

The Supply and Demand Optimization Platform: A Co-Creation Project in Value Chains That Reduces Food Losses

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Abstract

Every day around the world, vast amounts of edible food are tossed away, generating massive food losses. Worldwide, the amount of food lost or wasted each year adds up to a staggering 1.3 billion tons (metric tons), with Japan accounting for about 6.12 million tons. Food loss takes place at every step of the value chain—starting with production and processing and moving up through distribution, retail, and consumption. One of the main causes of food loss and waste is the mismatch between supply and demand. This paper examines NEC's Supply and Demand Optimization Platform which has been created to help solve these pressing issues, thereby improving the productivity and efficiency of the food industry and minimizing the societal harm cause by massive food wastage.

Keywords



supply and demand optimization, food loss, food waste, disposal reduction, food industry, demand forecasting, AI, service, co-creation

1. Introduction

Japan today is confronted by a multitude of diverse and interrelated issues that pose a critical challenge to the nation's future. These include a growing labor shortage aggravated by an aging population and declining birthrate, increasing diversification of cashless payments, changes in the consumption environment, and a rapidly intensifying array of hazards ushered into being by the relentless advance in digital technology, as well as food wastage generated by surplus production.

While these are all issues that need to be addressed by society at large, we believe that they are also exigent issues that should be dealt with directly by the industries and organizations whose activities affect or are affected by these issues.

As part of NEC's commitment to helping improve the overall well-being of society, this paper introduces a system which leverages the power of NEC's digital technology to take on one of these issues—the problem of food loss.

2. Food Loss and How NEC Hopes to Solve It

2.1 Food loss has become a social issue

The annual amount of food loss in Japan alone is 6.12 million tons—1.6 times the amount of food donated to victims of famine around the world. More than half of Japan's food loss—about 3.28 million tons—is generated by businesses.

In the United Nations 2030 Agenda for Sustainable Development, the objective to reduce food losses along production and supply chains by 2030 is laid down in "Goal 12. Ensure sustainable consumption and production patterns."

In line with this global goal, NEC is using its Supply and Demand Optimization Platform to eliminate food waste, thereby contributing to the reduction of food waste generated by businesses (**Fig. 1**).

2.2 NEC's approach to eliminating food loss and waste

About half of the food loss and waste generated in any given year is reportedly generated by industry.

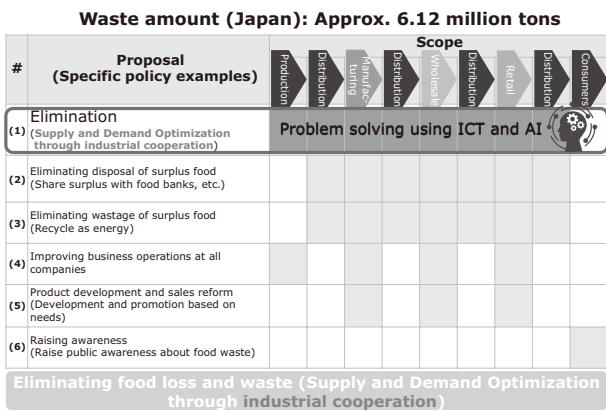


Fig. 1 Proposal to solve the food loss and waste issue.

Up to now this issue has been addressed on an individual company and business basis, but as companies and businesses become increasingly connected to each other in the complex and entangled nature of the modern economy facilitated by accelerating progress in Internet and IoT technology, it is generally accepted that it is no longer possible to solve these problems in isolation.

NEC has elucidated six basic approaches to solving these issues as shown in Fig. 1. Critical to the solution of these issues is the utilization of ICT and AI to optimize supply and demand through industrial cooperation to eliminate food loss and waste. NEC believes that one of the keys to solving problems, which have so far thwarted individual businesses and companies, is to integrate a broad range of data possessed by individual businesses; marketing data on consumption trends and weather forecast data that can affect consumer behavior.

Reduction of food loss can also be expected to help reduce overall waste in value chains, resulting in tremendous improvements in efficiency when successfully accomplished. This in turn will increase profits and improve competitiveness.

It may also significantly ameliorate environmental destruction, food crisis, and poverty, which are all increasingly pressing global issues.

The formation of a large-scale circular economy system such as described above is precisely what NEC is aiming to achieve.

3. Data Distribution Platform, Co-creation, and AI Are Needed to Solve These Issues

3.1 The Supply and Demand Optimization Platform used for the data distribution platform

We have developed the Supply and Demand Optimiza-

tion Platform to help multiple companies across a broad range of business categories to cooperate with each other to solve these issues. Data provided by companies is integrated in the Supply and Demand Optimization Platform and new value is created by using NEC-original AI technology. The accumulated data is integrated with past sales data for each company, as well as with various types of causal data, then analyzed by the Heterogeneous Mixture Learning Technology—NEC’s proprietary AI technology. Not only does this have high precision, it also has the potential to create new value according to the application.

