# Online Monitoring of On-Shelf Availability

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## Abstract

This paper presents a mobile application to monitor on shelf availability. The application has been developed to respond to the request of one of the biggest FMCG companies in EGYPT. The application role is to monitor the availability of the SKU's on the shelves of the retail stores and to update the availability sheets at the managers' end online. The application, fed by the company's SKUs in the retail stores, is installed on the supervisors' android phones, and is synchronized online with Excel sheets on the supply chain managers devices. Once an SKU decreases and reaches an out-of-stock (OOS) predefined level the supervisor updates the appropriate cell in the application screen on his mobile phone, this new level is automatically transferred to the excel sheet at the manager's files. The replenishment decision can be taken immediately. The application developed has been applied to monitor the SKUs in thirty retail stores all over Egypt in time with simple, cheap and easy to use application on android Smartphones. The application improved the supply chain performance at a minimal cost and eliminated the probability of SKUs to become OOS.

## Keywords
supply chain -  on shelf availability - out of stock- real time monitoring –low cost mobile applications

## 1. Introduction

Supply chain management is full of challenges that can result in higher costs, waste materials, and production errors. According to Patil, D. et al Uncertainties in supply, process and demand are recognized to have a major impact on the manufacturing function. As per Chopra, S. and Meindl P., retails are an important echelon in the supply chains it is the interface between the manufacturer and the customers. Retail management is the process of creating a suitable ambience of the Store for customers to help them buy their needs in an easy way. Gruwen T.W. identified several factors that affect the buying decision of the customers such as store display and presentation of products, the ambience of the store, the customer treatment, the store design and layout, the discounts and rebates and the promotional schemes.

On-shelf availability (OSA) is an important factor in products presentation. It is about providing a product, in a saleable condition when and where the shopper wants it. Although it sounds simple, in practice it is a complicated process affected by many interdependent factors including suppliers, retailers, warehouses and stores. Ensuring good availability is an industry-wide issue affecting all retailers and manufacturers. Moussaoui, I et al., identified five categories of drivers of OSA, namely operational, behavioral, managerial, and coordination drivers triggered from failures at the planning or execution stages of retail operations. The fifth category – systemic drivers – encompasses contingency factors that amplify the effect of supply chain failures on OSA. Effective on-shelf availability depends on how efficiently retailers manage some of the top supply chain challenges in the areas of inventory reduction, and warehouse and transportation efficiency. Retailers need to clearly identify the root cause of out-of-stock scenarios. It is essential to understand that the problems are often interconnected and distributed across the supply chain. The different scenarios as described by Grubor, A., et al include products available in the retailer's back of house but not on the shelf, products available at the retailers' distribution center but not in the store. product available with the manufacturer but not in the retailer's store or distribution center, and product not available across the supply chain.

Furthermore, out-of-stock events (OOS) occur when a stock keeping unit (SKU) is temporarily unavailable in a store in which it normally appears. These OOS pose a significant problem for consumers, manufacturers, and

retailers alike: A product cannot be sold unless it is available on the shelf. The OOS rate is calculated as the average percentage of SKUs not in stock at the time of the audits. Many studies found that both the range of causes of OOS as well as the appropriation of causes varies significantly, among these studies are those conducted by Verna, S. and Juneja, P. This makes finding a reliable consensus somewhat challenging. However, OOS causes can be summarized in store ordering strategies, store shelving mode, distribution centers management, store forecasting, under estimating the demand for a product, late delivery by a supplier, using the wrong lead time. More causes can include safety stock level that is too low, under ordering, product quality issues, supplier refusing to deliver, a shortage of working capital, or supplier refusing to deliver.

Since the competition between companies is high and with the desire of every company to achieve maximum profit and reach a high level of customer satisfaction, an FMCG company branch in Egypt found it necessary to improve OSA and overcome OOS problem. This work is based on the creation of an easy instrument to get real-time monitoring of the products on shelves to reduce OOS problem and consequently, get higher level of customer satisfaction and higher profit.

