

Planning Support Tool for Torobayo Beer Production using System Dynamics

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Abstract

We present a tool to support beer production planning for Kunstmann company using system dynamics. A description of the production system was made, which served as base for the construction of the proposed model, through Vensim software. Storage for fermentation and conditioning in Unit-Tanks (UTs), filtering and temporary storage in Drunk-Tanks (DTs), packing and product inventory were studied. The proposed model includes 3 level variables (UT, DT and Inventory) and 5 connected flows, taking into account the delays in the fermentation and maturation of beer, and the capacities of filtering, packaging and inventory. The process eventually stops when a desired inventory is reached. The structure described corresponds to the generic structure of a UT. By taking advantage of modeling with Vensim's subscripts, together with a disposition in a spreadsheet of few parameters, this structure was simplified to generate up to 12 UTs in parallel. This tool allows those who carry out the planning work to test different scenarios and, particularly, to detect bottlenecks present in the DTs, in an agile, faster, and graphic way. With this tool, the production planner could evaluate theoretical production scenarios changing the main parameters that define the entire process, improving company's decision making.

Keywords

Planning, Beer, Production, System Dynamics, Simulation.

1. Introduction

Brewing requires planning to meet the time requirements involved in the process. Likewise, the installed capacities and the demand for the product must be taken into consideration. On the other hand, expertise about the complete process of who evaluates the production plans (and boiling in particular) is fundamental for the achievement of timely production. At Cervecería Kunstman, production planning is carried out using the experience of the production managers, making use of the data that have been accumulated over time. This way of carrying out the planning schedule has shown weaknesses, since the entire system operation may not be considered and, eventually, inefficiencies or non-fulfillment of orders could be incurred if the product is not prepared in a timely manner. In the framework of a project in which we were studying the production structure of industrialized and artisanal breweries in the city of Valdivia, Chile, this problem was mentioned by the manager of the plant, which motivated us to think about the matter and propose ways of deal with it. The idea then was to propose a model that would involve the main variables that make up the entire process.

Cervecería Kunstmann can be classified as an industrialized brewery but still maintaining the peculiarities of a craft brewery. Since 2002, *Compañía Cervecerías Unidas* (CCU) acquired 50% of the company, which has allowed Cervecería Kunstmann to increase its production and reach new markets thanks to CCU distribution channels. It produces 16 different varieties of beer under its brand, the main one being Torobayo beer (around 75% of production). For this reason, it was decided to study its production, inventory and sales process and its impact on planning.

Production planning involves several elements: sales forecast, production forecast, orders, warehouse, inventory of supplies, the availability of beer currently in the UTs (Unit-storage-Tanks) used to mature beer, and in the DTs (Drunk-storage-Tanks) used to place the beer ready for bottling), as well as the finished product inventory. From the state of these variables, the production scheduling is carried out. Specifically, the idea is to project the inventories of the brewery for the following months. The result of the programming is informed to all those involved so that they are aware of what must be produced in the following weeks and their compliance percentage is verified daily in the sales,

production, and inventory reports. The production program represents all the hectoliters (hl) that will be produced weekly and once the orders are received, the adjustments are made to the schedule for accomplishing future orders. All this implies that Cervecería Kunstmann must keep control of how to project production based on the actual sale of CCU and they do so by observing orders, dispatches, pending dispatch, the sold-out forecast, inventories, etc.

The variability and uncertainty of the mentioned variables could lead to different ways of planning production. Furthermore, it is not always easy to visualize the behavior of the added variables and the effect that delays in the process could have. That is why having a simple and straightforward tool that allows setting the values of the parameters and visualizing the dynamics generated in the main variables, would provide the company with more appropriate ways of carrying out planning.

1.1 Objectives

To develop a tool to support beer production planning for Kunstmann company, located in Valdivia, Chile, considering production, fermentation, filtering, packaging, and inventory of its main product Torobayo beer, using system dynamics methodology. The main idea is to improve the way UTs and DTs in producing Torobayo beer are utilized, combining few parameter specifications of a boiling plan in Excel with a model in Vensim (2019) to visualize the state variables dynamics generated by that plan. It could also be used as a training tool for those who start working in the world of beer production.

