Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi
Yıl: 2021 Cilt-Sayı: 14(2) ss: 378–395

Academic Review of Economics and Administrative Sciences
Year: 2021 Vol-Issue: 14(2) pp: 378–395

http://dergipark.org.tr/tr/pub/ohuiibf/

Araştırma Makalesi
Research Article

ISSN: 2564-6931
DOI: 10.25287/ohuiibf.703440
Geliş Tarihi / Received: 13.03.2020
Kabul Tarihi / Accepted: 22.03.2021
Yayın Tarihi/ Published: 12.04.2021

THEORY OF CONSTRAINTS: THE APPLICATION OF WINE PRODUCTION FACILITY

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Abstract

With the effect of globalization, businesses need to survive by becoming resistant to competition. Traditional costing methods have been insufficient in the face of needs of businesses to increase their profitability. The purpose of the constraints theory that emerged for these reasons, is to identify and eliminate the constraints that will prevent businesses from operating efficiently. In this context, the theory of constraints is discussed and the basic principles of this theory are emphasized in the study. In this study, it is aimed to determine the optimum production amount by using the constraints theory. Thus, the current profitability of the business is observed after the constraints theory is applied. In practice, the production process of a wine producing enterprise has been examined and analyzed with the basic principles of constraints theory. As a result of the study, it was determined that the optimum product mix of the enterprise is 3000 bottles of white and 836 bottles of red wine according to the constraints theory. While the company made a profit of 93.736 TL with this production method, it was determined that the profitability of the enterprise increased according to the traditional approach.

Keywords : *Theory of Constraints, Contraints, Strategic Cost Management.*

Jel Classification : *M40, M41.*

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Atıf/Citation (APA6):
Karakoç, M., & Şık, E. (2021). Theory of constraints: The application of wine production facility. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 14*(2), 378–395. http://doi.org/10.25287/ohuiibf.703440.

Karakoç, M., & Şık, E. (2021). Theory of constraints: The application of wine production facility. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 14*(2), 378–395.

KISITLAR TEORİSİ: ŞARAP ÜRETİM TESİSİ UYGULAMASI

Öz

Küreselleşmenin etkisiyle işletmelerin rekabete dayanıklı hale gelerek varlıklarını sürdürmeleri gerekmektedir. İşletmelerin karlılıklarını arttırma ihtiyaçları karşısında geleneksel maliyet yöntemlerinin yetersiz kalmıştır. Böylece ortaya çıkan yöntemlerden birisi olan kısıtlar teorisinin amacı, işletmelerin verimli çalışmasına engel olacak kısıtların tespit edilerek ortadan kaldırılmasıdır. Bu çalışmada, kısıtlar teorisi kullanılarak optimum üretim miktarının belirlenmesi amaçlanmıştır. Böylece, kısıtlar teorisi uygulandıktan sonra işletmenin mevcut karlılığı gözlemlenmiştir. Uygulamada, şarap üreten bir işletmenin üretim süreci, kısıtlar teorisinin temel ilkeleri ile incelenmiş ve analiz edilmiştir. Çalışmanın sonucunda işletmenin optimum ürün karmasının kısıtlar teorisine göre 3000 şişe beyaz ve 836 şişe kırmızı şarap olduğu tespit edilmiştir. İşletme bu üretim şekliyle 93.736 TL kar elde ederken, geleneksel yaklaşıma göre işletmenin kârlılığının arttığı belirlenmiştir.

Anahtar Kelimeler ***:*** *Kısıtlar Teorisi, Kısıt, Stratejik Maliyet Yönetimi.*

Jel Sınıflandırması ***:*** *M40, M41.*

INTRODUCTION

With the effects of globalization, the main goals of the businesses, which are being afloat under tough market conditions and achieving the goal of making a profit, are getting harder day by day. The volatility of market conditions is increasing day by day. It is getting impossible to go on business operations without a loss in local and global markets where competition is high. Thus, strategic cost management has a significant role for the continuity of business operations and achieving strategic goals. Considering that quantitative data (revenue and cost) stand out while making especially nonroutine decisions in businesses, the concept of cost gets more important for businesses and the obligation of determining on those values properly comes up (Alkan, 2001: 180). Not only cost calculations can be done with strategic cost management but also the changes in the components used in calculations can be observed so that audits can be done every time. Thus, possible wastes might be hindered and performance audit could be done.