## 2. The Problem and the solution framework

This work depicts the problem of poor shelf monitoring problem encountered by one of the world's largest consumer goods company branch in Egypt. They produce four hundred brands across a range of food, home and personal care products. The focus of this study is on the spices, nuts and pulses products of the company. The Company possesses thirty counters spread all over Egypt. It can only monitor the five biggest ones daily. The other counters are monitored weekly. This problem of "poor shelf monitoring" may lead to out of stock products.

### 2.1. Consequences of the Problem

For spices, herbs, nuts and pulses products, out of stock instances can be a costly issue. With so many competitors in the fast-moving consumer goods industry, it is easy for a consumer to see that his desired brand is out of stock and grab another brand. Out of stock instances have significant strategic impacts. They result in a direct loss of brand loyalty and equity and encourage the trial of competitors' brands, which can lead to a permanent consumer switch. It is vital to retain as many customers as possible and to build strong customer relationships with them. If a product is not available to customers when they want it, the customer loyalty felt towards the brand will begin to deteriorate. Consequently, OOS results in loss of sales for the company.

### 2.2. Solution framework

OSA is a measure of retailer performance. Out of Stock is a major problem in retailing, as it leads to lost sales and decreased consumer loyalty. The term Out of Stock is used to describe a situation where a consumer does not find the product on the shelf, at the time he/she wishes to purchase it. The root causes leading to OOS include inventory inaccuracy, unexpected high demand, restock frequency and poor shelf monitoring. The different approaches to improve shelf monitoring include store audits, radio frequency identification devices, weighted sensors, real time mobile application.

To solve the company's problem a real time monitoring mobile application has been developed. Although automated visual analysis has been taken into consideration in studying such problems (Chaudhary, S and Murala, S), and the work done by Bottani, E. et al. considered the use of RFID in monitoring OSA, this work concentrated on the economic and social aspect consequently, the low development cost and the provision of jobs in a developing economy environment were of significant concern. The mobile application is installed on the supervisors' mobile devices with Android operating systems. Fed with all SKUs in the retail, the application is synchronized with excel sheet at the supply chain manager's. Once the SKU approaches the OOS predefined level at the retail store, the supervisor updates the cell of the pertaining data on the device in his possession. The updated data is instantly transferred via internet to an excel sheet at the company where analysis is conducted and information is drawn and used by the management to support the decisions. The solution framework is shown in figure 1.
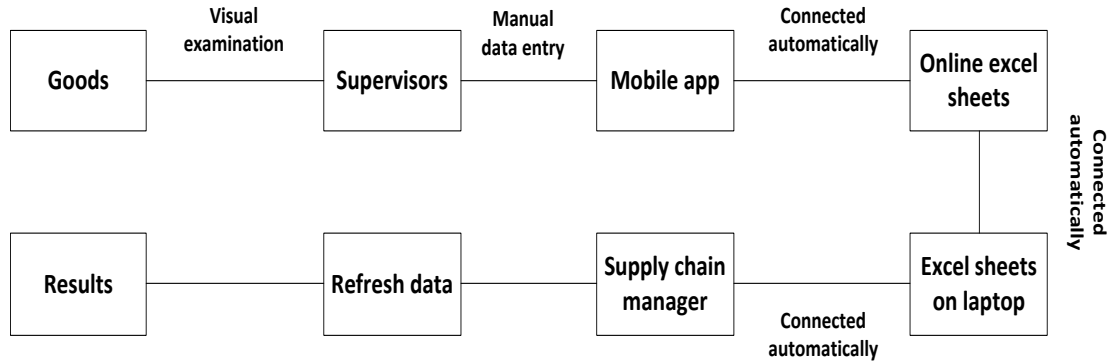
Figure 1. Solution Framework

## 3. Design Considerations and Development

The work started by meeting and communications with the designated department in the company to agree on the relevant KPIs, their measurement formulae and their success indicators. Following this step, the development requirements were prepared.

