HOSPITAL SUPPLY CHAIN MANAGEMENT AND OPTIMISATION

M.Kachwee and Mr D.Hartmann *
School of Mechanical, Industrial and Aeronautical Engineering
University of the Witwatersrand, South Africa
*Dieter.Hartmann@wits.ac.za

ABSTRACT

This project was directed at seeking solutions to the constraints imposed on the pharmaceutical supply chain of one of the largest and busiest state-owned hospitals in Africa. We attempted to identify the major sources of waste and inefficiency in the pharmaceutical supply chains and to quantify these wastes where possible.

The inventory management processes currently in operation at the hospital are fairly ineffective and inefficient. Stock outs are regular, annual inventory procurement costs average R 12 million, average monthly trade deficits accumulate to R 3 million of unaccounted stock, and almost R 700 000 of expired medication is disposed of annually.

This points towards inadequate management and supply chain nous. Comparison with best practices showed significant failings and highlights opportunities for improvement.
1 INTRODUCTION

Supply chain management and optimisation are major research themes in process operations and management for all sectors within the service, retail and manufacture environments [1]. Research is conducted and improved continuously in the areas of capacity and production planning, facility location and design, logistics networks, inventory and warehouse management, and all other areas aiming to pursue strategic supply chain management.

For a government pharmaceutical supply chain, only a handful of these areas can be addressed, since resource allocation and funding are fixed, and in most cases, insufficient to address all supply chain issues. Various interventions by the national Department of Health and external entities play a role in the increasing complexity of the pharmaceutical supply chain.

Numerous intensifying issues regarding the late payment of suppliers, late renewal of tenders, and hence the withdrawal of medication supply by manufacturers has arisen in recent years. Above this, the lack of efficiency and effectiveness of daily pharmaceutical operations encourage lengthy queues, high shrinkage rates, employee absenteeism, and regular inventory stock-outs at many of the nation’s public hospitals’ pharmacies. With the high volumes of consumers served on the daily basis and the aforementioned issues taken into consideration, it was necessary to gain a more profound understanding into the complexities surrounding the pharmaceutical supply chain through a local hospital. Acquiring this understanding would enable one to increase the knowledge of pharmaceutical management and operations, and the opportunities for much needed streamlining and optimisation.

1.1. The state of pharmaceuticals in South Africa

In May 2012, the Sowetan newspaper reported that there had been a shortage of anti-retrovirals (ARVs - used to treat HIV and AIDS) in six of the nation’s nine provinces. Approximately 1.7 million people had been placed at risk due to the shortage of the life sustaining drug [2].

In June 2012, Gauteng’s centralised procurement department for pharmaceuticals, the Medical Supplies Depot (MSD) in Auckland Park, was short of the HIV drugs Abacavir and Efavirenz and the diabetes medication Metformin. MSD spokesman Simon Zwane stated that in an attempt to prevent future shortages, the MSD would increase its stockpiles of essential and fast-moving medicine from six weeks to three months [3].

In July 2012, the Western Capes’ Groote Schuur Hospital and Tygerberg experienced major drug shortages for essential medication such as insulin for the treatment of diabetes, steroids to treat inflammatory conditions and certain chemotherapy drugs. Helene Rossouw, spokeswoman for Health MEC Theuns Botha, said the shortages had originated at the national level as a result of tenders not being awarded and suppliers not being able to source drug stocks for South Africa [4].

The Department of Health reported that its hospitals were owed over R1.5 billion by consumers [5], hence the backlogs in payments to suppliers. This becomes an issue since a report published in 2011 [6] indicated that South Africa’s pharmaceutical industry would grow by 22% (the value of sales) by the year 2013, this provides the opportunity to drug importers to set up manufacturing bases in South Africa.
1.2. Background to the hospital
The research site is one of the largest and busiest state-owned hospitals in Africa with over 1100 beds. The pharmacy provides medication to all areas of the hospital, including theatres and clinics.