2. Literature Review

Beer consumption in Chile has increased in recent years, going from 25 liters per capita in 2001, to 50 liters per capita in 2018 (ACECHI 2019). The reasons for the increase can be attributed to different factors such as the greater sophistication of the consumer, being a drink with a lower alcohol content and the rise of innovation and introduction of different styles of beer, mainly from the artisanal segment, among others. Craft beer is today a consumer trend that encompasses around 3% of the market (Paz 2019). Valdivia is a recognized city in Chile in the beer industry as it has 22 active producers.

Artisan beer producers are characterized by making their products with native or local ingredients (ACECHI 2017), without preservatives and that much of the process is done manually (Kausel and Behn 2016). Bascur (2013) establishes that a brewery is industrial when it has a production of over 18,000 hl per year, while a brewery is artisanal when the annual production is less than that amount, characterized by having a broader product portfolio than an industrial one. Microbrauer (2019), in the same line as Bascur, establishes that the limit between an industrial brewery and a craft brewery would be around 15'000 hl per year. Following this classification, Cervecería Kunstmann is an industrialized brewery, since it produces around 200 thousand hectoliters per year, while most of the other breweries would be considered artisanal.

The System Dynamics methodology proposed by Forreter (1961) and detailed by Sterman (2000) allows modeling a production process, identifying the state variables and the relationships among them (model structure), and then simulating it and observing the dynamics generated by that structure. By using Vensim (2019) software it is possible to represent such a structure and simulate the model obtained. Some simulation models of the beer production process have recently been developed that account for the existing relationships between the main variables involved (Ramírez and Cárdenas 2020; Cárdenas 2019; Castillo 2019).

A main problem observed in relatively small breweries is how to plan their production (Ramírez et al. 2020), as they do not always have sophisticated computer planning systems. That is why, based on the needs expressed in this regard by the staff of Cervecería Kunstmann, arise the idea to develop a tool that contains a model of the production process that covers from the arrival of orders, boiling, fermenting, packaging, inventory, and delivery to fulfill backorders, integrating recent data into planning scenarios. In this paper we present a preview of what we have developed so far as a support tool in decision-making in production planning at Cervecería Kunstaman. This type of tool, easy and quick to build, could be used by artisan producers to plan their production too.

3. Methods

The development of the tool here proposed followed these steps:

- Description of the company by work meetings with Cervecería Kunstman staff. The product of this work was an influence diagram of the main variables involved in the brewery.
- Based on this description, a first generic model was proposed that brought together the main variables that involve beer boiling, fermentation, maturation, packaging, and distribution. The obtained model was presented to the management of the company for its validation.
- With a generic model for one UT, a model for the 12 UT was built. Basically, this model replicates the structure of the model for one UT in the other 11 UTs. Two DTs are used, each serving 6 DTs, to start the packaging process.
- Finally, using subscripts of Vensim (2019), the model structure was simplified, and the parameters for a propose planning scenario were place in a spreadsheet, then uploaded into the model to carry out a simulation. So, both spreadsheet and the model together allow user to visualize the dynamics generated on the state variables by a proposed scenario.

4. Model

4.1 Real System Description

The brewing process consists of several consecutive stages, in which the output of one stage is the input of the next. These stages are mashing, boiling, fermenting, conditioning, filtering, and bottling. For the purposes of this work, it is not of interest to detail each sub-process, but rather to identify those that by their nature imply a limitation for production. After mashing, the beer wort is boiled in a brew kettle. There are two brew kettles at Cervecería Kunstman: The first one can boil 8 times per day, with a capacity of 90 hl for almost all beer styles and 100 hl for Totobayo beer. The second one can boil 10 times per day, as its technology speeds up the process, with a capacity of 100 hl. After each whole boil process (whirlpool, hopback, and wort cooling) is completed (8 to 10 h, depending on beer style), the wort begins to ferment. Once the fermentation time has elapsed, the conditioning (maturation) process begins, in which the beer is left to cool down to stabilize the flavor and aromas obtained from fermentation. The fermentation and maturation stages are carried out in UTs, which have the characteristic of carrying out both stages in the same vessel. Table 1 shows the distribution of the 40 UTs that are currently operating in the brewery, together with the style of beer assigned to each one. As it may see Torobayo uses UTs of 900 hl.

