Section 1: Week 3: Smart Restaurant Proposal

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Smart Restaurant Proposal

The Black Bean started life as a simple ‘mom-and-pop restaurant,’ but has since rapidly grown to over one hundred locations. Now the business faces challenges ensuring the consistently high-quality experience customers know and love. As mitigation, the organization wants to deploy technology that provides business intelligence across the end-to-end lifecycle starting at the supply chain, continuing into each restaurant location, and finally presenting a personalizing mobile and social media presence.

# Current State of the organization

One of the critical challenges for Black Bean comes from its inability to continue scaling existing processes. Performing inventory management through local spreadsheets was sufficient when the business managed a handful of sites. As the organization grew, its ability to report on its current state became more distorted through latencies. Latency delivering sales information to head-quarters causes incorrectly placed products to spoil in one location and meanwhile be unavailable at another. Similarly, as a small group of franchises, the marketing team understood the identity of their customers. Now that the business spans numerous locations, they face challenges connecting with the highly diverse communities.

Black Bean’s IT department has addresses aspects of these challenges through point-of-sale solutions. These initial systems have standardized reporting templates that managers can manually populate. The organization also has investments in distribution and supply chain processes, but have not connected telemetry to cloud services. They also benefit from a positive work culture where employees are willing to embrace technology, assuming its beneficial and not overly complicated.

# Determine functionality and missing capabilities

There are three distinct pillars that Black Bean wants acumens into, specifically the supply chain, restaurant efficiency, and customer experience. These insights need to answer adaptive questions to leadership in a dynamic market place.

## Supply Chain Monitoring

The company specializes in desserts made from highly perishable ingredients. With the ability to monitor the various distribution centers’ environmental controls, such as humidity and temperature, product life can be extended and reduce waste. Integration of the point-of-sale (PoS) would ensure that products are routing to the ideal regions. As these efficiencies materialize, the forecasting error will reduce inventory in storage without risking shortages.

## Restaurant Efficiency

If the eatery cannot process orders within a reasonable time, customers will choose a competitor instead. To process orders quick enough requires sufficient wait staff that possesses enough training and domain knowledge. There are several other key performance indicators (KPI), such as trends in table reservations, that management would like to monitor for validating efficient order-flow (Liyanage et al., 2018).

## Customer Experience

Customer Relationship Management (CRM) has converged with social media and created a firehose of user-generated content (UGC) (Gioti et al., 2018). Now organizations need new techniques for topic extraction and sentiment analysis across the unstructured text. Traditional loyalty programs are ineffective because they focus on existing customers, despite the majority are new users (Koubai & Bouyakoub, 2018). These issues require pivoting to marketing strategies that align the corporate voice with the target audience’s values.

# What kinds of tooling would you recommend

The business intelligence solution needs to consume heterogeneous data sources and present role-based perspectives into the operational state. These data sources will originate across the business pillars as IoT sensors, mobile app interactions, point-of-sale data, hierarchical inventory fulfillment centers, advertising impressions, customer and employee feedback, and internal streams. Different aspects of these feeds will be relevant to customers, material suppliers, the wait staff, leadership, marketing, and sales teams, among others.

The format and mechanism for providing this information to the different audiences require specialization. For instance, identifying too many apples is cached in a regional warehouse should trigger a local advertising campaign to customers for apple pies, and in parallel, notify the local farmers to delay further shipments. The signal to the customer might occur through a mobile push notification, versus the farmer receives an email — meanwhile, the leadership team overseas that communications through a desktop web portal.

Making sense of these micro-optimizations is difficult for humans due to the depth of information to parse (McCrea, 2019). Systems need to detect these ‘too many apples’ scenarios that will happen with sufficient lead-time to make an actionable decision. These situations require machine learning models that can assess big data sets to surface these hidden rewards. Artificial intelligence is becoming democratized through Machine Learning as a Service (MLaaS) technologies, such as Microsoft Cognitive Services and Amazon SageMaker. These tools lower the cost and complexity and allow businesses of any size to reap value.

