OPTIMISATION KEEPS THE BEER FLOWING

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THE INSTITUTE FOR LOGISTICS, TRANSPORTATION, AND PRODUCTION OF THE UNIVERSITY OF HAMBURG implemented a model-based production planning system at the Swiss brewery Feldschlösschen. Feldschlösschen is the leading brewery in Switzerland, with a market share of 40% and revenue of nearly CHF 1 billion (approx. £776 million). The company was founded in 1876 and acquired by the Carlsberg Group in 2000. The largest production site in Rheinfelden produces 1.8 million hectolitres per year.

Beer manufacturing contains brewing, fermentation, maturation, filtration, and filling. Feldschlösschen cooperates with the project team of the University of Hamburg because there is no suitable industrial production planning solution that covers brewery needs, such as unique storage tank operations with processing times. Feldschlösschen defined three requirements for the planning system: considering all operations and resources, modelling the multilevel production system and process restrictions, and optimising production and inventory schedules. Therefore, we

designed a planning system customised for breweries. The mathematical program optimises each resource of the entire product system to support holistic planning.

Figure 1 illustrates the brewery production process. At first, the brew house brews the base beer. The base beer stays in the storage tanks for fermentation and maturation. Next, the filtration filters undesirable particles to produce semifinished beer. Buffer tanks keep semifinished beer until further processing. Finally, the filling lines fill the beer in bottles, cans, and kegs. The warehouse stores the finished beer until delivery to the customer. Various production and storage tank resources are available at each production stage. In addition to the general brewing process, particular beer types such as speciality beer, alcohol-free beer, and mixed beer require additional processing with special equipment.

Challenges regarding changing consumer preferences, complex production processes, and transparent planning necessitate the application of an advanced analytics tool

CHALLENGES AND APPLICATION

The brewing industry is confronted with new challenges as a result of changing consumer preferences. The demand for speciality and alcohol-free beer has increased in recent years. As mentioned before, such beer types require special equipment and hence adaptations to the production system. Feldschlösschen's product portfolio includes 220 finished goods out of 100 semifinished goods. The production

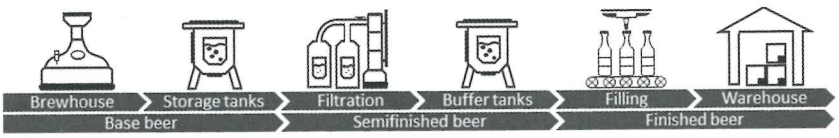

FIGURE 1 THE BEER PRODUCTION PROCESS

system contains 13 production resources and 8 storage groups. The growing number of products and resources increase the planning complexity.

Since most supply chain planning issues have strong dependencies, the decision making is centralised in the supply chain planning department. For this reason, the planning department strives at a transparent planning procedure to simplify the decision communication and improve solution acceptance. Challenges regarding changing consumer preferences, complex production processes, and transparent planning necessitate the application of an advanced analytics tool. Therefore, the project team developed a model-based production planning system.

The planning department requires a comprehensive scenario analysis tool for tactical tasks and strategic issues as well as an operative planning tool. Tactical planning tasks include selecting shift schedules or identifying temporarily required capacity extensions. Strategic planning issues contain evaluating the impact on the production system regarding changes in product portfolio, production volume, and production equipment. The detailed process mapping for the tactical and strategic planning activities guarantees operational feasibility. The operational planning tool provides detailed schedules that includes production quantities, inventory levels, required overcapacities, production sequences, and storage tank allocations.

PLANNING SYSTEM

The planning system consists of a user interface for data collection and validation as well as a dashboard for visualising the optimisation results embedded in a cloud-based optimisation framework (see Figure 2). The user-friendly interface is designed for production managers and planners without a mathematical optimisation background. The server stores the data and hosts the optimisation engine.

The employed brewery-specific production planning problem considers relevant process restrictions, such as the available number of storage tanks, different storage tank groups, and processing times. The planning system implements the optimisation model and algorithm in GAMS/CPLEX. The computationally intensive optimisation runs on scalable cloud services to reduce computing times and hardware costs.