The main out-patient dispensary (OPD) distributes the highest volume of medication from all pharmacies located in the hospital, and is located above the pharmaceutical store room, hence it is responsible for the distribution of medication to all the hospitals’ wards, theatres, clinics and satellite pharmacies (oncology, adult, paediatric and anti-retroviral). The hospitals’ pharmacies dispense more than 1400 pharmaceutical items to out-patients, and approximately 1100 pharmaceutical items to in-patients in wards and theatres daily, whilst processing approximately 1200 medication scripts with a limited resource base, of staff and equipment.

1.3. Literature review
Previous research by tertiary education students in Gauteng [7, 8, 9] into operations at hospitals and medical supply depots concluded that the lack of resources (people, equipment, systems and finances), inefficient store layouts and absence of process quality control were some of the contributing factors which lead towards discrepancies into pharmaceutical operations. From previous studies one can also note that in-house pharmacy processes were fairly inefficient since no proper data trails existed, a lack of collaboration between the relevant entities in the supply chain existed, and certainly a lack of ‘best practice’ philosophies were present.

The following background material is required to understand the context of the research conducted.

1.3.1. Supply chain management
The supply chain is divided into core and extended functions. The core functions of the supply chain (SC) are related to activities which are restricted to the four walls of the organisation, these activities form part of the supply chain management (SCM) space [10]. The extended functions of the SC are those activities or functions which are extended vertically at either end (suppliers or customers) of the organisations’ SC, therefore creating an extended SC and the enablement of collaboration where applicable [10].

![Figure 1 - The supply chain landscape](image)

1.3.2. Supply chain maturity model
The supply chain maturity model is a model used to assess the level of capability for each of the processes defined in the Supply Chain Operations Reference (SCOR) model - plan, source, make and deliver - and also the SC management practices which govern the strategies and links all functions together [11]. The model is also used to evaluate the extent to which Information Technology (IT) enablement enhances the practices and collaboration between entities of the SC [11].
1.3.3. Supply chain optimisation

Best practices can be classified as processes which have been ‘tried and tested’ in industry which have proven to be effective and efficient in multiple aspects. Issues arising from determining which best practices is the most optimal includes defining a level of practice which is suitable to a specific SC: what resources are available for the processes to be implemented, what level of commitment from the organisation can be expected and what unintended consequences need to be assessed prior to implementation. All the above aspects need to be scrutinised and assessed according to the milieu of the operation.

Lean is a systematic approach to improving value to the customer by detecting and eliminating waste (time, effort and materials) through kaizen (continuous improvement), by flowing the product at the pull of the customer, in pursuit of perfection [13].

The implementation of lean philosophies in various industries has enabled organisations to become more customer-focused, flexible and profitable. The reduction of various forms of waste in a SC allows for the building of adaptive, collaborative SC’s [13]. One has to ensure that for lean to be effective, it should not only be applied to a certain aspect or entity of the SC, but rather to the entire SC. Some of the many benefits of using lean tools include reducing cycle times, the ability to prominently deliver, improved throughput and turnover times, faster lead times and improved working capital through the reduction of holding inventory.

2 OBJECTIVES

The following objectives had been formulated for the research investigation:

I. To investigate and understand the management of the pharmaceutical supply chain at the hospital, and its respective complexities.

II. To investigate the hospitals’ pharmaceutical inventory management system.

III. To compare the current pharmaceutical supply chain against industry best practices.

IV. Quantifying waste due to poor inventory management.
3 METHODOLOGY

A rich case study [14] was undertaken which investigated the supply chain and inventory situation at a large public hospital. This required the acquisition of qualitative data to highlight operational issues which would act as the constraints for models built from quantitative data.

The data would be acquired through the following avenues:

1) Interviews with the:
   i. Customers and pharmacists of the pharmacy
   ii. General members of dispensary staff (assistants, trainees)
   iii. Ward stock staff
   iv. Doctors and nurses
   v. Procurement manager (including staff of the procurement department)
   vi. Storeroom manager (including staff working in the storeroom)
   vii. The chief pharmacist or pharmacy manager

2) Visual observation of pharmaceutical operations, i.e. the flow of information, finances, services, products and the use of resources throughout all entities of the pharmacy.

3) The mapping and modelling of pharmaceutical inventory processes to compare them to industry best practices.