Other audiences will desire tooling that transforms the data into more personalized views, such as menu recommendations or targeted advertisements. Even something deliciously appealing, like cake and ice cream, will get a different reaction from market segments.

# Research and Evaluate Solutions

## Restaurant as a Service

For businesses that do not want a lot of hassle or customizations, a SaaS solution might be the best fit. These platforms follow Enterprise Resource Management (ERM) designs with a few optimizations for the restaurant industry. Two well-known providers are OpenTable (ENP Newswire, 2018) and Rosnet (Marketwired, 2015), both with full business intelligence suites that focus on inventory management, order-flow, employee scheduling, and visitor forecasting. Other providers, such as Foody, concentrate on customer enjoyment through a collection of KPS that measure order delivery times, mobile order-flow, and personalized menus (Liyanage et al., 2018).

## Deploying IoT

The use of Personal Digital Assistants (PDAs), like the Apple iPad, is a well-established trend. These devices reduce order entry errors but lack a broader integration with the rest of the experience (Saeed et al., 2016). Saeed et al. propose a solution that pairs a mobile customer app with an employee web portal. Their solution allows for mobile Near-Field Communication (NFC) to request a table, order items, and pay the check. The employee web portal tracks these lifecycle events and provides real-time updates to the management. When wait times exceed a threshold, remediations can be applied. Koubai and Bouyakoub (2018) designed an IoT solution that augments and facilitates workflows, using dedicated mobile apps for chefs, wait staff, customers, and connected smart devices (e.g., ovens and refrigerators). These apps then provide a continuous feedback loop that delivers transparency to all parties about the state of the order.

## Point of Sale

According to experts, “the larger the forecasting error, [or] the higher the desired customer service level more inventory that must be carried (Viale, 1996).” This inverse relationship means that Black Bean needs to minimize carried inventory to maximize profits. This optimization can be thought-provoking in complex supply chains due to the bullwhip effect (Croson & Donohue, 2003). While local order-flow has a predicable oscillation, upstream producers encounter an amplification effect. These forecasting errors cause inventory shocks and introduce waste. Williams and Waller (2011) pioneered electronic and automated mechanisms that share point-of-sales (PoS) data with both suppliers and internal purchasing teams. Kousiouris et al. (2019) expand on these ideas with a proprietary solution that integrates retail-outlet PoS data (demand) with sensors across the distribution center (supply) to produce a semantic model. A deep neural network (DNN) monitors the semantic model to discover deviations between the supply and demand states.

## Social Business Intelligence

The combination of business intelligence and social media is a relatively young field that attempts to mine user-generated content (UGC) for insights (Gioti et al., 2018). Along with personalized marketing and customer relationship management, businesses can use these feeds for corporate reputation monitoring. Hu et al. (2019) describe a cloud-based solution that consumes Twitter tweets and Glassdoor employee reviews to track market sentiments towards brands. Their solution relies on natural language processing (NLP) to normalize text before using Latent Dirichlet Allocation (LDA) topic modeling. Their supervised learning algorithm uses Elastic-Net regularization and K-Nearest Neighbors (KNN) to track changes over time.

## Ad-hoc AI

Despite a broad agreement that artificial intelligence can fundamentally improve business processes, many businesses are hesitant to adopt it (NEDSI, 2019). NEDSI proposes an adoption strategy that starts simple on a clear business case. For instance, a supervised learning system could use historical table reservations to predict the count of future guests (Ma et al., 2018). Ma et al.’s solution transforms the historical data with multiple regression algorithms and reports the average prediction. This particular solution was bais and effectively returned the mean value for a given calendar week. Nevertheless, MLaaS is reducing the time and complexity to evaluate hypotheses, even if they become abandoned later.

# Choose an Optimal Solution

Black Bean will need to borrow aspects from each of these reference implementations to build a holistic solution across their end-to-end lifecycle. This analytics pipeline would start with instrumenting the distribution centers with IoT sensors. Each distribution center aggregates at the edge, these ‘high volume/low quality’ data points into ‘low volume/high quality’ real-time service telemetry for the cloud (Harper, 2019). As trucks transport the product, GPS positioning allows centralized supply chain services to update the estimated delivery times continuously. If there are issues during this process (e.g., weather delays), then proactive mitigations can occur.

