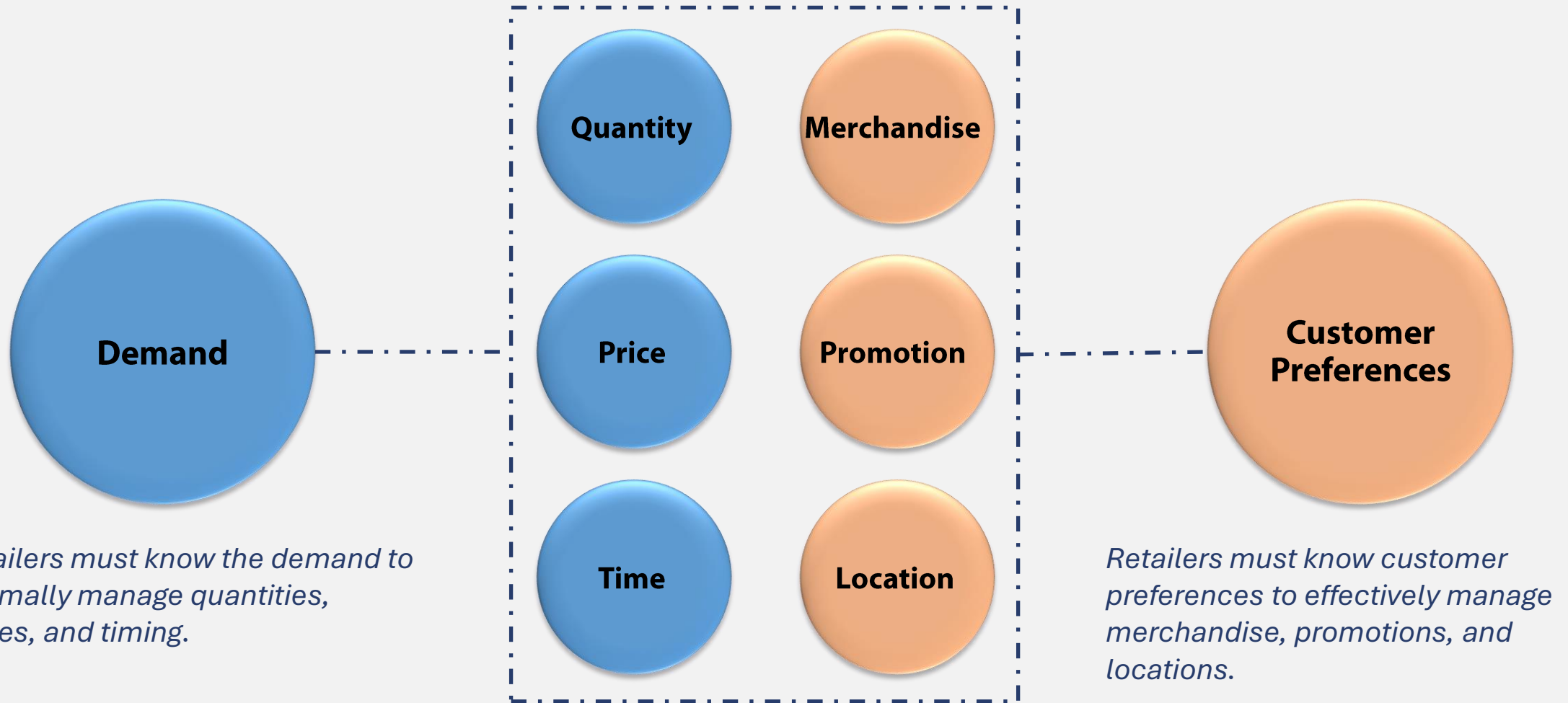




NOVEL SOLUTIONS TO EXISTENTIAL RETAIL PROBLEMS

by YieldWise Inc.

The Problem: what are the right quantities of the right merchandise with the right price and promotion to be delivered at the right time to the correct location?



How to “Know” Demand

Redefining Demand Forecasting



Shift in Demand Forecasting Paradigm

Traditional

Commonly accepted, but **incorrect and misleading**, understanding of demand forecasting and forecast error:

Forecast = expected value of demand

Forecast error = difference between forecasted value and actual value

Accuracy: Measure of how closely the forecast value matches the actual value

Precision: The spread of the forecast residuals

Probabilistic

The **comprehensive and correct understanding** of demand forecasting and forecast error:

Forecast = the distribution of possible demand values (the range of potential demand values)

Forecast error = the error in the distribution (the discrepancy in the range)

Accuracy: Measure of how close the forecast distribution is to the actual distribution

Precision: The dispersion of the forecast distribution



Advantages of Probabilistic Paradigm [1]

The methodology helps identify how traditional views on demand forecasting and forecast errors are causing business problems and harming competitiveness.

- **Demand and out-of-stock:**

Does being out-of-stock pose an equal risk as being overstocked?

Or... does each one have its own probability and mitigation plan?

- **Intermittent demand:**

(characterized by having several sporadic or highly varying periods of demand, **60%-75%** of merchandise have intermittent demand)

Do you sell 0.1 units each week?