What this platform does is much more than simply sharing the data owned by different companies. It solidifies ties between multiple companies across a broad range of business categories by linking data acquired from the real world in the digital space. In other words, NEC is focusing on how to create digital links between companies and on adding value to the accumulated data.

3.2 Co-creation with customers

Utilizing data that transcends individual company frameworks, we can optimize the performance not just of individual companies but of entire industries, enhancing efficiency at every link in the value chain to deliver products to consumers in order to create new value.

In our view, creation of new value requires a commitment to seeking solutions and building business models through “co-creation” with customers from multiple companies across a broad range of business categories. One example of our practical approach is to periodically hold study meetings with customers facing issues in demand-supply operations. Together with the customers, we create new values by extracting issues and examining solutions, as well as by conducting validation and verification.

3.3 Original AI technology that converts data into value

One of the most important digital components undergirding our approach to solving these issues is AI, which can forecast sales and demand for products and services.

AI’s strength lies in its ability to make predictions based on its analysis of enormous amounts of data far beyond human capability. More accurate forecasts will make it easier to improve the efficiency of inventory management and personnel assignment.

One of the biggest benefits we can get from demand forecasting using AI is the elimination of various types of waste, including food waste.

The AI which serves as the core of this platform is NEC’s proprietary Heterogeneous Mixture Learning Technology. Unlike common machine learning technology based on black-box type algorithms, the Heterogeneous Mixture Learning Technology is actually able to explicitly explain the reasoning behind its forecasts, how those figures were derived, and any rules it discovered. This capability is invaluable as a means of providing comprehensive support for human decision making and making it easier to improve forecast methodology using trial-and-error testing.

3.4 Provided values

By leveraging AI-generated demand forecasting derived from the Heterogeneous Mixture Learning Technology, the Supply and Demand Optimization Platform can optimize every aspect of the food supply chain. It will help food manufacturers to optimize inventory and production, food wholesalers to optimize inventory and distribution as well as improve efficiency of resources, and food retailers to optimize ordering.

By helping to optimize supply and demand throughout the food industry’s entire value chain and by solving various issues such as excessive production, returns due to exceeded expiration dates, excessive inventory, and unsold stock, the Supply and Demand Optimization Platform will support reduced food loss and increased profits.

4. Commitment to Strengthening the Foundation of the Supply and Demand Optimization Platform Services

The foundation of the Supply and Demand Optimization Platform is its data distribution platform (collection, accumulation, processing, and delivery) and prediction analysis mechanism (regression analysis mechanism using the Heterogeneous Mixture Learning engine). On top of this base, five service functions are provided: data linkage/accumulation, data integration/standardization, demand forecasting, visualization of reasons for forecasting, and support for operations and decision making. By directly supporting the decision-making process in our customers’ businesses and operations, we are promoting solutions for social issues (reduction of food loss).

To enhance the effectiveness of the platform’s service functions, we are focused on the promotion of data integration, expansion of service coverage, and improvement of provided value. In this section, we will look at the ways we are working to achieve these goals, as well as reflect on our commitment to creating a “new normal” (Fig. 2).

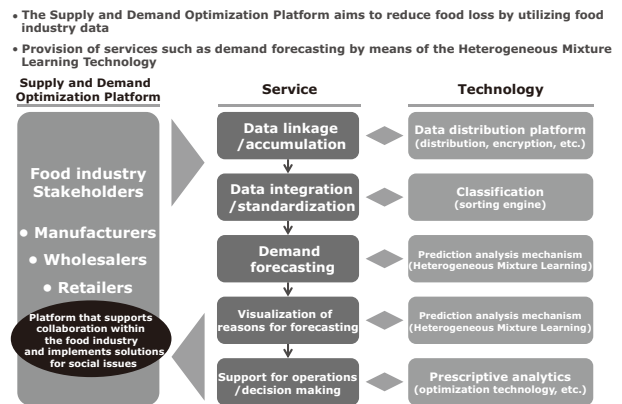


Fig. 2 Supply and Demand Optimization Platform.

4.1 Promotion of data integration: Classification (data arrangement AI)

NEC’s Supply and Demand Optimization Platform is specifically designed to help solve the social issues of food loss and waste by connecting, integrating, and analyzing data gathered from manufacturers, wholesalers, and retailers, as well as third-party entities. Because companies do not typically collect data with this application in mind, data layouts can vary significantly from one company to the next. To enable the Supply and Demand Optimization Platform to perform prediction and analysis, the data must be integrated and accessible on a cross-functional basis. To address this technical issue, we have developed a classification engine that utilizes the Data Understanding with Semantic Technology, which is the fruit of one of NEC’s R&D units (Data Science Research Laboratories).