Table 1. UTs capacity and quantity per style of beer

UT capacity	Quantity	Style of beer
90 hl	3	Experimental
180 hl	5	Doppel Bock (2) – Gran Lager (2) – Trigo (1)
270 hl	12	Bock (1) – Chocolate/Sommer Pils (2) – D’olbek Ale (2) – Gran Torobayo (1) – IPA (2) – Lager (1) – Lager sin filtrar (1) – Sin alcohol (1) – Trigo (1)
540 hl	8	Bock (1) – Gran Torobayo (1) – Lager (2) – Lager sin filtrar (1) – Sin alcohol (1) – Torobayo (2)
900 hl	12	Torobayo

Source: Cervecería Kunstmann (2019a)

For example, to fill a UT of 540 hl, 6 boiling of 90 hl are made. The boiling of a beer style is carried out until the production program is fulfilled, which generally consider the complete filling of the UTs in order not to waste fermentation capacity. However, as Torobayo beer has theoretical brew batches of 100 hl, the fermentation and maturation vessels of 540 hl are filled up to a capacity of 500 hl, which may vary slightly depending on the actual capacity of boiling. Once the UT is filled, the boiling of another style of beer continues. Table 2 shows fermentation and maturation time by style of beer.

Table 2. Fermentation and maturation time by style of beer

Style of beer	Days
Alcohol-free	14
Torobayo	20
Bock – Chocolate – Gran Torobayo – Lager – Lager sin filtrar	27
Trigo	30
Doppelbock – IPA – Sommer Pils	41
Gran Lager	50

Source: Cervecería Kunstmann (2019a)

Next, the beer filtration stage is achieved, eliminating all the remains of yeast and proteins precipitated in the UTs, clarifying the beer, and giving it its characteristic shine and its incomparable flavor and aroma. It is only carried out when the beer is going to be bottled. The beer goes from UTs to a DT, which are connected directly with the packing line. Depending on the packing line capacity, among other things, it may take up to 3 days. Table 3 details the capacities of the 10 DTs currently installed in the brewery.

Table 3. DTs capacity and quantity at Cervecería Kunstmann

DT capacity	Quantity
30 hl	2
180 hl	1
300 hl	5
900 hl	2

Source: Cervecería Kunstmann (2019a)

Torobayo beer is ready to be packaged in different formats such as bottles, BCL, cans, KEG and KNR. Currently, the brewery has six independent packaging lines. Generally, it works with two or three simultaneous packaging lines and its rotation is due to the weekly production program that the brewery manages.

The packaged Torobayo beer is transported on pallets to the finished product warehouse to be dispatched later. Weekly, between 20 and 25 shipments of loaded trucks are made with an approximate capacity of 154 hl for bottles and 126 hl for barrels. In summer, up to 14 trucks can be dispatched per day due to the high demand in orders arriving at the brewery. Cervecería Kunstmann can have an approximate of 6000 hl of finished product stored in the cellar. Sometimes extra space may be added outside the cellar to comply with the production schedule. The accepted value for damage to the product in the warehouse is 1% of the finished product.

4.2 Model Description

4.2.1 Model Structure

Figure 1 shows the *UTI* level structure. The *UTI* level increases by *boilingI* flow and decreases by the *filteringI* flow. It takes into consideration fermentation and maturation time, packing time and some other parameters that allows activate or stop boiling depending on the plan scenario being evaluated. Boiling is guided by the shadow variable *cycleI*, which stores the days in which it may be done, and it will happen until *UTI capacity* is reached. Also, boiling can be stopped completely if the *UTI* is not activated (*ACTIVATE UTI*=0).

Once Torobayo beer has been completed the fermentation and conditioning time, the entire *UTI* content is filtering, and sending to *DTI 1* (beer received by *DTI* via *UT 1*). Beer is ready for packing, which takes some time to complete it. The *DTI 1* level represents the vessel connected to the packaging lines. *DTI* serves 6 *UTs* (*DTI 1*, *DTI 2*, etc.). If *DTI* is in use, filtering flow is stopped. Also, packeting flow is delayed according to *TIME FOR PACKING 1*. The

packaged beer is sent to inventory via *rate1* variable, which is equal to *packing1* flow, but is used as a shadow variable to bring this flow to the inventory level. This is a generic structure replicated for each of the 12 UTs.

