

Toyota Motor Corporation

Case Study

Learn how an automated decision-support system powered by the Gurobi Optimizer enables Toyota to maximize profitability while ensuring compliance with environmental regulations.

The Challenge: Maximizing Profitability While Ensuring Compliance with Environmental Regulations

Generally speaking, automakers aim to produce as many of their most profitable models as possible in order to increase their sales globally.

However, they must also comply with stringent environmental regulations that are imposed by different countries around the world. Violating these regulations can result in penalties, fines, and the suspension of sales – so automobile companies strive to ensure total compliance.

Automakers cannot simply develop plans to produce and sell as many high-margin models as possible. Their plans must also include fuel-efficient models that meet country-specific environmental regulations.

Every day, automakers must figure out how to rapidly generate plans that will simultaneously maximize profitability and ensure compliance with environmental regulations.

These environmental regulations can be extremely complex and can vary widely from country to country. Often, there are numerous different requirements (such as fuel efficiency requirements and separate emission standards) imposed by multiple agencies in each country. Typically, these environmental regulations get increasingly strict every year.

However, in many countries, the market for eco-friendly cars is expanding as more and more consumers are looking for cars that are better for the environment.

About Toyota Motor Corporation

Toyota Motor Corporation was founded in 1937. In 2019, its sales reached 10,742,122 vehicles, making it the second largest automaker in the world.

Toyota's mission is to "make ever-better cars" that are safe, superior in quality, and better for our environment. To help achieve this goal, Toyota is embarking on new mobility and logistics service initiatives with connected cars. The automaker is also committed to developing Fuel Cell Vehicles (FCV) and other innovative technologies that can change the world.

At Toyota, the departments involved in information systems include the IT Management Division, the Corporate IT Division, the IT Advanced Development Division, and the Information Security Promotion Office. Corporate IT works very closely with Toyota Systems Group (one of Toyota's companies) to design various information systems in a wide range of fields including sales, production and logistics, quality, accounting and human resources, and management.

In this case study, we will examine how an information system developed by Toyota's Corporate IT Division and powered by mathematical optimization technologies is being used to facilitate faster and better decision making.



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The Solution: An Automated System Powered by the Gurobi Optimizer

Performing environmental compliance simulations requires complete and up-to-date knowledge of all relevant regulations.

In the past, the managers at Toyota in charge of global environmental compliance would review the regulations in their assigned country or region, and then use Excel to manually run multiple simulations. These manual simulations would show how many of each model should be produced in order to maximize profit while adhering to all relevant environmental requirements.

This process was difficult and time-consuming as these simulations had to be run multiple times and checked each time by those responsible for environmental regulations in the various countries and regions.

Also, automakers typically make more profit when they manufacturer and sell large, high-end vehicles – and, in Toyota's case, these would be the Land Cruiser and Crown.

In order to determine the right product mix, Toyota needed to be able answer questions like: "If we produce 1,000 hybrid Priuses, 200 Lexus LS, and 50 Land Cruisers, would we meet US CAFE (Corporate Average Fuel Economy) standards? How much annual profit would this generate?"

Answering these types of questions involves analyzing a large number of scenarios and adjusting various

constraints to determine the optimal product mix that maximizes profits while meeting environmental requirements.

Toyota decided to use mathematical optimization to address this problem and figure out the optimal product mix – as this AI technology is capable of automatically generating high-quality solutions in a short amount of time.

After evaluating various mathematical optimization solvers, they chose the Gurobi Optimizer – the fastest solver on the market today.

The Gurobi Optimizer is used in Toyota's AKARI ("Advanced Knowledge and Real-time Intelligence") Environmental Regulations Module to rapidly perform simulations that take into account the environmental regulations in each region and country.

These simulation results are then fed into the AKARI Profit Planning Module, which runs additional simulations to calculate things like the projected profit for the next fiscal year.

Before the implementation of the mathematical optimization solution, it used to take an immense amount of time and effort to conduct such financial simulations and calculate profitability based on production volume and product mix.

But now, with this automated system powered by the Gurobi Optimizer, anyone can instantly perform these complex calculations with the simple click of a button.



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The Results: Rapidly Generating High-Quality Solutions

Prior to the implementation of the automated planning system powered by the Gurobi Optimizer, it was labor intensive and time consuming to create sales plans that effectively balanced the two objectives of profit maximization and environmental compliance.

Using manual planning tools and techniques and relying on their experience and intuition, Toyota's management team used to spend days conducting simulations and evaluating different scenarios – as each simulation had to be performed separately.

Now, with the Gurobi Optimizer, the speed of calculation has dramatically improved and it takes only a few minutes to conduct each simulation.

More important than speed, however, is the new system's ability to automatically generate solutions

of the highest quality and accuracy – which was simply not possible with manual planning tools and techniques.

Toyota aims to implement and launch other AKARI modules – including Development Planning and Product Planning – by the end of the company's 2020 fiscal year, and will also explore possible ways to integrate and link the various modules.

Additionally, the automaker will look for opportunities to expand its use of mathematical optimization across its enterprise-wide operations.

With mathematical optimization, Toyota has been able to significantly improve the speed and quality of its decision making.

The automaker believes that, with technologies like the Gurobi Optimizer, it is possible to achieve automation (either fully or at least to some extent) and optimization of the decision-making process.



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About the AKARI Profit Strategy Systems Project

Toyota's Corporate IT Division launched the AKARI ("Advanced Knowledge and Real-time Intelligence") Profit Strategy System project to improve the company's process of formulating profit strategy.

The first step of the project was to develop a Profit Planning Module, which is used to generate the company's medium-term profit plan.

In the second phase of the project, the Corporate IT Division created the Environmental Regulations Module, which uses the Gurobi Optimizer.

The TOBIRA ("Toyota Business Insights for Rapid Action") Management Dashboard is a system that provides Toyota's management with the information and insights they need to make the best possible business decisions in a timely manner. AKARI is integrated with TOBIRA – AKARI automatically processes data from each of its modules, and then feeds this data to the TOBIRA dashboard.

The AKARI Project has two modules (the Profit Planning Module and the Environmental Compliance Module) that are currently operational, and numerous other modules that are under development – with three new modules slated to be launched during the company's 2020 fiscal year.

About the AKARI Project Team

The Project Manager of the AKARI project is Daisuke Furutsu from Toyota's Corporate IT Division, who has been with the company for more than 20 years. He started off his career at the Toyota Motor Corporation in Accounting Headquarters, where he focused on cost and profit management. After more than two decades in that department, he transferred to the Corporate IT Division in 2015, where he embarked on new initiatives. He is working closely with the Revenue Management Unit on a hybrid initiative that aims to combine business and IT to improve Toyota's profit strategy.

The modeling and programming development for the AKARI project were performed with the technical support of Nomura Research Institute, Ltd.



Daisuke Furutsu

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For more information, visit [Gurobi.com](https://www.gurobi.com), email info@gurobi.com, or call +1 713-871-9341.

OctoberSky Co., Ltd. is the domestic distributor of the Gurobi Optimizer in Japan.

For more information, visit octobersky.jp or email info@octobersky.jp.