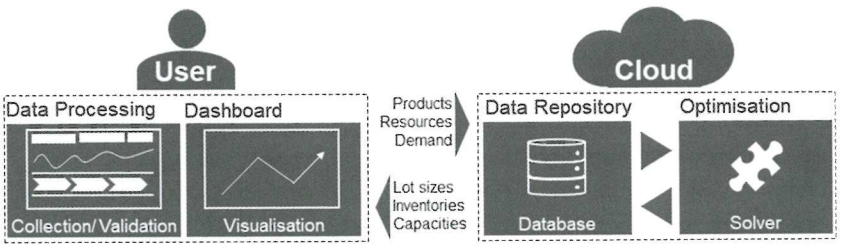

FIGURE 2 THE PLANNING SYSTEM

The user interface provides the input data collection from various sources, i.e., master data from the ERP system and additional data from spreadsheets. The basis data query includes the product, resource, and demand data for operational planning. Collecting and adjusting data sets enables the creation of different production scenarios for tactical and strategic analysis. The user interface visualises the collected data for quick checks and provides a comprehensive data validation to ensure structurally correct data sets for optimisation.

The integrated visualisation tool displays the optimisation results in dashboards. Derived key performance indicators predict the future performance in operational planning, e.g., utilisation and costs. In addition, the indicators quantify the impact of different production scenarios for comparison. The management report contains an overview and a detailed dashboard. The overview dashboard enables a simple identification of bottleneck resources. The detailed dashboard provides production and storage tank schedules.

The user-friendly interface is designed for production managers and planners without a mathematical optimisation background

ADDED VALUE

The customised planning system applies to operational, tactical, and strategic planning activities. Considering all relevant process stages and restrictions guarantees practicable production schedules. In addition, the detailed plans reduce the manual planning effort and the need for reactive capacities due to improved planning quality. The scenario analyses improve cross-divisional decision making by quantifying the impact on the entire production system of planning decisions by other departments in various production scenarios.

Besides nonmonetary benefits, the new planning system reduces investment costs by avoiding reactive capacities and inefficient equipment as well as realising operational cost savings by optimised production and inventory schedules.

SUCCESS FACTORS

The involved departments were integrated in the software development process from the beginning to ensure the acceptance of model-based planning solutions. Besides higher trust in the optimisation results, this procedure gets detailed process knowledge from expired planners and customise the tool for the end-user's need. Thus, the project team implemented a supportive data validation and calculation report to support users in data collection and result interpretation. The data validation ensures correct data sets for optimisation. Additionally, the calculation report displays unexpected relaxations of constraints during the optimisation, for example, the used capacity exceeds the given capacity. This information supports planners in identifying bottlenecks and adjusting production scenarios.

CONCLUSION

The project team developed a model-based production planning system designed for the brewing industry and the implementation at the Swiss brewery Feldschlösschen. The main advantage of the proposed system is the consideration of the relevant process stages and restrictions as well as the application of different planning activities in one planning system. Considering the process-specific constraints improves the planning quality. Integrating all planning activities in one planning system guarantees operational feasibility for tactical and strategic decisions. Applying the new planning system supports Feldschlösschen in reducing planning effort, reactive capacities, inefficient investments, and operational costs.

Feldschlösschen's Head of Supply Chain Planning & Product Change Management said: "The software supports strategic and tactical planning decisions in standardised reports. The most significant value added is the analysis of the interactions between production stages as the consequence of decisions. This enables us to better quantify investment requirements and evaluate future strategies. It reduces investment costs by identifying actual need and realises operational cost savings by analyzing strategic scenarios in a holistic manner. Furthermore, it improves decision communication to the relevant departments."

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OUTLOOK

The project team currently works on higher modularity, integrating advanced optimisation methods, and considering related planning problems to extend the planning system. Higher modularity

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simplifies adaptations of the planning system to other production sites and industries. Furthermore, integrated advanced optimisation methods are able to cope with further challenges, for example, stochastic programming to manage demand uncertainty and multicriteria optimisation to balance different company targets. Moreover, considering additional related planning problems improve holistic decision making in supply chains, e.g., production network design.

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FOR FURTHER READING

Mickein, Markus, Matthes Koch and Knut Haase (2022). A Decision Support System for Brewery Production Planning at Feldschlösschen. *INFORMS Journal on Applied Analytics* 52:158–172.