In spite of being utopic because of the recent rapid changes, what is desired for businesses is to make constant and increasing profit. However, due to the above-mentioned reasons, the rules, demands and customer expectations are changing rapidly in local and especially global markets, so the primary goal of businesses is to survive and continue their lives in tough market conditions. However, there has always been at least one obstacle for businesses to reach their goals. Being a software programme, the theory of constraints, first introduced by the physicist Eliyahu M. Goldratt in 1979, was used by a limited number of companies because of the conceptual conflict and it reached its final form in 1984. It managed to reach a large mass with Goldratt's work named "The Goal" and the theory of constraints turned into a philosophy with his subsequent works "It's Not Luck" and "Critical Chain" (Akkaş, 2016: 4).

In this study, the theory of constraints was discussed and the basic principles of this theory were focused. Wine production facility project was studied and the constraint was revealed. After finding the constraint, optimal production mix was calculated in order to enable maximum profit, which is the primary goal of the business.

I. LITERATURE REVIEW

Some of the studies related to the theory of constraints in recent years in Turkey are listed below. Gürses (2007) have examined the theory of constraints and he applied this theory in Project Management which is the one of the biggest application fields. The theory of constraints were applied to the approach of Critical Chain Project Management and the benefits provided were specified at the end.

Erol (2008) have investigated the theory of constraints as a tool for strategic cost management. The goal of cost management is to enhance the profit of the business up to the maximum level. In order to achieve this goal, first of all, having high competitive skills and keeping up with every change are inevitable in tough market conditions. Production facilities must determine the constraint and manage those constraints in the best way to reach success.

Büyükyılmaz and Gürkan (2009) have searched the basic concepts and the structure of the theory of constraints. Besides, the advantages and disadvantages of the theory of constraints were addressed. Following this goal, the studies about the theory of constraints in the literature were examined and at the end it was specified that the theory of constraints presents more effective solutions to detect the problems hindering the achievement of the goals and to eliminate them rather than classical approaches.

Aytekin et al. (2012) have aimed to specify the factors decreasing the effectiveness of demand systems which are parts of institutional information technologies management process, to reveal possible causes of those factors and to develop the relationships between causes and factors. Following this goal, Aytekin et al. developed a sample application related to the use of thinking processes of the constraints theory.

Tekin and Şahin (2014) have analyzed the motivation factors on the employees of an industrial enterprise operating in PVC sector according to the theory of constraints and they searched the effect of motivation on the success of the enterprise.

Yükçü and Yüksel (2015) have applied the theory of constraints to hospitals which are one of the production and service businesses. Being a service sector in which human health significant, eliminating and managing the constraints in hospitals is among the priorities. Authors focused on the theory of constraints and they searched the practicality of this theory in hospitals.

In the practical part of the study, the constraints in a state hospital and how they were eliminated were explained. Ayanoğlu and Şakar (2015) have applied the theory of constraints in order to solve out the problems of a courier firm. In their study, the staff, vehicle, machinary and equipment constraints of the firm were defined, those constraints were properly managed, they were eliminated and at the end the performance of the firm was increased.

Demircioğlu and Akkaya (2016) have applied the continuous improvement process of the constraints theory in a paint thinner production facility from dyeing sector. Having analyzed the profitabilty status of the facility, it was found out that the facility had the capacity constraint and after detecting optimal production mix, the constraint was eliminated.

Another paper which is prepared by Akman and Olcan (2017) have gave information about the studies conducted between 2005 and 2016 in Turkey and the theory of constraints and they made a detailed literature study. Between those years, 31 articles were prepared and they were classified into 5 groups. Akman and Olcan, who classified the studies according to sectors, usually focused on hypothetic studies.

Yükçü et al. (2017) have investigated the basic concepts of the theory of constraints. Authors have made suggestions about quitting from constraint in businesses.

Karagün and Sözen (2017) examined the theory of constraints theoretically and mentioned constraint types, capacity concept and types in their studies. In addition, the concept of limited

contribution was explained in their study and the effect of constraints theory on business profit was demonstrated with an application.

Antmen and Erik (2019) concluded that the current profitability of the business increased approximately thirty-seven times by using the constraints theory and break-even analysis together in their study.

Akçimen and Antmen (2019) concluded in their study that the production process created according to the constraints theory in a manufacturing enterprise operating in the metal sector can increase the profitability of the enterprise.

In the studies of Demircioğlu et al. (2020), the most appropriate production process was determined by using the constraints theory and the activity-based cost system together in an enterprise producing food packaging products, and it was tried to determine to what extent it affects the profitability of the enterprise. As a result of the study, it has been revealed that the production process determined by using both methods creates more profitable results than the production process determined according to the traditional method.