### 3.1. Key Performance Indictors (KPIs) selection

The system is developed to monitor OSA and data is synchronized with an excel sheet in which a number of selected KPIs are calculated. The KPIs are set by the company to suit its strategy. The used KPIs are:

### 3.1.1. Lost sales

Lost sales are lost selling opportunities. This performance indicator helps understanding reasons of lost sales and can help maintain accurate forecasts. Controlling lost sales leads to increase profit, increase customer service level and improve inventory management process [Gruen, T. et al.].

$$\text{Lost monetary sales } = \text{ average selling price } \times \text{no. of lost customer } \times \text{working days}$$

OR

$$\text{lost monetary sales} = \frac{\text{total sales losses (dollars)}}{\text{total sales losses (dollar)} + \text{total sales (dollar)}}$$

OR

$$\text{lost unit sales} = \frac{\text{total sales unit losses}}{\text{total sales unit sold } + \text{total sales unit losses}}$$

### 3.1.2. Sales Target

Sales target measure and compare current sales to target sales. The sales target KPI measures current sales (either dollar value or number of wins) and compares that value to a target or past performance. This sale KPI helps visualizing the performance of sales teams in a tangible way and motivates them. Moreover, sales target offers equal earning opportunities for all. It achieves compensation objectives, remain flexible to market changes and achieve sales goals.

$$\text{On target \% } = \frac{\text{actual sales}}{\text{target}} \times 100$$

$$\text{Difference } = \text{actual sales} - \text{target sales}$$

The sales target mark success when the sales passes the sales target or the previous period's value. It also helps predicting consumers' behavior.

### 3.1.3. Product Performance

The product performance KPI ranks product sales based on revenue performance to inform the sales team which products are selling well. At the same time, the company should rank the poorest performing products to determine which products are failing to resonate with customers. The product performance indicator helps the organization

identifying the top product performance thus considers some reserves such as preventing top product from becoming out of stock. Furthermore, it helps informing the sales team which products are selling well. Good product performance is marked by increase in product sales revenue, increase in number of units per order and increase in the average dollar value of each purchase order.

$$\text{product performance} = \frac{\sum \text{Product revenue}}{\text{period}}$$

OR

$$\text{product performance} = \frac{\sum \text{quantities of product sold}}{\text{period}}$$

## 3.2. Application Development

The application is used for monitoring on shelf availability, it is developed using the mobile app builder AppSheet. Four development requirements were planned followed by the management mode of the application and at the end the security mechanism of the application was set.

### 3.2.1 Development requirements

#### 1. Spreadsheet generation

The application is based on the table structure of data in the spreadsheet. The spreadsheet is neat and tidy and have a defined set of columns and corresponding headers to help the application to identify the values in those columns. To speed up the recognition of the columns data have the same format as shown in Figures 1 and 2. New data are added as new rows, not as columns.



Figure 1 Meaningful column headers on spread sheet



Figure 1 Similarly formatted data on spread sheet

#### 2. Application Construction

The application is constructed using Appsheet's add-on for Google Sheets to turn the company sheets into a mobile application

#### 3. Application Customization

An interactive emulator helps previewing the mobile application. Moreover, there are tabs for data edition, control of the appearance and settings. The latter is responsible for the name of the application, the choice of the level of security and the ability of the application to work online and/or offline