4) Data collection for pharmaceutical inventory:
   i. Amount of product dispensed
   ii. Amount of product procured
   iii. Amount of product in holding
   iv. Amount of product returned
   v. Amount of product disposed

This would be adequate for the scope of this phase of the project, and will allow for conclusive data to be acquired from which logical and meaningful recommendations and evaluations can be proposed.

4 OBSERVATIONS & RESULTS

To begin with, the pharmaceutical SC consists of the following entities, where the primary role of each entity is briefly described:

   i. National Health - responsible for the offering of tenders
   ii. Provincial Health - responsible for the tender selection process
   iii. Suppliers - the supply of original pharmaceutical medication (OPM) and generic pharmaceutical medication (GPM) to the Medical Supply Depot
   iv. Medical Supply Depot (MSD) - based in Auckland Park, the MSD is Gautengs’ centralised procurement department responsible for ensuring the management of supplier contracts, and the distribution of pharmaceuticals to the provinces’ hospitals
   v. The hospitals - responsible for the dispensing of medication to consumers
The following figure describes the end-to-end supply chain of pharmaceuticals in South Africa:

![Figure 3 - The pharmaceutical supply chain](image)

### 4.1. Pharmaceutical operations

This section highlights the effects of inventory management, processes and tendering on the overall pharmaceutical SC performance.

#### 4.1.1 Inventory management

The storeroom for all medication at the hospital is located directly below the out-patient dispensary (OPD), hence access for staff is gained through the pharmacy into the storeroom. It should be noted at this point that the storeroom has an open-door policy for all pharmacy and store room staff without mandatory security checks. This is due to the absence of safekeeping strategies and resources (personnel and equipment), and non-adherence to established standard operating procedures.

Within the storeroom is a packing department which repacks bulk volumes of medication into smaller quantities for dispensing purposes. An accuracy level of ±75% existed in this process.

Additionally, inventory received from the MSD is manually relabelled by the store manager with a felt tipped pen since the original label is illegible when placed on higher shelving. A considerable amount of inaccuracy exists due to the vast amount of boxes which require relabelling and the monotony of the process itself. Figure 4 shows human error where a 500 mg dosage medication was relabelled as 1000 mg (1 g shown in the figure); meaning the incorrect product may be dispensed to the consumer.
The storeroom holds approximately R57 million worth of stock at any given time. In the absence of an electronic inventory system, an inaccurate manual inventory logging system is used (see figure 5),
No proper forecasting techniques are used to determine order quantity levels. Demand data is used to determine order quantities - from order point to order point, the average is taken - which is usually two withdrawals from stock data. This ensures that high levels of inventory are ordered hence increasing inventory drastically.

One of the main issues faced by the hospital is the minimal communication between the hospital and the MSD. Added to poor response times this leads to orders being placed twice and double stocking of inventory.

4.1.2 Dispensing

Products are dispensed to patients with minimal information regarding the patient, i.e. the doctor who issued the medication, the department from which the prescription had been issued, the type of medication dispensed and the respective amount. This is also true for products which are dispensed internally to wards, theatres and clinics within the hospital. This leads to gaps in the information trail required for forecasting and recording purposes for the hospital. Table 1 shows the amount of product purchased for a specific month and the respective inventory dispensed, and consequent deficits. This means that poor record keeping directly leads to as much as R 49 m per year in unaccounted medication, which may be lost, expired or likely stolen.

<table>
<thead>
<tr>
<th></th>
<th>Apr-12</th>
<th>May-12</th>
<th>Jun-12</th>
<th>Jul-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Items Dispensed</td>
<td>301939</td>
<td>368962</td>
<td>337276</td>
<td>314146</td>
</tr>
<tr>
<td>Dispensed Items Value [R]</td>
<td>R 16,742,042</td>
<td>R 14,030,878</td>
<td>R 11,817,401</td>
<td>R 10,969,396</td>
</tr>
<tr>
<td>Procurement Cost [R]</td>
<td>R 20,104,974</td>
<td>R 17,297,794</td>
<td>R 15,436,410</td>
<td>R 13,311,046</td>
</tr>
<tr>
<td>Deficit [R]</td>
<td>R 3,362,931</td>
<td>R 3,266,915</td>
<td>R 3,619,008</td>
<td>R 2,341,649</td>
</tr>
</tbody>
</table>

4.1.3 Tender management

The MSD manages tender contracts. On numerous occasions supplier contracts expire and as required, the tender selection process is initiated. The notification of the expired tender contract is only brought to the attention of the MSD when the hospital requires additional supplies of a certain product, the waiting period for that product may then be extended by up to two months.