II. THE THEORY OF CONSTRAINTS

In many resources, the theory of constraints is referred as a theory introduced by Goldratt. Agreeing upon that the theory was developed by Goldratt, bottleneck theory was revealed in "Power-oriented Management Theory" (Machtorientierte Führungstheorie) which was published by a German economist and author Wolfgang Mewes and in the study Energo-Kybernetic System which was published in 1971 (Akkaş, 2016: 6). According to the theory of constraints developed by Goldratt, new insights about business management were asserted. The first of those insights is optimised production technology scheduling (OPT) and the other is Throughput Accounting (TA) (Atmaca & Terzi, 2007: 298). Production scheduling system, which was thought to be more productive when just in time production system was applied, was started to be used by big companies and in time this scheduling system turned into the theory of constraints developed by Goldratt. Starting with the name of OPT, the theory of constraints reached its original form in 1984 as it was developed in due course (Arslan, 2008: 13).

The book "The Goal" written by Eliyahu M. Goldratt and Jeff Cox in 1984 described the theory of constraints with the main lines. In the book, Alex, the manager of the factory, tries to save the factory from a bottleneck and he asks for a help from a physicist named Jonah. Reminding us the dialogues of Socrates, the first question asked in this relationship is 'What is the ultimate goal of most manifacturing companies?' (Goldratt & Cox, 2012: 48). Goldratt emphasizes that the goal of businesses is to minimize costs and stock while increasing the flow (Goldratt & Cox, 2012: 104). Flow is the money created by system through sales. On the other hand, stock (inventory) is the sum of the money which system attributes to the ones it buys so as to sell. Operating expenses are explained as the money created by the system in order to turn stocks into flow (Goldratt & Cox, 2012: 76–77).

The goal of the theory of constraints is to make the business more productive and increase the performance. That's why the focus of this theory is constraints. Considering the insight "A chain is no stronger than its weakest link." constraints could be defined as the components which slows down the total production time of a product and prevent a system from achieving the goal of earning money (Yükçü & Yüksel, 2015: 559). Goldratt approaches constraints and bottlenecks of a business as an opportunity and since each production activity is connected to the following process, he considers production process of a business as a chain and the present constraints as the weakest link of the chain. Moreover, he claims that the performance of the business is as productive as the process in which the constraint exists. Goldratt exemplified this situation with his son and his friends' mountain hiking in his book "The Goal" (Goldratt & Cox, 2012: 113). Focusing on this scouts group, he looked for answers

to the questions such as what the constraint is, where the bottleneck starts and what could be done as a solution.

Being a management philosophy, the theory of constraints consider the business as a system and tries to enhance the benefit expected from this system in a cycle of ongoing development by focusing on the operations which might create bottlenecks in the system process (Öner & Şahbaz, 2013: 5467). According to Goldratt, the goal is to equalize product flow in the bottleneck to market demand. The capacity of a factor is equal to capacities of bottlenecks (Goldratt & Cox, 2012: 161–182).

The goal of the constraints theory is to determine the constraints which prevent system from working efficiently, to manage those constraints and eliminate them. The theory of constraints is based on the assumption that there is a constraint that prevents the business from making progress towards the goal of maximum profit. Upon finding this constraint and eliminating it, it is observed that productivity and profit goal of the business increase. After determining on the constraint of a business, an increase in the profit of the business is provided by managing the present capacity and bringing production mix of the business up to the optimum level.

Besides of the Goal written in 1984, Goldratt wrote some other books which contributed to the development of the constraints theory. In 1990, he tried to determine the constraints which influence decisions in a business in "The Haystack Syndrome". In his book "It's Not Luck" published in 1994, he gave information about thinking processes and tool used in those processes. Came out in 1997, "Critical Chain" explains constraints in a project management. In his book "Necessary But Not Sufficient", published in 2000, he explains problems in information Technologies (Atwater & Gagne, 1997: 6–7; Büyükyılmaz & Gürkan, 2009: 178).

