# Automation of Pharmacy Inventory Management

**Zekerijah Šabanović**

Medical Faculty of Tuzla, University of Tuzla, Bosnia and Herzegovina
zekerijah.sabanovic@untz.ba

**Abstract:** Pharmacy inventory management (PIM) comprises business activities which are connected with the size and placement of stocked drugs. To manage minimal and maximal drugs stock, orders dynamics etc., pharmacies must track expiration dates of each drug in stock. Outdated drugs can't be counted as stock and produce lot of costs, especially for their disposal. The most number of pharmacies in Bosnia use European Article Numbering (EAN13) barcode by which is impossible to define drug expiration dates. Radio Frequency Identification (RFID) enables full automatization of PIM, but it is still not in use, mostly because of high costs of implementation of this system.
In our research we have observed 52 Bosnian pharmacies and presented another approach to barcode technology which can be used in automatization of PIM. As the base we have used existing EAN13 code, adding 6 digits for expiration dates. We have successfully created and tested program for extraction of EAN13 and expiration dates from that barcode using separate files in database to keep inputs, outputs and stocks of each item by expiration dates.

**Key words:** Pharmacy Inventory Management, Automatization, Barcode Technology, Radio Frequency Identification (RFID), Clarion Programming Language

## Introduction

Inventory management is the systems and processes of maintaining the appropriate level of stock in a warehouse. The activities of inventory management involves in identifying inventory requirements, setting targets, providing replenishment techniques and options, monitoring item usages, reconciling the inventory balances, and reporting inventory status (Sysoptima, 2005). The main activities (amongst the others) are: inventory planning and demand forecasting, inventory monitoring and balance reconciliation and inventory reporting. There is different types of costs that take part in inventory cost structures: ordering (or setup) cost, carrying (or holding) cost (cost of capital, cost of storage, cost of obsolescence, deterioration, and loss), stock out cost, item costs, shipping costs and other cost subject to volume discounts.

To have a successful pharmacy inventory management, it is very important (especially for drugs) to track and control of the expiration dates. As researches show (Charlotte A. S., 2002) (McCarthy G., 2005): Much of the pharmaceutical waste occurring at a pharmacy was due to expired pharmaceuticals. The development of reverse distribution companies has enabled pharmacies to ship all outdated drugs as products back through these firms for the purpose of returning them to the manufacturer for credit. Any outdated items that do not meet the manufacturers' return policy become waste at the reverse distributor which becomes the waste generator, since this is where the decision to discard the item is made.

The most number of pharmacies in Bosnia (in the Europe also) use EAN13 barcode as the standard by which is impossible to define expiration dates. Pharmacies in Bosnia mostly follow expiration dates manually. Employees walk around from shelf to shelf and write down quantity with separate expiration dates of each lot (or item) and send this, paper based reports to the managers. They enter the data into computers (mostly in Excel), analyze them and make appropriate decisions connected with orders, prices, sales etc. This approach to the pharmacy inventory management is less successful.

### 1. THE ROLE OF INFORMATION TECHNOLOGY

#### 1.1. Barcode Technology

There are two main types of barcodes which are used in enterprises: linear (1D) and two-dimensional (2D).The usage of first one is much chipper and simple but it can present smaller number of human readable codes. Linear barcodes are used widely and there is a lot of types of them like: UPC, CodaBar, Code 25, 39, 128, Pharmacode, European Article Numbering -EAN, etc. There is a lot areas for use of barcode technology like: inventory management, stock control, manufacturing, patient identification, drug identification, purchased items scanning, work orders scanning, equipment tracking, document management, entertainment (tickets with barcode) etc. (Šabanovic Z., Osmanbegović E., 2010). EAN13 barcode is used as a standard in most European countries.

#### 1.2. Radio Frequency Identification (RFID)

The purpose of an RFID system is to enable data to be transmitted by a portable device (using radio frequency), called a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the
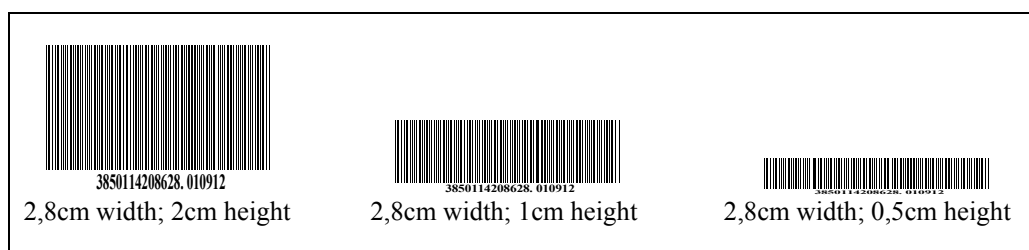
tag may provide identification or location information, or specifics about the product tagged, such as price, color, date of purchase, etc. RFID technology has been used by thousands of companies for a decade or more. RFID quickly gained attention because of its ability to track moving objects. There are a lot of current and potential uses of this technology (Association for Automatic Identification and Mobility, 2010) like: asset tracking, manufacturing, supply chain management, retailing, payment systems, security and access control.

