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Introduction to Out-Of-Shelf Monitoring Systems

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Out-of-Shelf Monitoring Systems for Retail

Introduction

Studies[i] show that, on average, 5% to 10% of the products offered today in grocery stores are unavailable at any given time, a situation which has not improved in two decades. Products that are not available to the consumer on dedicated shelf space are referred to as being out-of-shelf (OOS).

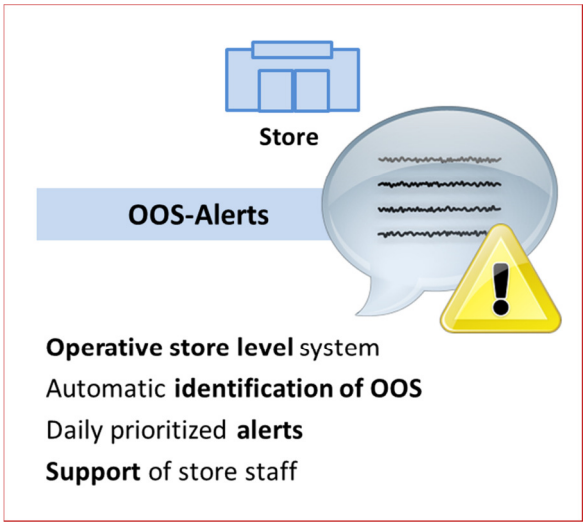
Out-of-shelf situations have been an ongoing concern in grocery retail for many years, and causes and cures are recognized to be diverse. At the same time, many organizations recognize that addressing the problem requires a greater visibility for out-of-shelf situations within the organization. With this aim in mind, they are working on developing and evaluating processes and systems that improve visibility throughout the supply chain.

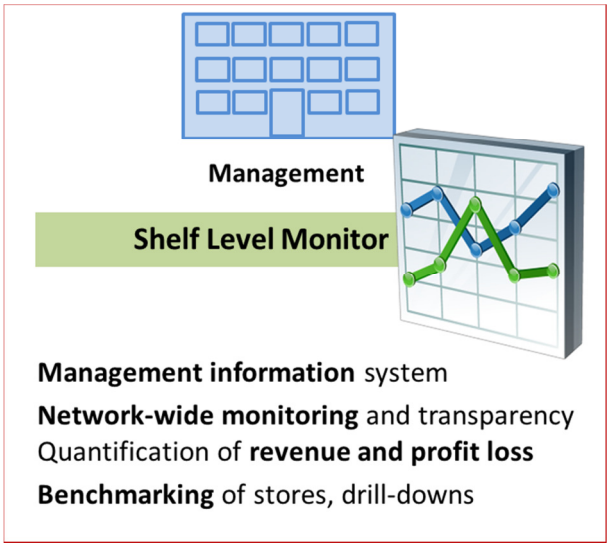
Of particular interest is store-level monitoring technology to detect out-of-shelf situations and send alerts to store management. This document outlines the key technological aspects of **indirect out-of-shelf measurement technology**, and quantifies system performance and limitations along several dimensions.

Objectives of an out-of-shelf monitoring system

Key objectives of an out-of-shelf (OOS) monitoring system:

- In-store staff alerts
- Broad coverage (product portfolio)
- High precision alerts
- Scalability for large distribution networks
- 'Near real time' monitoring





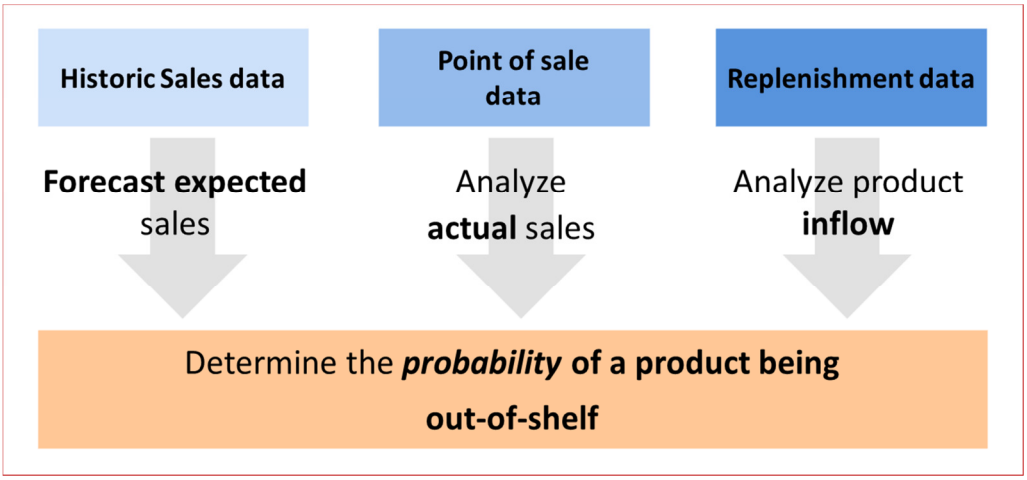
In some cases, the desired features may include network-wide visibility and benchmarking of OOS rates.