#### 4. Application Installation

AppSheet is downloaded from any device's applications 'store. Subsequently the Mobile Application for On-shelf availability developed is run through the AppSheet application.
The mobile application is then distributed to the team by sending an installation link by email. When users click on the link from a mobile device, they are asked to install AppSheet on their devices. As shown in figure 3.
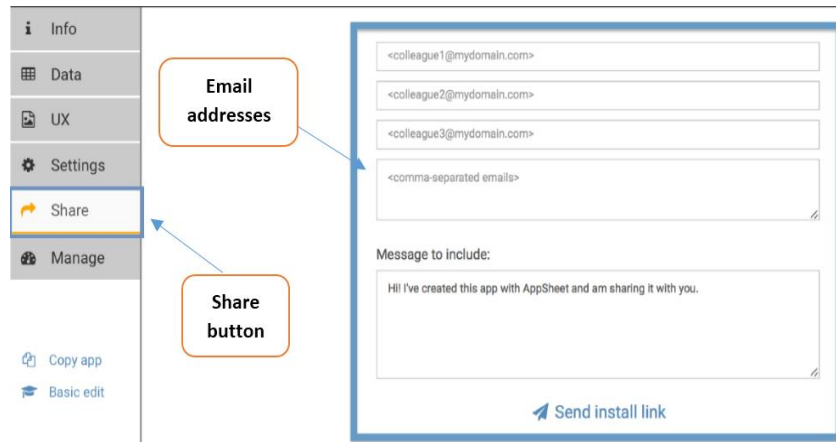
Figure 3. Share tool on app settings

### 3.2.2. Managing the application

There are a few simple checks to make sure the application is ready for use and deployment. Upon following these steps AppSheet verifies that the application is ready to deploy—if not, it informs the creator about the steps need to take. As shown in figure 4.
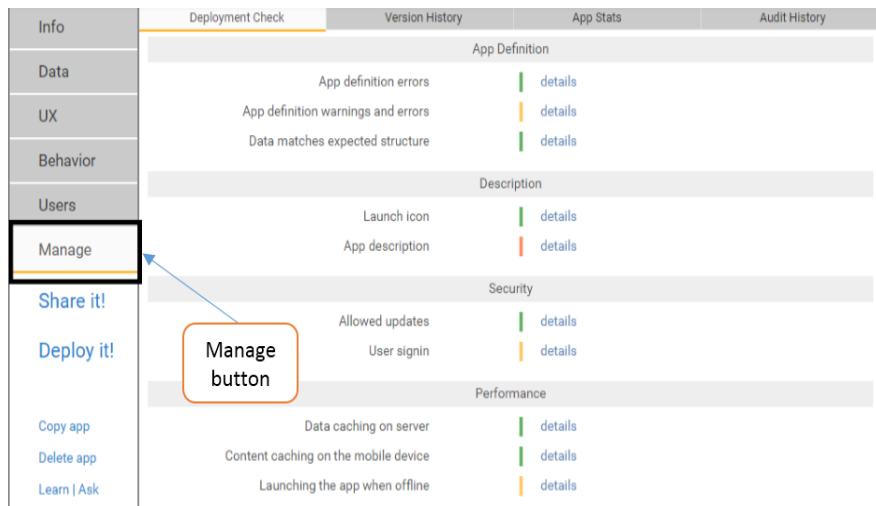


Figure 4 Management tool on AppSheet settings

### 3.2.3. Securing the application

There are three mechanisms of control, namely distribution control, Access control and Data control. The Distribution control limits the use of the Application to the targeted users only. The Access control enables the generation of a white list of users. The Data control enables the Application creator to limit what can or cannot be seen by the users.