## Material and Methods

In September 2011. we have observed 52 small and middle size pharmacies in North Eastern of Bosnia and Herzegovina. Tracking of drug expiration dates is very important for all of them. For simulation and testing purpose we have generated extended barcode which includes EAN13 barcode and 6 digits for expiration date (with point as delimiter) (Picture 1, Picture 2). Through experiments, as the most appropriate we have found Codabar which can accept up to 30 numeric digits. We have printed barcodes in 600*600 dpi in various sizes (width from 10cm to 2cm) using Datamax I-4604 thermal printer which is used for label printing applications that demand high-resolution graphics, two-dimensional barcodes or very small labels. For barcode scanning we have used two types of barcode scanners: Metrologic mk9590-61a38 (lower resolution reader) and 3800g Linear & PDF Image Reader (2dimensional and high resolution reader).

In Clarion programming language we have created form for extended barcode scanning and routine for EAN13 and expiration date extraction from it (Šabanović, Z., Osmanbegović, E., 2010). Separate files (tables) were added to the relational database to keep expiration dates and quantity for each item (with different expiration date).

Picture 1. Samples of smallest extended barcodes (Codabar) that can be decoded



3850114208628. 010912
2,8cm width; 2cm height    2,8cm width; 1cm height    2,8cm width; 0,5cm height

Picture 2. Sample of drug with extended barcode (front side) and EAN13 (top side)



## 3. RESULTS

By analyzing of data from 52 observed pharmacies we have found that 100% of observed pharmacies use barcode technology for point of sale purposes, 17,3% generates and prints barcodes (EAN13 only 11,5% of pharmacies), 88,5% of pharmacies track expiration dates manually (Table1). In observed pharmacies there is no any specific Decision Support Systems – DSS, built to help and automate pharmacy inventory management. There is no usage of RFID technology in pharmacies inventory management

**Table 1**. Usage of barcode technology (52 observed pharmacies)

| Description | Number of pharmacies | Percentage |
|---|---|---|
| Point of Sale (POS) usage of barcode technology | 52 | 100,0% |
| Other uses of Barcode (inventory management) | 7 | 13,5% |
| Barcode generate and print | 9 | 17,3% |
| EAN13 generate and print | 6 | 11,5% |
| Manual tracking of drugs expiration dates | 46 | 88,5% |
| Usage of RFID | 0 | 0,0% |
| Computer generated drugs orders | 11 | 21,2% |
| Usage of specific DSS in pharmacy inventory management | 0 | 0,0% |
| Usage of Excel in pharmacy inventory management | 36 | 69,2% |

Picture 3. Form for extended barcode scanning



During testing of form and program routine made in Clarion (Sofvelocity Inc., 2011) (Picture 3, Picture 4) we didn't find any errors in drugs expiration dates extraction and storing them in the database. Barcode can be printed in a minimal size 2,8cm of width (Picture 1). Smaller barcode pictures cannot be scanned and decoded. Files/tables which keep expiration dates have been successfully added in existing relational database Sofvelocity Inc., 2011)  (Diagram 1)