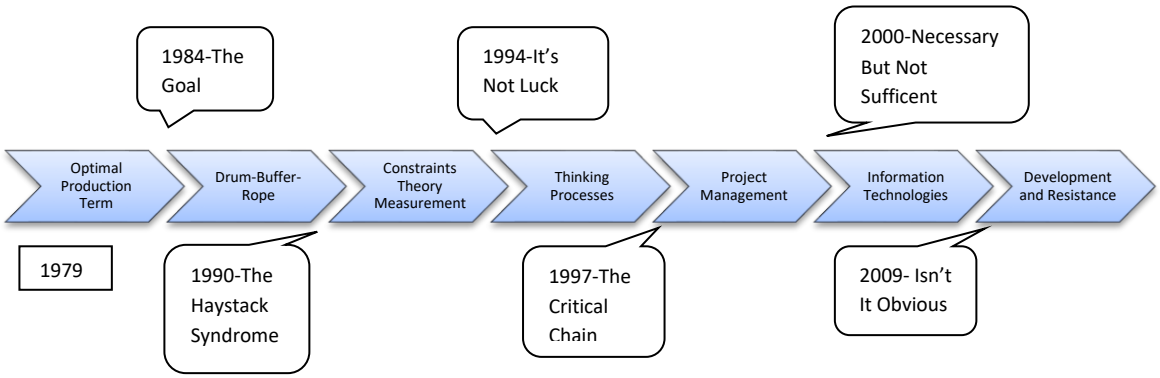

Figure 1: Development of The Constraints Theory

Reference: (Watson et al. 2007: 388; Akkaya, 2015: 7)

II.I. The Assumptions and Principles on the Theory of Constraints

Each business has an establishment goals such as being afloat in high competition environment, maintaining continuity and making maximum profit. In this main target process, any factor that hinders the business and decreases its performance is a constraint. The theory of constraints is based on this issue. The assumptions which are the theory of constraints are based on are explained below (Tollington, 1998: 44-45).

a. The main goal is making a profit: The establishment goal of the businesses is making a profit and make it permanent. If the structure of a business is considered as a chain, the whole power of the chain is dependent on the power of the weakest link in the chain (Kaygusuz, 2005: 136). The weakest link must be detected and empowered in order to increase the success of the business, that is, power of

the chain. Therefore, it is significant to discover the weakest link of the business, in other words to determine the constraint in production process. In a process where a constraint exists, increasing the performance of the other units rather than the constraint does not contribute to the whole performance of the business.

b. Each business has a constraint: There is always one constraint for each product in a business (Okutmuş et al., 2015: 140). The constraints might stem from the inside of the business or the outside such as low competences of employees, low quality raw material, low demand and company policies (Ergün & Karamaraş, 2002: 98). In production businesses, the constraint from the inside are usually about capacity and hereby controlling or eliminating is possible through calculations. However, defining and controlling constraints which are not expected and coming from outside of the business is more difficult (Kaygusuz, 2005: 137). The constraints in the production process is under the effect of time and they might be sometimes temporary or sometimes long term ones.

c. The plannings in production process: Especially in the production businesses, according to this theory based on the assumption that there is always one constraint in the process of production, there must be always production plannings. Planning is an obligation for the continuity of getting maximum output in a place with a constraint (Kaygusuz, 2005: 139). While making those plannings, first constraints must be determined and then it should be kept in mind that there might be variability in products and their mix. Believing that there would be no change will be one of the biggest mistakes. In any case of a change, optimum production mix must be specified in the frame of the plannings.

With a large application area, this theory is based on two basic assumptions in the context of improvement. The first one is to improve system by dividing it into small pieces and heal entire system by combining those improved pieces. (Yükçü & Yüksel, 2015: 559). The second one is to increase the productivity of each production process and so increase the general productivity of the system.

After determining the constraint, it is systematic thinking which is used to solve problems or manage changes to be done in a system rather than analytical thinking. This theory considers business as a chain. If we accept that each link is a unit, the main goal is to empower the weakest link. However, rather than the weakest link, empowering the other links (other units) does not contibute to the system. Moreover, determining the constraint correctly gives significant imformation to the administrators to get to know the system better, to have comprehensive knowledge of real capacity and to make system have a better performance.

II.II. Types of Constraints

Although there is no common approach to classify the constraints mentioned in the theory of constraints, some authors classify them as internal and external while some others categorize them as marketting, source, policy, ram material and logistics. The other classification can ben mentioned as behavioural, administrative, market, capacity, logistic and equipment constraints (Şahin, 2012: 14).

We will focus on those six classifications, which is the general view.

Figure-2 Types of Constraints

a. Behavioural Constraints: The reaction which a person shows logically to his environment or to the special occasion is defined as behaviour and factors such as past experiences, education, training and subconscious are effective in the formation of behaviour. Behavioural constraints usually comprise of the behaviours of employees, occupational habits and the practices at work. When an employee's behaviour contradicts to the practices at work, there comes up behavioural constraint. This situation influences the business negatively and it can be qualified as an obstacle in the improvement of production process since they are difficult to be eliminated (Solak, 2012: 12). Compared to the other constraints, it is easy to control the effect of the behavioural constraints on limited contribution margin and profit (Kaygusuz, 2005: 139).

b. Administrative Constraint: The decisions and operational procedures notified by the business might influence process negatively. In terms of process and finances, wrong decisions made by administrators migh result in occurance of constraints.