## 4. Mobile Application Implementation

The steps followed to monitor OSA and to report OOS and to subsequently calculate the KPIs is depicted in the flow chart shown in figure 5 and explained in the subsequent sections.
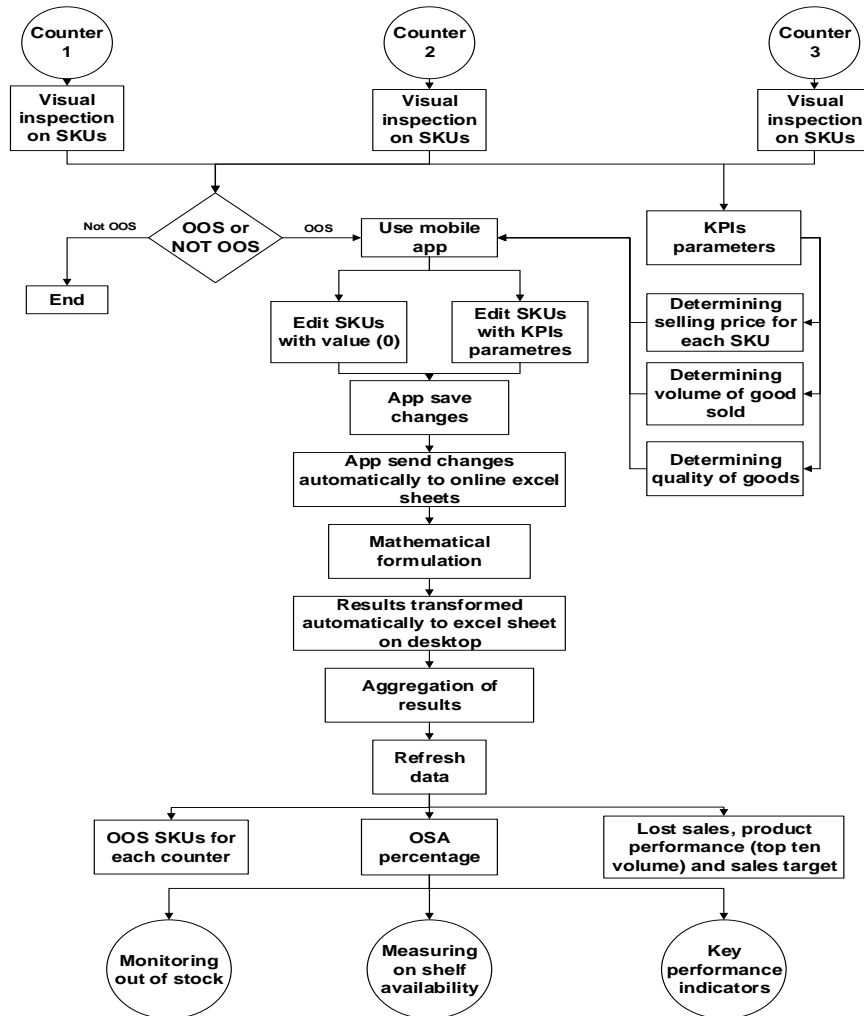
Figure 5.  Flow chart of the overall system

## 4.2. Components and actors of the system

### 4.2.1. Products

The company has a variety of products which are classified into four categories: herbs and spices, beverages, pulses, and dry food and nuts. Each type of product in each one of the four categories has its unique SKU a shown in figure 6.

### 4.2.2. Supervisors

The mission of the supervisors is to see the level of SKUs on the counters to determine which products are out of stock and to enter the selling price for each SKU, the volume of goods sold and the comments about SKUs shape

### 4.2.3. Decision Maker

The Decision maker (or manager) has the ability to refresh the data at his end to synchronize the excel sheets and draw conclusions based on data analysis.
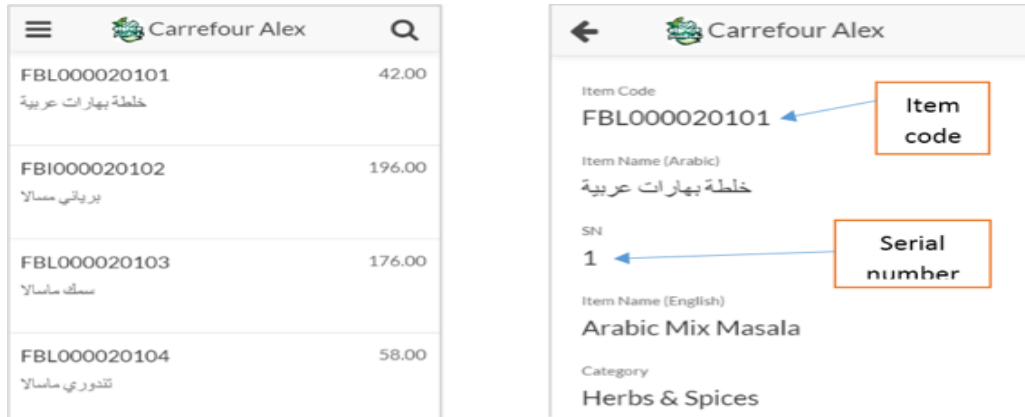


Figure 6. SKUs item code and serial number on the mobile application

### 4.2.3. Data entry

The supervisor begins to record the results on the mobile application. The recording process takes the time of pressing the "0" button to replace the "1" that indicates the original status of the SKU as available.