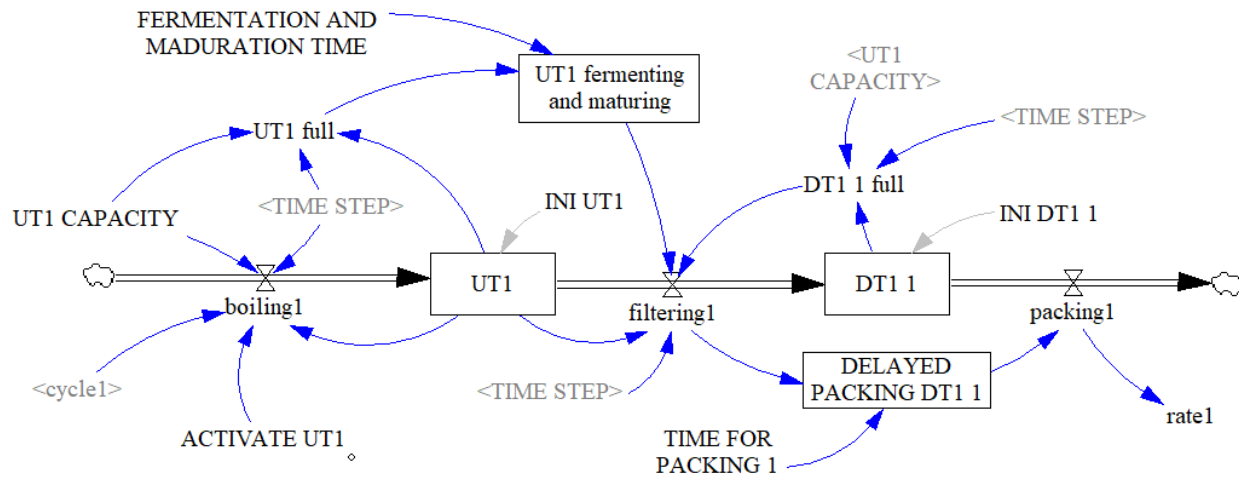


Figure 1. Model structure for *UT1* and *DT1 1*

Figure 2 shows the structure for inventory and pending order levels.

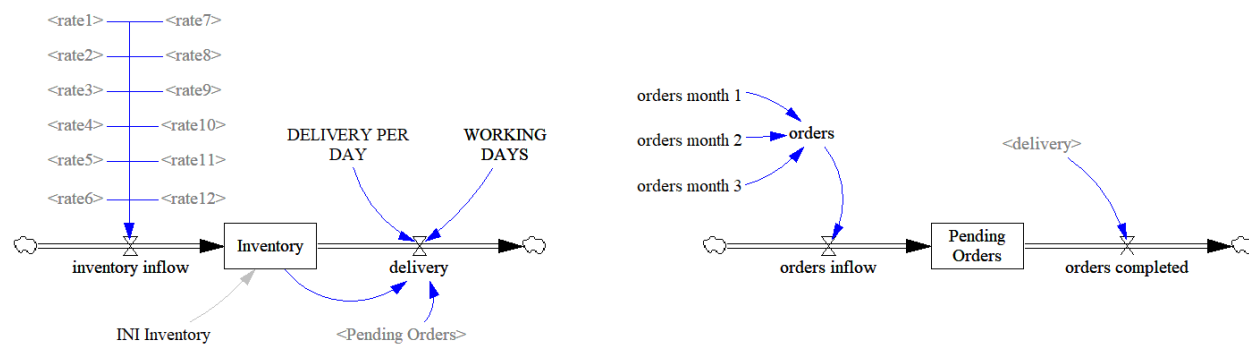


Figure 2. Model structure for *Inventory* and *Pending Orders*

The Inventory level increases due to *inventory inflow* (which comes from the 12 UTs via rates auxiliary variables) and decreases due to *delivery*. Whether there are *Pending Orders* and there is beer in stock *DELIVERY PER DAY* may be completed. The initial inventory will serve to fill the order for the first month while the beer is fermenting.

The *Pending Orders* level increases due to the arrival of orders (*orders inflow*) and decreases due to the fulfillment of orders (*orders completed*). The *orders inflow* consists of monthly orders that is configured by the user and transformed into a pulse on the corresponding days, while *orders completed* is equal to *delivery*.

Once the first boiling day (Monday, Tuesday and so on) has been established, the boiling schedule is generated to fill the UTs, which results in a generation of cyclical pulses of when to boil for a respective UT. It could be cooked 1, 2, 3, 4 or 5 days a week in different combinations. Therefore, a structure was developed that specify the day each UT will receive the wort according to the specified working days.

With this model, the use of each individual UT or DT can be visualized. The control planning allows testing different planning scenarios and provides user with visual alerts when DTs are used simultaneously by 2 or more UTs, which is not allow.