The transference of products between fulfillment centers and retail-outlets needs to align the supply and demand requirements. The bullwhip effect complicates these placements and requires a combination of PoS data sharing and artificial intelligence to discover an optimal arrangement. These challenges become amplified as the depth of the supply chain increases due to regional fulfillment centers populating local distribution hubs.

After the materials arrive at the retail-outlet, customers have specific quality and performance metrics that the franchise needs to meet. These measurements demand that the wait time is acceptable, the price is fair, and the ingredients are fresh. As the wait staff services the order, their workflow should interweave role-specific mobile apps that connect to the cloud. Employees become more productive through automated recommendations, and local supervisors can review the KPIs to identify training and knowledge gaps. Mobile apps also increase customer satisfaction directly by offering shortcuts, such as reorder the last meal.

Customers and employees interact with social media services, such as Twitter and Glassdoor, which becomes the voice of the market. Organizations need a strategy to listen to that voice and ensure it aligns with their cultures and values. Using natural language processing to perform topic extraction can enable aggregate views, and fine tweak the corporate message. Another critical aspect of social media is the ability to connect to the user through targeted and personalized ads.

All of these disjoined unstructured data sets need to blend into a higher-level real-time status of the corporation. One strategy is to transform these feeds into a unified logical semantic model. This approach allows the senior leadership to ‘slice and dice’ different sections of the business and confirms the facts that lead to a consistent and coherent story.

# References

Croson, R., & Donohue, K. (2003). Impact of POS Data Sharing on Supply Chain Management. *Production and Operations Management Vol.12, No. 1, Spring.*

ENP Newswire. (2018). OpenTable Unveils Business Intelligence Suite.

Gioti, H., Ponis, S., & Panayiotou, N. (2018). Social Business Intelligence: Review and Research Directions. *Journal of Intelligence Studies in Business Vol. 8, No 2*, 23-42.

Harper, J. (2019). Business Intelligence Tomorrow. KMWorld May/June, 12-16.

Hu et al. (2019). Generating Business Intelligence Through Social Media Analytics. *Journal of Management Information Systems Vol. 36, No. 3*, 893-930.

Koubai, N., & Bouyakoub, F. (2018). MyRestaurant: Smart Restaurant with Recommendation System. *International Journal of Computing and Digital Systems Vol. 8, No. 2*.

Kousiouris et al. (2019). Microservice-based framework for integrating IoT, semantics, and AI for SCM. *The Korean Institute of Communications and Information Sciences ICT Express 5*.

Liyanage et al. (2018). Foody - Smart Restaurant Management and Ordering System. *2018 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)* 1-6 Dec 2018.

Ma et al. (2018). Predicting Future Visitors of Restaurants Using Big Data. *Proceedings of the 2018 International Conference on Machine Learning and Cybernetics*, Chengdu, China, 15-18 July 2018.

Marketwired. (2015). Rosnet Serves Up Analytics for Restaurant Clients. Marketwired.

McCrea, B. (2019). Where is Supply Chain Software Headed? *Modern Materials Handling, January*.

NEDSI. (2019). Artificial Intelligence and Supply Chain Management−Applications and Challenges. *Proceedings for the Northeast Region Decision Sciences Institute*, 806-838.

Saeed et al. (2016). Near-Field Communication Sensors and Cloud-Based Smart Restaurant Management System. *2016 IEEE 3rd World Forum on the Internet of Things* on Dec 2016, 686-691.

Viale, J. (1996). *Basics of Inventory Management: From Warehouse to Distribution Center*. Course Technology Crisp.

William, B., & Waller, M. (2011). Top-Down versus Bottom-Up Demand Forecasting. *Journal of Business Logistics Vol. 32, Issue 1*, 17-26.