- Each SKU is presented by a "1" for 31 days on the application which means that the default is the availability of the products. If the product becomes "not available" at the counters' end, the supervisors replace the value "1" by  a "0" which mean that the product is OOS as shown in figure 7.
- Each SKU has a selling price, volume of good sold and comments button on the application for each day as shown in figure 8.
- After recording results on the app, the app sends automatically the results to online excel sheets which have all mathematical relationships to determine the KPIs as shown in figure 8.
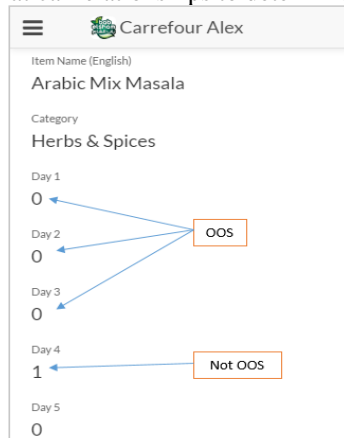


Figure 7.  SKUs OOS or not OOS with values (0,1) on the mobile application
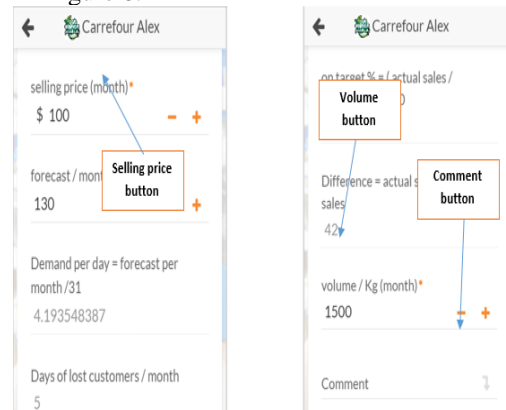
Figure 8 Selling price, volume of good sold and comments buttons on app

### 4.2.4. Online excel sheets

The full excel sheet appears on the manager's terminal (decision maker's end). It can be synchronized at anytime, and KPIs at any counter can be calculated automatically as shown in figures 9, figure 10 and Figure 11



Figure 9 Online excel sheets with values (0,1) of SKUs



Figure 10 Online excel sheet with lost sales calculated





Figure 11. Online excel sheet with KPIs calculated

### 4.2.5. Aggregation of the Excell sheets

All online excel sheets for each counter are connected automatically to one excel sheet on the desktop by using aggregation techniques.

## 5. Analysis of the outputs

From the aggregated sheets the decision maker can monitor the on-shelf status. The monitoring procedure includes the following three sections:

*1. Monitoring OOS SKUs for all counter as shown in figure 12*



Figure 12 Aggregation of OOS SKUs of all counters with values (0, 1)

The filter tool on excel enables the company to determine the daily OOS for each SKU as shown in figure 13.



Figure 13.  Filtering OOS SKUs for each day

*2. Measuring OSA percentage for each SKU for all counters per (day/month/year) as shown in figure 14.*

$$OSA \% = \frac{\text{Number of OOS SKUs}}{\text{Overall number of SKUs}}$$

| Counters | OSA percentage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Day 8 |
| Carrefour Alex | 95% | 97% | 97% | 100% | 99% | 99% | 100% | 100% |
| Hyper one Zayed | 96% | 98% | 100% | 100% | 100% | 100% | 100% | 100% |
| Spennies Arab Mall | 100% | 99% | 100% | 99% | 100% | 100% | 99% | 100% |

