Digitalization of the Food Supply Chain: An Opportunity for the Fisheries Industry

by Christian E Coronado-Mondragon

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Figure 1: The Internet of Things (IoT) and other technologies have permanently transformed the technological and managerial landscape of supply chains.

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Introduction

Traditionally perceived low-tech primary industries such as agriculture and fisheries are undergoing a big transformation in terms of adoption of disruptive new technologies. Specifically, new information technologies are radically transforming the supply chain of these industries. Technologies like the cyber-physical system interphases, the Internet of Things (IoT) (Figure 1), Wireless Network Sensor Theory, predictive data analytics, cloud computing, and increased challenging cybersecurity constraints have permanently transformed the technological and managerial landscape of these supply chains. The IoT has been especially disrupting for managers since it provides a nearly perennial source of data for decision making. The difficulty faced by most managers is what to do with the available raw data. At best, managers will underutilize the managerial potential of raw data; at worst (and unfortunately likely to be in most cases), most managers and practitioners will ignore it because they do not know what to do or how to analyze it. The digitalization of operations and supply chains can be seen as a new paradigm that offers new opportunities. At the moment, there is an ongoing proliferation of enabling information technologies developed to assist modern-day operations.

Given this conundrum, the availability of a pool of existing IoT producing data systems and the opportunity to improve the decision making process for supply chains, we developed a methodology and used a case study to demonstrate that IoT-generated data can be used to improve the performance and management of supply chains.

Specifically, we decided that the SmartAtlantic buoy system for ocean observation (www.smartatlantic.ca; Figure 2) not only produces valuable and freely available raw data of the current ocean conditions but at the same time it represents a reliable multiyear repository of ocean conditions such as average speed wind (m/s), peak wind speed (m/s), wind direction from (°magnetic), air temperature (°C), barometric pressure (millibars), humidity (%), dew point (°C), average sea surface temp (°C), maximum wave height (m), significant wave height (m), peak wave period (sec), average wave direction from (°magnetic), average wave spread (degrees relative), average current direction toward (°magnetic), and average current speed (mm/s). Further to that, according to the Northwest Atlantic Fisheries Organization (NAFO), the waters around southern Newfoundland, and coincidentally within the area of operation of important SmartAtlantic buoys, are regulated by the NAFO convention on quotas. One of the most valuable species captured in the waters of the NAFO's 3P convention and in range of at least one SmartAtlantic buoy are the snow crabs (Figure 3) in the area of Red Shoal in Placentia Bay, N.L. Snow crab are water-sensitive crustaceans, which migrate to areas of colder water and its fishing its tightly regulated by seasonal quotas.

Methodology

Methodologically speaking, we developed a bi-layer approach that consisted of an inner layer for the management of an array of selected sensor-generated data and an outer layer for the statistic and predictive analysis of such data. More specifically, in the inner layer of our analysis framework, we used ocean readings of critical data generated by the Red Shoal buoy. In the outer layer, we employed analytical tools to analyze historical data to predict the ideal areas for the capture of snow crabs to maximize yields. Our data framework included an analysis of season landings for the snow crab in the Red Shoal area for the years 2016 to 2019, and it was cross-referenced to the daily ocean observations for each season in these years.

Figure 2: The SmartAtlantic buoy system for ocean observation produces freely available raw data of ocean conditions.

An algorithm, named LEACH, was used to prioritize and establish a clustered hierarchy that focuses on energy utilization by the sensors. The obtained sensor readings were validated and then analyzed using an online Python data compiler (available at anaconda3/Jupyter notebook) to run predictive time series and to produce aggregated scatter diagrams. Python is a data compiler that allows the analysis of large amounts of data in a seamless manner. For this study, more than ten thousand readings were analyzed from the years 2016 to 2019.

Figure 3: Snow crab is one of the most valuable species captured in the waters near Red Shoal in Placentia Bay, Newfoundland.

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Implications

Our work signifies an effort to show the benefits of digitized supply chains for traditionally perceived low-tech industries. These benefits not only represent the ability for managers to conduct predictive analysis accurately but, perhaps most importantly, to enable the complete visibility of the supply chain (from capture or production to the final consumer). This full supply chain visibility approach can bring certainty to this industry, the fisheries, which has been susceptible through the years to the lack of quality, falsification of records, and malicious product mislabelling; certainly, digitalization can bring an end to these practices. In the specific case of the capture of snow crab, digitalization comprising IoT and predictive analysis allows for optimized fishing operations, these being improvements on scheduling and planning and maximization of allowable landings.

Conclusion

In the supply chain of seafood products, digitalization can have a major impact at the point of origin/point of capture. Our two-layer conceptual approach proved applicable to the fisheries of high-value species such as snow crab. In terms of data analytics, the data collected from sensor readings associated to ocean monitoring buoys were analyzed using time series/scatter diagrams to identify trends and patterns to produce a prediction which could maximize snow crab landings in the Red Shoal area of Placentia Bay. We believe this case study is useful to demonstrate the viability and applicability of our approach. The proposed approach can be seen as a tool that can assist in the management of the supply chain and the adoption of more efficient practices in the fisheries sector which is experiencing a process of digitalization; characterized by the adoption of IoT solutions to monitor product history and provenance tracking, among others.

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