In the control panel (see Figure 3) we can configure the scenario we want to test. It works with sliders, which modify the value of a parameter when using SyntheSim mode of Venisim. The effect of these changes is immediate, giving the possibility of adjusting them again if desired. First, we must choose the days when Torobayo beer can be boiled (Tuesday, Wednesday, Thursday and Friday: activated = 1).

Figure 3. Control panel (selected parameters)

Then we must indicate the number of days that elapse since a UT is filled until it is available to be filled again. This time includes the processes of fermentation, maturation, emptying and sanitization of the UT. Subsequently, it must be indicated which UTs will be available to be filled with Torobayo beer (a UT may not be used due to different reasons: it may be destined for another style of beer, it could be disabled due to faults, or because low demand). It is possible to activate or deactivate a UT by sliding the bars shown in Figure 3. In addition, its capacity can be specified, between 500 hl or 900 hl.

The initial inventory and the final time of the simulation may be indicated. Finally, the monthly value of the orders and the maximum capacity of the daily delivery could also be entered.

4.2.2 Visualizer with Subscripts

The tool presented up to here serves so that whoever is planning can simulate scenarios according to the value of the parameters observed in the real system. It is a simulator executable through the SyntheSim mode of the Vensim. However, its complex structure could be simplified, using the Vensim facilities. Vensim subscripts allow the same structure to be executed in parallel with different parameters. To simplify the structure of the 12 UTs of the previous model, the subscripts were used in conjunction with an Excel file, which performs all the calculations of the cooking programming based on the data entered by the user, while Vensim is used as a visualizer of the dynamics generated by a particular plan schedule. The parameters entered in the Excel file are the following:

- Number of active UTs being used in each scenario: between 1 and 12.
- Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday: boolean variables that take value of 1 when it is allowed boiling that day, and 0 otherwise.
- UT cycle time: number greater than or equal to 21 days, which represents the number of days it takes a UT to be able to receive beer again. This time includes the fermentation, maturation, and sanitization processes.
- Orders month 1, orders month 2 and orders month 3: hectoliters of beer expected to be sold in the three months of the simulation.
- Daily delivery: hectoliters of beer that the brewery can deliver in one day.
- Initial inventory: hectoliters of beer in inventory at the beginning of the simulation.

5. Results and Discussion

5.1 Simulation using SyntheSim

Simulation model: The graphs with the simulation results, as shown in Figure 4 and Figure 5, are located next to the control panel. Figure 4 shows details about elapsed times when UT1, UT2, UT3, UT4, UT5 and UT6 were used. In Figure 5 shows when boiling was carried out to fill up those UTs, and those days when DT1 was used by each UT.