Picture 4. Routine for EAN13 and drugs expiration date extraction

```
Extract_EAN_ExpiryDate    ROUTINE

  IF barcode = '' then exit.

  extract_date# = 0; EAN13 = ''; exp_date = 0; Day" = ''
  Month" = ''; Year" = ''

  LOOP x# = 1 TO LEN(CLIP(barcode))

    IF SUB(barcode,x#,1) ='.'                    ! Delimiter (here point)
      extract_date# = 1
      CYCLE
    .
    IF extract_date# <> 1                        ! EAN13 extraction
      EAN13[x#] = SUB(barcode,x#,1)
    ELSE                                          ! Expiry Date Extraction
      Day"   = sub(barcode,x#,2)
      Month" = sub(barcode,x#+2,2)
      Year" =  sub(barcode,x#+4,2)
      BREAK
    . .
  Date" = clip(Day") & '.' & clip(Month") & '.' & clip(Year")
  exp_date = DEFORMAT( Date", @d5.)

  DISPLAY
```
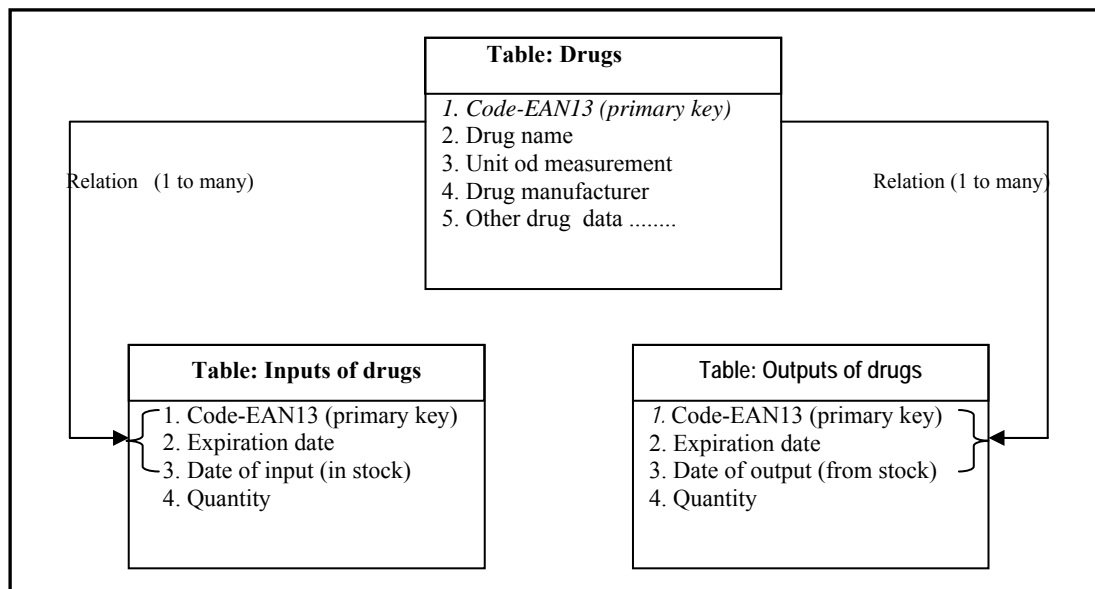
Diagram 1. A part of database created to store drug expiration dates of inputs and outputs

**Table: Drugs**

*1. Code-EAN13 (primary key)*
2. Drug name
3. Unit od measurement
4. Drug manufacturer
5. Other drug  data ........

Relation   (1 to many)

Relation (1 to many)

**Table: Inputs of drugs**

1. Code-EAN13 (primary key)
2. Expiration date
3. Date of input (in stock)
4. Quantity

Table: Outputs of drugs

*1.* Code-EAN13 (primary key)
2. Expiration date
3. Date of output (from stock)
4. Quantity

## Conclusions

Based on our research we can conclude that barcode technology is used regularly in most Bosnian pharmacies but they cannot track expiration dates automatically. Extended barcode (which shouldn't be printed on the same side with existing EAN13) is cheap and very successful solution for drugs expiration dates tracking. This barcode can be even smaller since many drugs has only month and year as expiration date (for ex. 12.2012), so for coding is necessary additional 4 digits. Even with full expiration date we can make barcode smaller using ordinal numbers of days in year (3 digits) and one digit for year (for example 0042 - extracted drug expiration date is 04.01.2012).

On the drugs manufacturers side extended barcode should be printed on the package of each item (for point of sale purposes). In the hospital, wholesale and community pharmacies with smaller changes in their pharmacy information systems (software and databases) they should be able to track drugs expiration dates (with single barcode scan of drugs inputs and outputs) increasing level of automatization of pharmacies inventory management (planning of drugs stock, determining of drugs prices, generating drugs orders automatically and decision making process.

## References

Association for Automatic Identification and Mobility. (2010) *Technologies: Bar Code & RFID*   Retrieved from http://www.aimglobal.org/technologies/barcode/

Charlotte, A. S. (2002) *Managing Pharmaceutical Waste.* Journal of the Pharmacy Society of Wisconsin. Retrieved from www.premierinc.com/safety/topics/epp/downloads/PSW_article.pdf

McCarthy, G. (2005) *Managing Pharmaceutical Waste*. Connecticut Hospital Roundtable. Retrieved from www.ct.gov/dep/lib/dep/p2/institution/pharmaceutical_waste.pdf

Sofvelocity Inc. (2011)  *Clarion Language Programming*, Pompano Beach, Florida.

Softvelocity Inc. (2011) *Data Modeller*,  Pompano Beach, Florida.

Sysoptima, (2005) .  *Inventory Management Overview - Demand Forecasting, Inventory Monitoring and Inventory Reporting*. Retrieved from  http://www.sysoptima.com/scm/inventory_management.php

Šabanović, Z.,  Osmanbegović, E., (2010) *The role of barcode technology in inventory management*.  Conference proceedings. Management, izobraževanje in turizem. Portorož. Slovenia.