Out-of-Shelf Monitoring Technology

Indirect measurement systems

The purpose of out-of-shelf monitoring systems is to provide store-level, 'near real time' alerts for out-of-shelf situations, and, in some cases, to generate network-wide OOS reporting and benchmarking.

OOS analysis is performed indirectly: the system computes the probability of a product being out-of-shelf by analyzing expected and actual sales. This analysis, in most systems, is based on product-level and store-level sales forecasts.



Rule-based systems

Rule-based algorithms identify OOS situations based on rules that are 'hard-coded' into the system. These systems will only be able to generate a binary yes/no out-of-shelf signal, and will not be able to quantify and take into account the probability of an out-of-shelf situation. Usually the definition of the rules is the responsibility of the implementing grocer, requiring specialized staff and significant amounts of time. In particular, 'fine-tuning' of the system so that it works optimally within its capabilities is difficult to achieve and typically can only be done over the course of multi-week 'practice' runs.

Systems based on machine learning algorithms

Systems based on machine learning theory identify and monitor a large number of patterns that contribute to indicating an out-of-shelf situation. While most observed patterns provide

a rather weak signal, by combining these monitored signals system performance increases. These systems can quantify the probability of each monitored item being out of shelf. A resulting ranking of alerts, based on a calculated precision, allows alerts to be selected appropriately and limited to a number that is manageable for store staff. Furthermore, the system can be tuned in parallel to provide network-wide reporting and benchmarking, which provides management with the visibility needed to measure and manage OOS over the network, by product group and by supplier.

The forecasting engine

The key ingredient required for such an OOS analytics technology is state-of-the-art forecasting technology.

- The accuracy of the technology will greatly affect the performance of the overall system. Any further analysis and heuristics are, after all, based on a precise prediction of what will be sold in the store.
- The flexibility to forecast on a daily, weekly and even monthly basis will widen the system's coverage to include slower moving products that might only sell a few items per week or month.
- A scalable forecasting engine is required to roll out the system to full sized retail networks. Limitations in scalability will vastly impact the performance and economics of the system.

Performance

The OOS-monitoring system's performance is defined via several interlinked criteria which are outlined below. A high performance system must be able to measure and fine-tune these criteria.

Sensitivity

System sensitivity denotes the percentage of in-store OOS situations that are captured.

Precision

Precision is the ratio of true OOS situations with respect to all OOS events reported by the software.

Trade-off between sensitivity and precision (or coverage and accuracy)

The ability of an indirect measurement system to detect an OOS situation is directly correlated with the sales frequency (or rotation) of the product. An indirect system will have a minimum rotation threshold below which the required sensitivity and precision cannot be provided.

Sensitivity and precision are a direct trade-off: neither 100% sensitivity nor 100% precision is possible; or rather 100% sensitivity implies 0% precision. The combined level of performance is driven primarily by the quality of the underlying forecasting technology, which can greatly boost both sensitivity and precision. The ability to fine-tune the trade-off between sensitivity and precision allows the system to be adjusted to a specific application and to meet a retailer's needs.

As reference, the lowest performing systems on the market today will provide a high precision for products that are sold at least 8 times on average over the monitored time period (e.g. 8 units/day for daily monitoring), while the highest performing systems can provide high precision for products that are sold at the rate of 1 unit/monitored time period.

Precision quantification

Some systems quantify the precision of each generated alert, which has several additional advantages:

- Alerts can be prioritized (e.g. by precision), so as to limit alerts to a manageable level in the store and avoid 'flooding' of store staff.