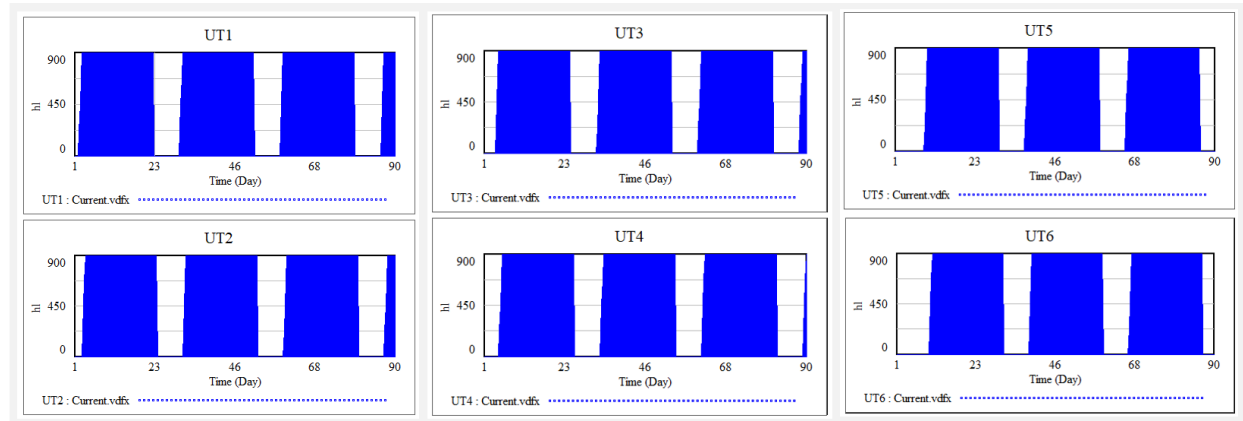


Figure 4. Visualization of UTs

Inventory and pending orders are also displayed during the simulated period. Results can be instantly modified depending on the parameters combination used when SyntheSim mode of Vensim is engaged. DT1 graph in Figure 5 shows the use of DT1. It can alert planner when boiling planning schedule ended with two or more UTs trying to use DT1 on the same day, even though DT1 can only be connected to one UT per day. There will be combinations of parameters in which two UTs will want to make use of the same DT, and it is precisely the kind of problems that this model seeks to evidence. So, that implies to modify the planning schedule and try it again.

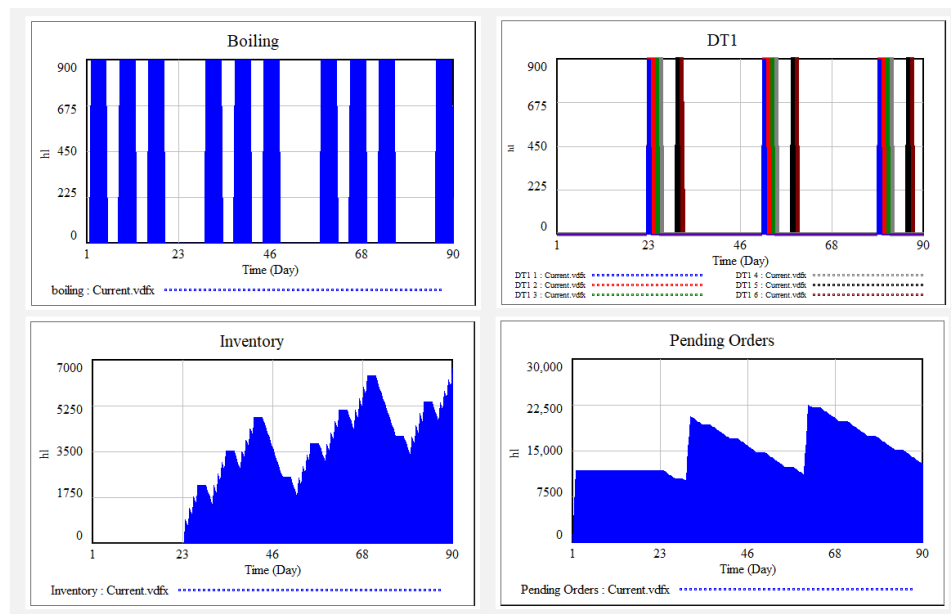


Figure 5. Visualization of main variables

5.2 Simulation using Subscripts

Once parameters have been entered in Excel, we can go to Vensim and run the simulation. The obtained results are identical to those shown in Figure 4. In Excel we enter the 6 parameters listed above and with that information it is possible to specify automatically the first day for boiling to each active UT. Depending on whether it is possible to boil that day or not, the spreadsheet calculates how many days are left to boil again. With this information plus the UT cycle time, the day on which the subsequent boiling will take place is calculated. From this calculation a boiling schedule is obtained.

For example, imagine Cervecería Kunstman wants to boil Torobayo beer 3 times per week (Tuesday, Wednesday, and Thursday). Each day must be completely dedicated for boiling to one UT only. Table 4 shows that for UT time cycle of 21 days, and 90 days simulation, the first boiling for UT1 occurs in day 2 (Tuesday), the first boiling for UT2 occurs in day 3 (Wednesday), and the first boiling for UT3 occurs in day 4 (Thursday). The second boiling for UT1 occurs in day 23 (Tuesday), the second boiling for UT2 occurs in day 24 (Wednesday), and the second boiling for UT3 occurs in day 25 (Thursday), and this goes on for the remaining boiling.

Table 4. Boiling days with 3 activated UTs

Boiling	UT1	UT2	UT3
First	2	3	4
Second	23	24	25
Third	44	45	46
Fourth	65	66	67
Fifth	86	87	88

Table 5 shows an example when 12 UTs are activated and Cervecería Kunstmann can boil from Tuesday to Friday, for UT time cycle of 21 days, and 90 days simulation as well.