Or... is there a 0.1 probability of selling 1 unit each week?



Advantages of Probabilistic Paradigm [2]

The methodology emphasizes the importance of correctly measuring demand forecast errors to instigate change.

Traditional metrics like MAPE, WMAPE, MASE, MAD, MAE, MSE, RMSE, and FVA **only assess the error of a single central point** per period.

A new metric, Total Percentile Error, **assesses the error in the distribution** of possible demand values:

$$\varepsilon_{general} = \frac{\sum_{b=1}^B w_b \left| \sum_{i=1}^n \mu_i (l_b - \lambda_{b,i}) \right|}{\sum_{b=1}^B w_b \sum_{i=1}^n \mu_i}$$

n is the number of observations

B is the number of percentile bins

w_b is the weight for percentile bin b

l_b is the size of the percentile bin b

μ_i is a weight assigned to the i -th actual

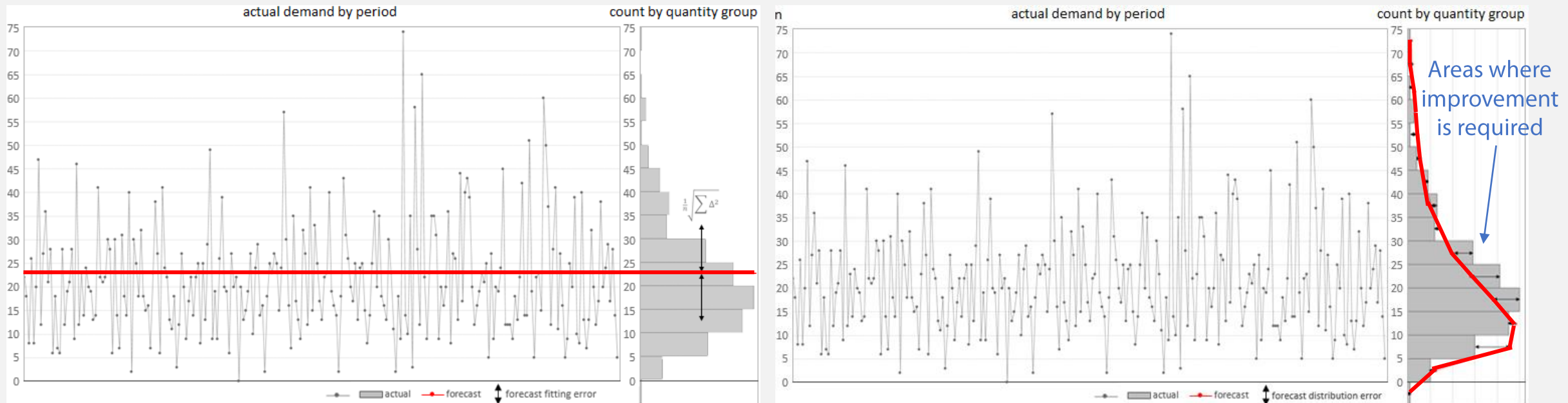
$\lambda_{b,i}$ is the spreading factor



Advantages of Probabilistic Paradigm [3]

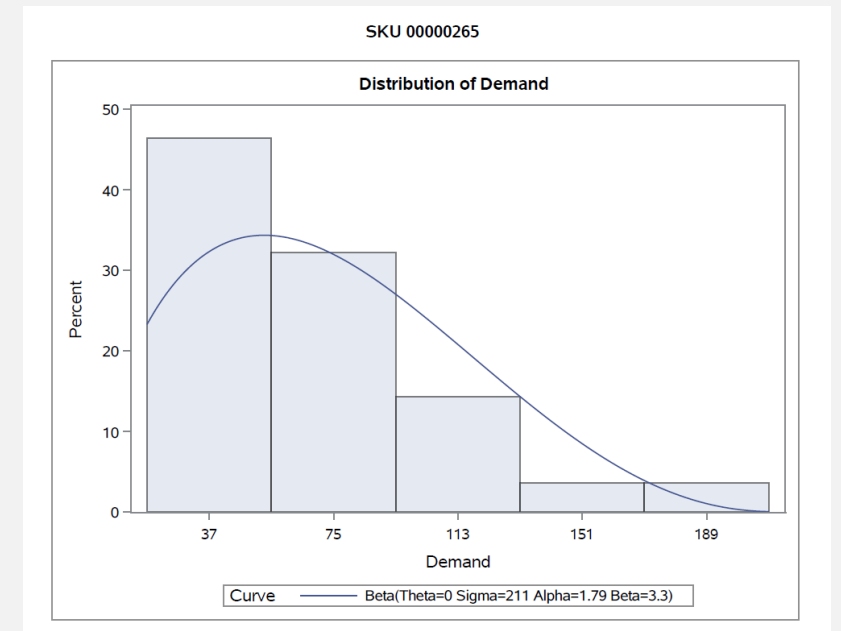
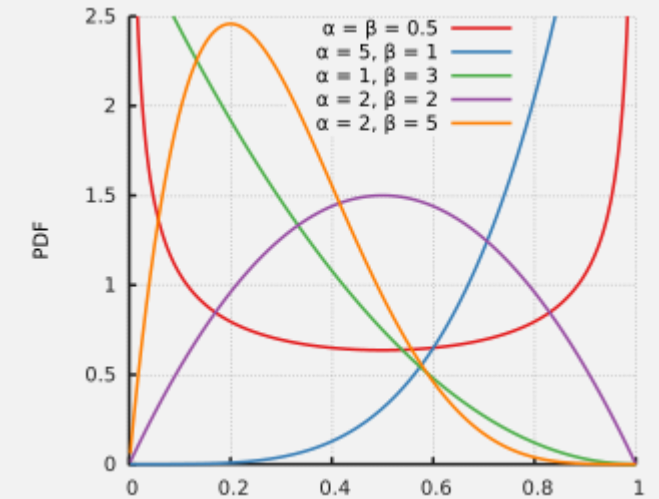
The probabilistic forecasting and the new metric of forecast error are eye-openers as to why all the previous efforts never worked.