- Network wide benchmarking and reporting is possible.

Latency (= detection speed)

The latency of an indirect measurement system describes how much time elapses from the start of an OOS situation until it is detected with the desired precision. In practice, time is measured by the number of time periods that are monitored. Typically a monitoring period of one day provides a good trade-off between system performance and complexity. However, it is also possible to have intra-day monitoring, with time periods of several hours.

Latency is also directly linked to product rotation. For a given time period, detection latency decreases with the number of units sold during this time period.

The flexibility of the underlying forecasting engine has a great impact on latency. Ideally, the forecasting engine is able to produce advanced hourly, daily, weekly and monthly forecasts for a given SKU at a store level. In particular, the system's ability to work with 'sparse' data (low rotation products) is essential, as it allows the detection window to be shortened until the minimum threshold for units sold per time period is reached.

The observation made above regarding system performance can also be made concerning latency: top monitoring systems will be able to detect OOS situations for products with average sales of 1 per monitored time period with the precision and latency that is typically required in food retail. For high rotation products selling several units on average per monitored time period, very short detection latencies equal or even less than 2 time periods can be achieved.

'Response-time' (= "real time capabilities")

'Near real time' is an often quoted feature requirement in OOS monitoring systems. In practice, this translates into two questions:

1) Latency: How long (i.e. how many time periods) will it take from the start of an OOS situation for the system to gain sufficient precision to issue an alert. Latency is directly linked to the ability of the forecasting algorithms to work with 'sparse' data (i.e. few data points); the fewer data points required, the sooner the alert can be issued.

2) 'Technical turn-around' time: how quickly and how often can the analysis be performed? Limiting factors are typically the degree of automation and the scalability of the system from an IT standpoint.

The 'technical' turn-around time for an alert analysis varies greatly, depending on monitoring systems, from minutes to several hours.

While 'near real time' is an often quoted requirement, retailers should adjust their expectations to what is reasonable from an operational point of view. For example, if store replenishment occurs just once a day and no backroom inventory exists, intra-day alerts will have no impact on the speed at which an OOS situation is eliminated and a daily monitoring time period makes the most sense. Intra-day alerts unnecessarily increase the complexity in such cases.

Scalability

In addition to the complexity of OOS detection itself, a second challenge is posed by the size of the network and the resulting amount of data that needs to be analyzed. Scalability problems typically result from two issues:

- The underlying IT infrastructure needs to analyze massive amounts of data within a short time frame and with short turn-around times. A roll-out to hundreds of stores requires high system scalability and robustness, but must not require massive investment. Solutions on the market provide different infrastructure solutions. Cloud-based systems, in particular, will usually outperform all on-premise systems in terms of scalability and cost.
- Systems requiring manual intervention (e.g. to tune forecasts, or to design and monitor potential rules) are expensive, slow, and difficult to scale because qualified specialists need to be found, hired and trained. It is therefore preferable to use a system that is largely self-calibrating and fully automated.

Summary

Monitoring systems are only part of the solution to out-of-shelf problems and cannot alone provide a 'magic fix'. Any serious attempt to improve shelf availability in a sustainable manner needs to start by continuously measuring and monitoring the situation. Modern out-of-shelf monitoring technology has reached a level of maturity that allows reliable performance for a significant part of the product portfolio at an affordable price, making such systems highly profitable from their first day of operation. Even more importantly, your customers will be delighted by the improved on-shelf product availability!

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Lokad

Lokad is a technology company focusing on big data analytics software for retail networks, wholesale and eCommerce. Client solutions include inventory optimization, loyalty card data analysis and out-of-shelf monitoring. The company is the winner of the 2010 Microsoft Worldwide Partner of the Year Award and is recognized as an international leader in cloud computing technology.

Microsoft Partner Network

2010 PARTNER OF THE YEAR
Windows Azure Platform
Winner

Lokad Shelfcheck Out-of-Shelf Monitoring

Shelfcheck On shelf availability monitoring provides prioritized out-of-shelf alerts to store staff and group wide transparency and benchmarking to management and suppliers.

The solution is fully cloud based and delivered in a software-as-a-service model which reduces investments and operating cost to a minimum. Full scale field test can be accomplished in weeks.

For further information please see www.lokad.com.

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