Due to the large amounts of stock held at the hospital, many of the items which enter the storeroom go undocumented and hence lack of knowledge of holding stock exists - this includes the amount of product which is present and the products whose expiration dates are approaching the earliest. This leads to large amounts of wasted product which is then regarded as medication waste and disposed. A recent study obtained from the Western Cape News Online [15] indicated that Gauteng disposed of R2.3 million of medication in the period April 2011 to April 2012 (see Figure 6). It should be noted that the waste for this hospital in this period equated to R768 116, which is 33.4% of the provinces’ total medication waste.
CONCLUSIONS

From the objectives, the following conclusions can be drawn:

The overall effectiveness and efficiency of the pharmaceutical SC is lowered due to operational deficiencies within each of its entities –

- At the hospital:
  - The work ethic of pharmacy and storeroom employees is poor due to the lack of effective performance reviews, poor communication with management, and minimal coordination and realisation of team and individual efforts
  - The inventory management system is coordinated entirely manually through handwritten log books, no form of systematic processes are followed to ensure reliable procedures, accurate records of information, and product flow
  - Due to the nature of the management of inventory at the hospital and communication networks with the MSD, SC instabilities occur such as incorrect demand forecasting and low product visibility
  - With high values of monthly ‘unaccounted stock’ at the hospital, the storeroom maintains an open-door policy (absence of safekeeping strategies) - documentation of goods received and product dispensed are of an ineffective nature due to the manual logging system (with human error); high levels of known shrinkage is present in the storeroom
  - The cost of poor management and inventory control is as high as R 40 m per annum

- The MSD:
  - Low reliability with respect to order placing with suppliers
  - Ineffective supplier management practiced
  - Verification of valid tenders for medication is poor

- National and Provincial Health:
  - Contract and tender management is particularly poor
  - Poor commitment and responsibility of upper management towards the improvement of the industry is propagated downwards to the rest of the pharmaceutical SC and its employees

In general –

- Overstocking in the storeroom should not be confused with good product availability to patients, wards, theatres and clinics
• The lack of collaboration and communication between pharmaceutical SC entities leads to a segregated SC, with fragmented operations which results in debasing management practices

6 RECOMMENDATIONS

Having conducted the investigation and analysed the pharmaceutical SC, the following recommendations are made to the hospital:

• Develop and implement an electronic inventory management system
• Improve safekeeping strategies immediately
• Conduct employee meetings on a more regular basis to ensure information is communicated to all the pharmacy and storeroom’s workforce
• Group or individual efforts should be realised and the awardees should be incentivised accordingly in an effort to minimise pilferage
• Greater expertise should be acquired for the management of inventory and its respective replenishment cycles - to allow for improved order scheduling, demand management, holding inventory reduction and product visibility
• More accurate data should be obtained from the dispensing and procurement departments during pharmaceutical statistics acquisition
• Improve the communication network between the hospital and the MSD

The following recommendations are made if forthcoming studies are to be conducted in this area:

• Arrangements should be made to conduct studies at Auckland Parks’ MSD. This shall enable greater understanding into the logistics network and supplier relationship management practices. Further arrangements should be made to possibly conduct studies at both Provincial and National Health - this would aid in the contextualisation of tender selection processes and resource allocation
• In-depth studies should be conducted into performance management and education and training - to understand the employee review system and employee empowerment strategies
• A risk analysis should be conducted to identify the more evocative consequences of ineptness to standard operating procedures and supply chain complexities
• In-depth investigations into the use of technology at the hospital should be conducted, to develop an understanding for further information technology integration into the current supply chain
REFERENCES