In addition to incorporating this technology in our Supply and Demand Optimization Platform, we have already begun to apply this engine to multiple areas such as master data management in mergers and acquisitions and third-party data arrangement.

4.2 Expansion of service coverage: small amount (zero) data predictive analytics

One of the services many companies expect from the Supply and Demand Optimization Platform is demand forecasting for new products. With new products, sales result data is not, of course, available. Clearly, the degree of difficulty in prediction is much higher than it is with popular products supported by plenty of result data. In fact, new product introductions are fraught with waste and lost opportunities at many companies. Therefore, this is an issue the Supply and Demand Optimiza-

tion Platform should address with a higher priority.

There are basically two approaches taken by NEC. The first is the utilization of predictive models of past similar products to make a prediction. There are a variety of methodologies such as patternization from past predictive models, application of predictive models designed for different purposes, and transfer learning. Currently, we are investigating the reliability of each methodology with a view to incorporating the most appropriate one into the platform. The second approach involves verification of prediction validity beginning immediately following product release with provision of an alert as early as possible. It is important to correct a prediction when the plan goes wrong. But it is also important to visualize and provide an alert regarding how it is wrong and what course of action may be taken. In this way, we hope to provide enhanced support for customer decision making.

4.3 Improvement of provided value: prescriptive analytics

Prediction results are always the output of predictive analytics and are used to help companies choose the optimal action or actions. For example, retailers perform actions such as predicting the number of sales for a given product and determine how many to order accordingly. Conventionally, business logic plays a supportive role in implementing these actions (calculation of recommended ordering quantity, for example). However, the effectiveness of this method is limited by the range defined by business logic. When you try to catch up with cases that fall outside that range, you end up having to review and add conditions endlessly. This makes it difficult to follow rapid market changes, and leaves the possibility that added conditions may have unintended consequences in other areas.

Further confusing the issue is the fact that various marketing activities are carried out at the storefront. There are also cases in which an order is made that ignores the expected sales amount, such as when the store manager wants to stack up a large number of promotional products to make them stand out. There are limits to how effectively this can be achieved with business logic. As a result, it is often necessary to bring humans into the checking and final decision-making process. This is what makes “prescription” difficult. (To avoid straying too far from the theme of this paper, we won’t pursue this discussion other than to note that NEC sees the decrease in working-age population as a social issue and is currently working on laborsaving solutions.)

In addition to maximizing sales and minimizing inventory losses, ordering based on the specific circumstances and policies of each store is necessary. This could

involve, for example, taking the store’s marketing plans into consideration. To facilitate this, we have begun intensive research into building a prescriptive analytics function into the Supply and Demand Optimization Platform. Specifically, in cooperation with our R&D units (Quantum Computing Office and Data Science Research Laboratories), we hope to introduce technology that doesn’t simply focus on optimized calculations, but can also “understand” the intentions of a store (intention learning technology) and imitate the staff (imitation learning technology). We are confident that introduction of prescriptive analytics will further contribute to the reduction of food loss and waste.

4.4 Commitment to the New Normal

Heterogeneous Mixture Learning, which is the base technology of the Supply and Demand Optimization Platform and serves as Supervised Machine Learning, was significantly affected by the impact of the COVID-19 pandemic. In adapting this technology to cope with changing requirements, NEC focused on two main issues: the first being how we can offer demand forecasting during a period in which rapid changes in consumption are taking place—when the state of emergency is in force, for example. The second issue is whether or not it is a good idea to have AI simply learn the data obtained during that period.

Similar issues have occurred in the past during severe weather events like a major typhoon or heavy snowfall. COVID-19, however, is different. For example, the emergency period has continued for far longer than other phenomena, and after the state of emergency has been lifted, some prediction targets return to previous trends while some do not. Although these are difficult issues, we take this opportunity as a motivation and in collaboration with our R&D units have begun research in both technology and management in order to evolve the Supply and Demand Optimization Platform into a platform that can deal even more effectively with rapid changes in consumption.

5. Conclusion

While our mission is to connect data and processes across a broad range of business categories, we believe that it is critical to establish as a foundational tenet the principle of not using that private data for anything other than the intended purpose and that we collaborate closely with customers to come up with ideas for safe and secure data management. This requires that we cease thinking of ourselves as merely an IT vendor that

manages data and instead regard ourselves as a company that safeguards the integrity of that data.

NEC already bases its activities on the Ministry of Economy, Trade and Industry's 2017 Industrial Data Sharing Promotion Project. Together with the customers who have approved of our objective, we have created guidelines for data utilization and publicized them through METI. While we promote this data utilization, we will continue our efforts to establish an environment where data can be provided and utilized safely and securely between companies and industries.

In addition, we regard the Supply and Demand Optimization Platform as a data distribution platform that we can use in the future to respond to needs in other consumer and manufacturing sectors.

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