Table 5. Boiling days with 12 activated UTs

Boiling	UT1	UT2	UT3	UT4	UT5	UT6	UT7	UT8	UT9	UT10	UT11	UT12
First	2	3	4	5	9	10	11	12	16	17	18	19
Second	23	24	25	26	30	31	32	33	37	38	39	40
Third	44	45	46	47	51	52	53	54	58	59	60	61
Fourth	65	66	67	68	72	73	74	75	79	80	81	82
Fifth	86	87	88	89	-	-	-	-	-	-	-	-

Subsequently, the complete planning schedule is generated in Excel. Table 6 shows how it looks for the first 21 days. We are assuming Monday (TIME = 1) as the first day. So, this plan schedule indicates boiling would be done for UT1 on Tuesday (TIME = 2), for UT2 on Wednesday (TIME = 3) and so on. This table is loaded by Vensim through a GET XLS LOOKUP function, obtaining 1 or 0 (as visualize in Table 6) depending on whether that day boiling must be carried out for that UT or not.

This version of our model with subscripts works as a viewer for a schedule that fits into an Excel file, and can generate easy-to-understand graphics for planners in Cervecería Kunstmann.

Some scenarios were evaluated using the two versions of the model proposed. For example, assume an initial value for inventory of 7000 hl, UT cycle time of 28 days, orders per months equal to 10000 hl, daily delivery of 461 hl/day, 9 activated UTs, and a simulation period of 90 days. Figure 6 shows inventory and Pending Orders levels for this scenario. As it may be seen, this scenario allows to fulfill pending orders, although not completely. Pending orders tend to increase.

An advantage of including a spreadsheet together with a simulating model is basically a significant reduce in model complexity, because in Vensim a single generic structure can represent all the UTs and DTs by using subscripts (it is no necessary to repeat the same structure 12 times). Also, working with spreadsheet, something Cervecería Kunstman staff is very familiar with, and of course it is versatile to deal with changes in the way planning schedule may be

configured. Unfortunately, it is not easy to represent such a model structure as the one we present here, because Excel does not deal with causality and interdependence among include variable. So, the result is a tool, which is in its early stages but, we believe, can help planner to understand the complexity and think about planning process considering the relevant variables and parameters acting together, as well as to visualize the dynamics generated among them. This tool could be used for training purposes too.

Table 6. Time schedule for boiling days with 12 activated UTs

TIME	UT1	UT2	UT3	UT4	UT5	UT6	UT7	UT8	UT9	UT10	UT11	UT12
1 (Mon)	0	0	0	0	0	0	0	0	0	0	0	0
2 (Tue)	1	0	0	0	0	0	0	0	0	0	0	0
3 (Wed)	0	1	0	0	0	0	0	0	0	0	0	0
4 (Thu)	0	0	1	0	0	0	0	0	0	0	0	0
5 (Fri)	0	0	0	1	0	0	0	0	0	0	0	0
6 (Sat)	0	0	0	0	0	0	0	0	0	0	0	0
7 (Sun)	0	0	0	0	0	0	0	0	0	0	0	0
8 (Mon)	0	0	0	0	0	0	0	0	0	0	0	0
9 (Tue)	0	0	0	0	1	0	0	0	0	0	0	0
10 (Wed)	0	0	0	0	0	1	0	0	0	0	0	0
11 (Thu)	0	0	0	0	0	0	1	0	0	0	0	0
12 (Fri)	0	0	0	0	0	0	0	1	0	0	0	0
13 (Sat)	0	0	0	0	0	0	0	0	0	0	0	0
14 (Sun)	0	0	0	0	0	0	0	0	0	0	0	0
15 (Mon)	0	0	0	0	0	0	0	0	0	0	0	0
16 (Tue)	0	0	0	0	0	0	0	0	1	0	0	0
17 (Wed)	0	0	0	0	0	0	0	0	0	1	0	0
18 (Thu)	0	0	0	0	0	0	0	0	0	0	1	0
19 (Fri)	0	0	0	0	0	0	0	0	0	0	0	1
20 (Sat)	0	0	0	0	0	0	0	0	0	0	0	0
21 (Sun)	0	0	0	0	0	0	0	0	0	0	0	0
22 (Mon)	0	0	0	0	0	0	0	0	0	0	0	0
23 (Tue)	1	0	0	0	0	0	0	0	0	0	0	0
24 (Wed)	0	1	0	0	0	0	0	0	0	0	0	0
25 (Thu)	0	0	1	0	0	0	0	0	0	0	0	0
26 (Fri)	0	0	0	1	0	0	0	0	0	0	0	0