**Figure 14 Daily OSA percentage for all counters**

*3. Monitoring the variation of KPIs for all counters per (day/month/year) as show in figures 15, 16 and 17.*
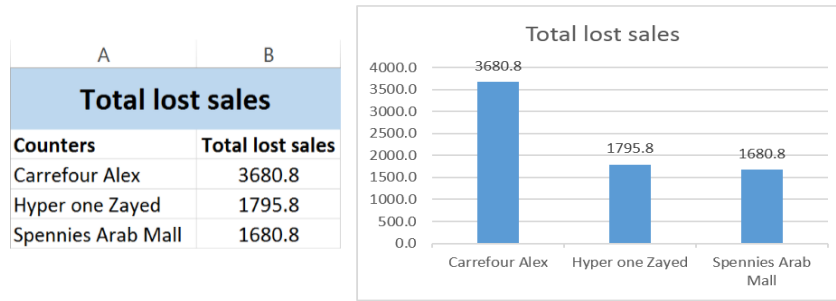


Figure 15. Lost sales (KPI) for all counters
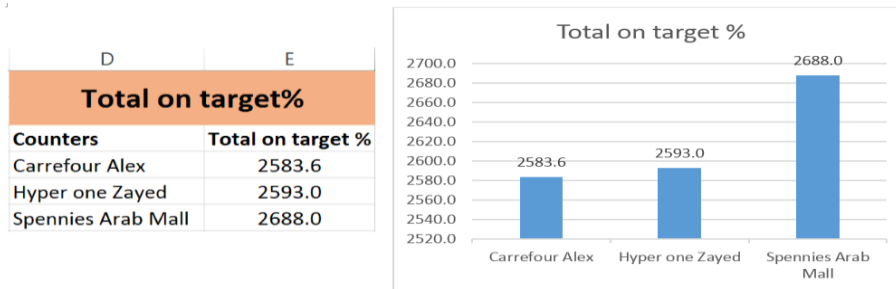


Figure 16.  On target % (KPI) for all counters
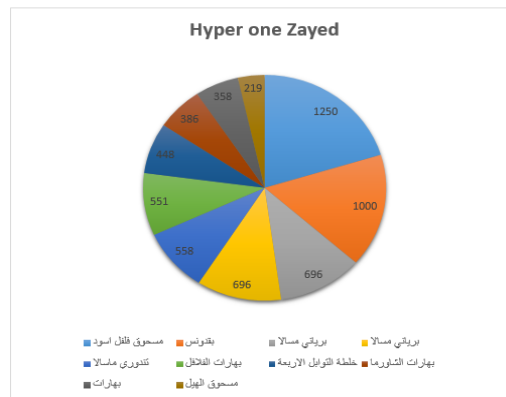


Figure 17. Top ten KPIs per counter (represented by volume of good sold)

## 6.  Mobile application cost as compared to other monitoring solutions

A rough estimation of the mobile application was conducted. The main cost elements taken into consideration are shown in figure 18. The company agreed that alike applications can be developed internally at the planning department as part of the teams' jobs hence no or minimal development cost can be considered.

| RFID technology | | | |
|---|---|---|---|
| | Tag | 20$ to 60$ | |
| | Antenna | 100$ to 300$ | Very high cost |
| | Reader | 500$ to 3000$ | |
| | Software | Existed | |
| | Development | Development cost | |
| | Maintenance | Maintenance cost | |

| Weight Sensors shelves | | | |
|---|---|---|---|
| | Sensor for each shelf, so large number of sensors will be exist | 150$ to 300$ | high cost |
| | Development | Development cost | |
| | Maintenance | Maintenance cost | |

