume [17], [18]. However, stocking at the lower level still leads to countrywide instantaneous situations of overstocking and stock outs because vaccines are stored where there is space rather than needed. A viewpoint to lessen buffer stock in some way is looked-for but this can steer stock out as well in the absence of consistent stock management approaches. Moreover, inventory management ensures an intermittent supply of stock to avoid stock out and have constant and proficient service, maintaining sufficient stock, controlling investment in inventories by keeping at an optimum level of production while minimizing carrying costs and time [19]. Purchasing, classification store keeping and stock taking are several undertakings in the domain of inventory management. Furthermore, the importance of inventory management includes ascertaining the present and future requirements for all types of inventory to avoid overstocking while avoiding ―bottleneck‖ and ensuring the safety, security of supplies, the avoidance of deterioration, theft, waste and obsolescence.

2.2 Ensure consistency to attain optimal stock levels and quantity for restocking.

There are policies for inventory of perishables like ordering, issuing, disposal and pricing but among these ordering and enticing entices and draws most interests [20]. It responds to the time and way to order the product and taking off those items from the inventory. As such, it directly influences the age of inventory items; hence, models for issuing policies need to consider both shortages and losses due to perishability. Furthermore, in order to intensify inventory, optimization is needed to meet its goal which is ascertaining reasonable level of stocks and the quantity of replenishment of supply [21], [22]. ABC Analysis and Cycle counting ensures accuracy determining the what is in stock, how much is in stock each item and where it is kept [23]. The main goal is keeping inventories on optimal level; avoiding stock outs and excesses, solves the controversial dependent tasks which is measured through availability of supply. Thus, a beneficial inventory management is a balance between availability of stocks and holding inventory cost.

2.3 Furnish report for efficient planning, inventory control and policy.

Cold chain performance depends on the provided steadfast discernment and routine system management and assessment of the inventory [15]. It is about how much and when to achieve stock reasonably following classification of what is needed. The effectiveness of the inventory management practices considered the just-in-time (JIT) inventory method [24]. A method where stocks are ordered based on the necessary amount to meet instantaneous manufacture needs and be settled at the time needed. The method rises productivity, lessens waste and reduces costs of inventory management and lead time costs. Moreover, the development of inventory management system is cited as best approach especially in monitoring the inventory information. Proper handling of the inventory system will help operations accordingly and will diminish poor planning [19]. It is also a set of policies and controls that will help decision making process in monitoring and maintaining the inventory level, the procurement for replenishment and size of the orders should be and all the cost incurred [25]. This significance is also true in the electronic supply management systems [26] where the physical counting is highlighted and recommended the use of SKU Identifier. It also electronically apprises the records, simplifies the reports of supplies on-demand. It facilitates the periodic inventory with the use of barcode scanner and system
Stock record system (SRS) in documentation system is an efficient inventory control, where it can be manual or automated. It is mainly used in taking and storing the details of inventory [27]. The first-in-first-out (FIFO) is the basis for dispensing stocks, without delays, which is mostly for items with expiration dates and limited shelf lives and record updating. There are also policies proposed [28] such as fresh-first (FF), old first (OF) and optimized priority (OP), where it allows the model identify which items to sell anytime to maximize profit but it is different from first-in-first-out (FIFO) and last-in-first-out (LIFO).

3 METHODOLOGY
This section will discuss the methodology used. The study adopted the system development life cycle method in developing the inventory management system of the City Health Office of Panabo City - EPI Vaccine Cold Chain as shown in Figure 1.

3.1 Planning
The researcher conducted an interview with the cold chain manager/vaccine in-charge of the City Health Office, City Health Office head. The in-charge discussed and explained the processes and policy of the inventory of the cold chain. The in-charge also presented the forms used for the daily transactions specifically the receiving and dispensing of vaccine including the temperature monitoring of the cold room and the process of re-ordering vaccine to the Provincial Health Office.

3.2 Analysis
Several meetings, interviews and observations were made to define the need and identify the processes to jumpstart the development of the said system to help the cold chain manager/vaccine in-charge increase the efficiency and lessen the paper works especially in recording vaccine transactions. Policies such as first-in-first-out (FIFO) and last-in-first-out (LIFO) or fresh first (FF), old first (OF) and optimized priority (OP) were tackled and discussed. Conceptual framework was created as guide in the development of the system as shown in Figure 2 as well as the data flow diagram in Figure 3 showing the processes included in the system.
vaccine supply through adding and updating of vaccine types, quantity and issuances to every barangay and adjustment of losses through deterioration, pilferage, wastages or damages as shown in Table 2. Ensuring the consistency on the numbers of vaccine vial in records and in the cold room to attain optimal stock levels and quantity for reorder time otherwise known as objective number two (2), gain a rating of 4.8 as presented in Table 2, which means that the system has met the required system functionality like displaying and notifying the user of the near to expire vaccine type, its quantity, expiration dates and re-order time; generates reports of stock in, issuances and current stock level. Moreover, the system also attains the rating of 5.0 for objective number three (3) which means the system met the user requirements needed to expedite furnishing of reports for efficient planning and control of inventory as exhibited in Table 2. All the processes included in the system achieves a very good performance and met the user’s requirement.

5 CONCLUSIONS AND RECOMMENDATIONS

In summary, the overall ratings shown in Table 2, based on the completeness of the user requirements and system functionality, shows concrete evidence on the acceptance of the EPI-vaccine inventory management system in the City Health Office of Panabo City. It helps the cold chain manager lessen the time consumed in recording transactions and automates the process such as receiving (stock in), dispensing (issuances) and adjustment on the quantity of vaccine due to losses through deterioration, pilferage, damage or wastage and a good start for a paperless transaction in the cold chain section. It also notifies users near to expire vaccine for easy identification and to prompt the vaccine cold chain manager of the number quantity to issue first which was adopted and used and applies the optimized priority (OP) policy that was suggested and discussed during the analysis phase. The reports generated such as vaccine transactions, given the date range specified, helps the vaccine cold chain manager and Office head to have an efficient inventory and achieve a better performance of the planning and control and later on the forecasting accuracy of vaccine demand. For future enhancement, the development of mobile and web-based submission of reports of the immunization, vaccine consumption undertaken and vaccine requisition from the health centers through the health workers from the forty (40) member barangay of Panabo City is suggested. Furthermore, embedding the system to a vaccine demand forecasting algorithm is the future plan of this study.

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| TABLE 2. SUMMARY OF RATINGS |

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