Probabilistic forecasting explains the magnitude of demand variability. The new metric of forecast error properly measures uncertainty in forecasts, guiding improvements in forecasting.



Probabilistic Methodology

1. **Demand is decomposed into different sources** of demand (e.g., types of customers, sales channels, etc.)
2. Empirical **probabilistic distributions over demand levels form the basis for demand forecasting**. The empirical distributions are modeled using the Beta distribution and demand forecasts are presented as the demand levels multiplied by their probability.
3. The **quality of the forecast is assessed using the Total Percentile Error** which:
 - Measures the complete value of a forecast, not just the average expected value per period.
 - Is robust to intermittency, outliers, trends, seasonality, promotions, etc.



Business Value

A probabilistic approach to forecasting and forecast error considers the entire demand distribution, resulting in

- **Significant improvements in inventory management.**
- **Reducing inventory levels while still meeting customer demand.**
- **Allowing retailers to objectively identify areas for improvement**, regardless of product type or demand pattern.

By understanding the probabilities of demand, retailers can make more informed decisions about capacity planning, purchasing, production, inventory management, and budgeting, thereby **minimizing risks and capitalizing on opportunities.**



How to “Know”

Customer Preferences

Redefining Customer Analytics ::

Customer and Product Success Profile



Shift in Customer Analytics Paradigm

Surveys are everywhere, as they are a never-ending dialogue with customers about their opinions on new or existing products, brand awareness, customer needs, and other topics.

Traditional

Survey data is often **inappropriately analyzed**, leading to **incorrect conclusions** about customer preferences:

- Survey responses are often treated as numbers, even though they are measured on an ordinal scale and do not represent actual values.
- Different difficulties of survey items (survey questions) and the dependencies among them are often overlooked.
- Different abilities of respondents are ignored.

Novel

Survey data is **appropriately analyzed**, and it leads to **correct conclusions** about customer preferences when:

- Responses measured on an ordinal scale are converted to a probability scale.
- The analysis considers the difficulty of survey items and the ability of respondents.
- Dependencies among items are used to identify foundational (key) survey items.



AI/ML Customer Analytics

Modified Polytomous
Rasch Measurement
Model

$$P\{X_{ni} = x\} = \frac{\exp \sum_{k=0}^x (\beta_n - (\delta_i - \tau_k))}{\sum_{j=0}^m \exp \sum_{k=0}^j (\beta_n - (\delta_i - \tau_k))}$$

Relational Bayesian
Network



Proprietary
algorithms

Identifies malfunctioning survey
items and untrustworthy
responses

Identifies difficulty of survey
items and ability of respondents

Establishes causal relations
among survey items

Produces actionable outcomes
for the respondents as a whole
and for individual respondent

By conducting a **series of short consecutive surveys**, the system can accurately identify customer preferences and product strengths and weaknesses **eliminating the bias of sample under-representation**. This process creates a **Customer and Product Success Profile** that quantifies the impact of foundational items on consumer preferences.



Business Value

The **Customer and Product Success Profile** (or Model) offers numerous **benefits** to a business:

- **Enhances demand forecasting** by integrating it with customer preferences.
- **Generates product demand.**
- Reveals genuine **customer opinions on product attributes** and promotions.
- Identifies **crucial product attributes** and their alignment with customer preferences.
- Provides **actionable recommendations** for product and promotion improvement
- Helps **prevent costly errors** in product and promotion decisions.



About Us

- YieldWise Inc., has developed an analytical platform that supports applications like SINTENO. The YieldWise application suite also includes:
 - A-SCALA which focuses on redefining student success, and**
 - EXOUSIA which focuses on redefining employee success**
- YieldWise is a leading provider of innovative analytical solutions specializing in the research and development of sophisticated analytical methods and software tools for various applications such as demand forecasting, design of experiments, survey analysis, statistical quality control, survival analysis, time series analysis and forecasting, computer and network performance evaluation and capacity planning, statistical and machine-learning consulting and training, as well as SAS, R and Stata software training and consulting services.