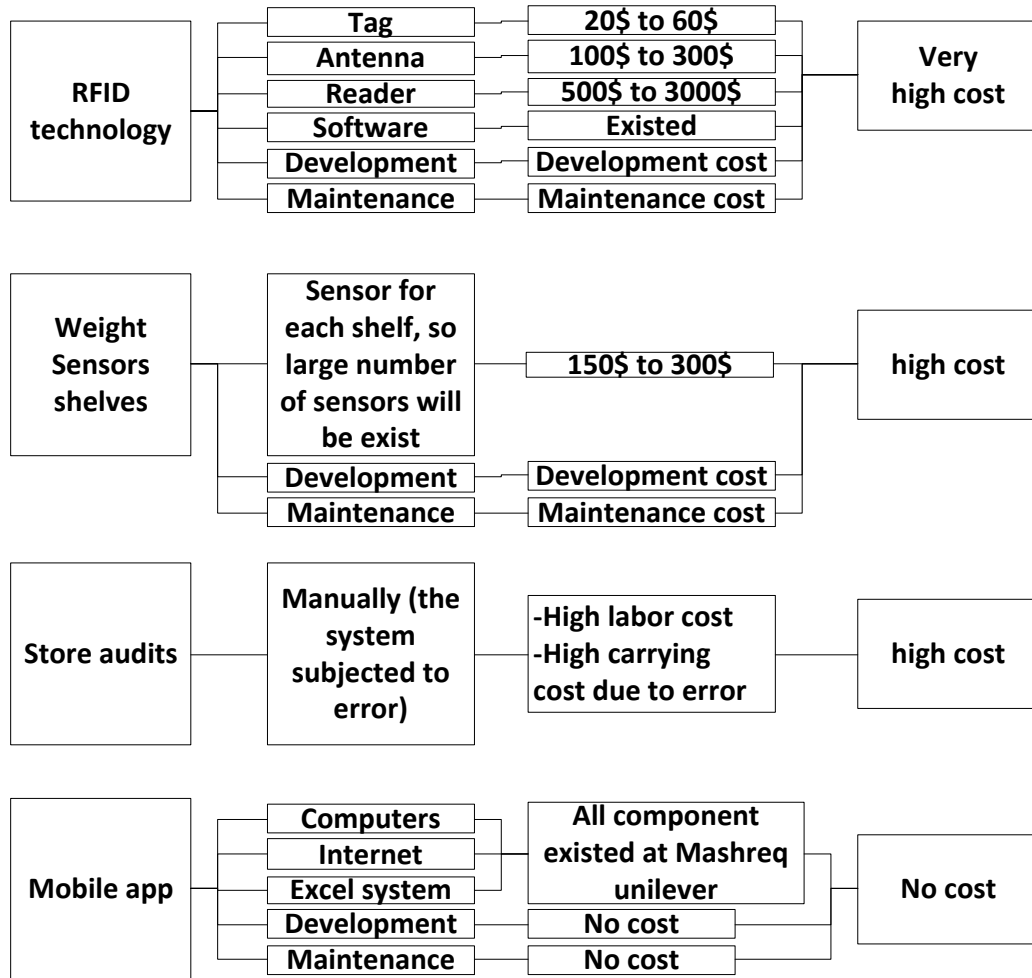| Store audits | | | |
|---|---|---|---|
| | Manually (the system subjected to error) | -High labor cost -High carrying cost due to error | high cost |

| Mobile app | | | |
|---|---|---|---|
| | Computers | All component existed at Mashreq unilever | No cost |
| | Internet | | |
| | Excel system | | |
| | Development | No cost | |
| | Maintenance | No cost | |

Figure 18. Comparison between the mobile application cost and other approaches

# 7. Conclusion

This work described the development of a mobile application for the online monitoring of OSA. The application is user friendly, easy to use and low cost. The application is synchronized with excel sheets at the supply chain manager's end (laptop or desktop). The implementation of the system within the company eliminated the probability of SKUs to become OOS hence enhanced the performance of the supply chain. Moreover, the implementation of the system solved the communication problems between different echelons of the supply chain.

The system developed helped collecting accurate data used in retail management assessment through the calculation of the KPIs designated by the company. These KPIs are used to achieve the work objectives and ensure customer satisfaction, better communication between supply chain manager and retails supervisors, prevention of OOS problems, improvement of OSA.

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