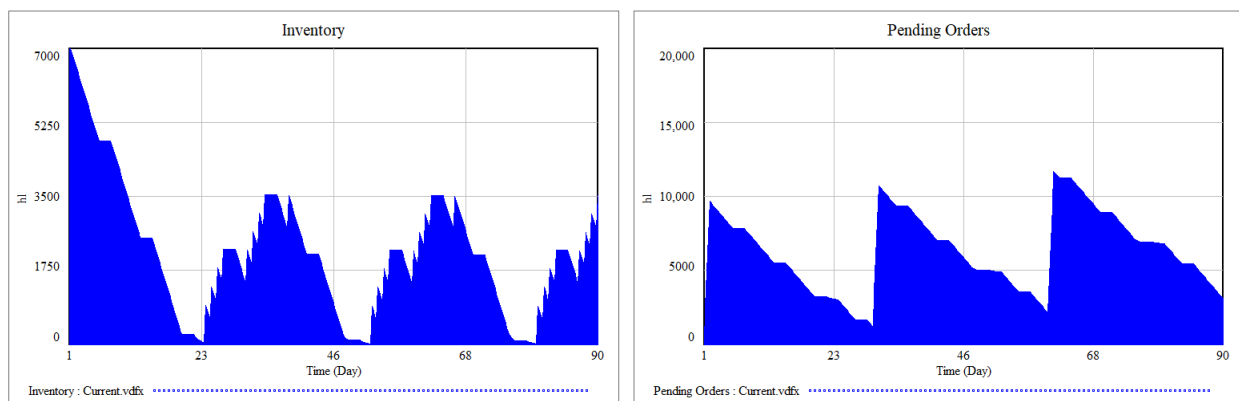


Figure 6. Inventory and pending orders in a scenario

5.3 Validation

This model was validated by three methods: structural verification, dimensional consistency, and extreme conditions (Sterman 2000). In the first two tests, tools integrated in the Vensim software were used: Check Model indicating that there are no errors in the construction of the model and Unit Check which point out that there are no errors in the units of the variables considered. When we apply extreme conditions, the results shown in Table 7 were obtained. Ultimately, and perhaps more importantly, we should mention all the discussion we had with Cervecería Kunstmann staff and, particularly, with the manager of the company. They gave us important and relevant feedback about the variables and the model structure here proposed.

Table 7. Summary of simulation results under extreme conditions

Parameter	Minimum	Maximum	Outcome
Working days	0 Day	7 Day	The model works correctly
Active UTs	0 UTs	12 UTs	The model works correctly
Initial inventory	0 hl	30'000 hl	The model works correctly
Daily delivery	0 hl/Day	1'000 hl/Day	The model works correctly
Orders per month	0 hl	20'000 hl	The model works correctly

As was mentioned above, both models without and with subscripts work identically. The results are the same for both models.

6. Conclusion

The tool presented in this work combines elements of modeling and simulation of the main variables involved in the Torobayo beer production process in conjunction with the changing data of the parameters used for decision making. The visualization of the main variables behavior that arises from the structure of the proposed model allows contextualizing the production planning discussion with the management and other departments of the company. Consequently, it considerably improves the understanding of the entire process and the communication between those involved. It is an appropriate tool, we believe, to provide skills to those who make planning decisions, by using simulations. In addition, its development is relatively fast, as it connects elements of System Dynamics with spreadsheets that are mostly used in the company. The first model is a simulator, while the second one, with the subscripts, is a graphics viewer of a proposed production schedule through an Excel spreadsheet, but considering the interrelation between variables, delays, etc., generating graphs easily understanding by staff. The tool proposed was validated, in part, by Cervecería Kunstmann staff, as well as via structural verification, dimensional consistency, and extreme conditions. Both models are equivalent and generate identical results. Therefore, the main product we present here is a tool, which is in its early stages but, we believe, can help planner to understand the complexity and think about planning process considering the relevant variables and parameters acting together, as well as to visualize the dynamics generated among them. This tool could be used for training purposes, for those who start working in the world of beer production, too.

Acknowledgements

This project was carried out in part thanks to the funding of InnovING:2030 project and to the collaboration of Cervecería Kunstmann. We are highly grateful to them.

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Acknowledgements

This project was carried out in part thanks to the funding of InnovING:2030 project and to the collaboration of Cervecería Kunstmann. We are highly grateful to them.

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