*c. Capacity Constraint***:** Capacity constraint could be considered just as the opposite of market constraint. In the production businesses, the first constraint that comes to mind is capacity constraint. It can be defined as that production skill of a business cannot defray demands from the market properly. It usually occurs when there is a demand from the market more than business capacity. Capacity constraint occurs when a demand for a resource exceeds the capacity of the resource and it prevents the business from getting more contribution (Yükçü & Yüksel, 2015: 592). The primary precautions against capacity constraint are additional equipment, overtime working or regulations in production process. With those precautions, production is increased and the need is fulfilled.

d. Market Constraint: The primary goal of the business is to sell its products at least in one market, then make a profit and keep it permanent. Fulfilling needs of the market is one of the primary duties of a business and when there is no market, business operations come to a standstill. In this case, when a foundation has a market constraint, the other constraint are less important. Therefore, market constraint is usually one of the most important constraints (Büyükyılmaz & Gürkan, 2009: 182). Market constraint occurs when there is lower demand than the capacity of the business and there could be many reasons for that. Market constraint usually stem from wrong decisions and policies of the administrators.

e. Logistic Constraint: It is possible to define all of the potential difficulties as a constraint. Those potential difficulties are likely to be seen from the first moment when raw material and equipments are carried to the production area to the moment when final product is obtained, dispatched to the market and transmitted to the final user as a constraint (Yükçü & Yüksel, 2015: 562). Having an extreme negative effect on the prestige of a business, logistic constraint is usually based on the problems seen in planning and coordination.

f. Raw Material Constraint: This constraint comes up when providers cannot supply necessary materials and raw materials on time and at the desired quality (Ünal, 2006: 49). Raw material is supplied through two methods. The first and the most favourite one is getting raw material from providers. The other one is, on the other hand, to produce raw material within business' own structure. In a system where there is no raw material (input), there is no production (output). In the meanwhile, quality of raw material must be at desired level. When there are some problems with supplying raw material, it could mean that there is a constraint for production. Raw material constraint results from late arrival of raw material and materials, low quality or deficiency in the market. When those problems are available, costs for raw material increases (Yükçü & Yüksel, 2015: 563). In this case, expenses of a business change and increases in expenses directly influence production decisions (Büyükyılmaz & Gürkan, 2009: 183).

II.III. Steps of Constraints Theory

Constraints theory is an approach which focuses on continuous improvement and development. Therefore, once a constraint is found and eliminated in an approach of continuous improvement, process

restarts operating. To that end, constraints theory comprises of a five recurrent steps (Goldratt & Cox, 2004: 307). Those steps are given in Figure 3 and listed as below:

1. Defining the potential constraint in a business,
2. Managing the determined constraints to increase the performance of the business,
3. Focusing on business' decision at the second stage,
4. Eliminating the constraints to increase business' performance,
5. After eliminating the constraint, getting back to the first stage.

Within this theory, based on the approach that there is always one constraint in the production process of a business, the goal is to determine this constraint, to manage it well and eliminate it. However, theory should be applied again for the business when the constraint is resolved. Constraints theory pursues the goal of continuous improvement and performance at the maximum level. That's why defining the constraint is significant. The weakest link in the system must be detected. As mentioned before, this constraint could be from inside or outside of the business. However, there occurs a bottleneck in the production process and there is seen a limiting effect on production process regardless of the type of the constraint. It is possible that there is one or more constraints in the production process of the business. At that point, what is important is that which of those constraints has the priority. After determining the primary constraint, plannings should be done in order to mitigate the negative effects of those constraints and to eliminate them.

All components of the system should support the strategy which is developed to manage the constraint in the best way. A sense of movement should be taken on to mitigate the restrictive effect of constraints and next step should be focused on (Goldratt, 1990: 58-63).

Once the constraints in production process are defined and planning are prepared to mitigate the negative effects or eliminate the constraints completely, the following step and which constraint would be the focus should be decided on. Limited contribution margin and profit will increase when constraints in the system are eliminated. At this stage, the future of the business should be considered (Kaygusuz, 2005: 140).

Once the constraints are eliminated, all of the procedures get back to the beginning and those procedures are repeated as required by the principle of constraints theory, which is continuous improvement and continuity of high performance. Although the constraint in a business is not eliminated, there is always one constraint according to this theory. Therefore, those procedures mentioned above are repeated again and again.

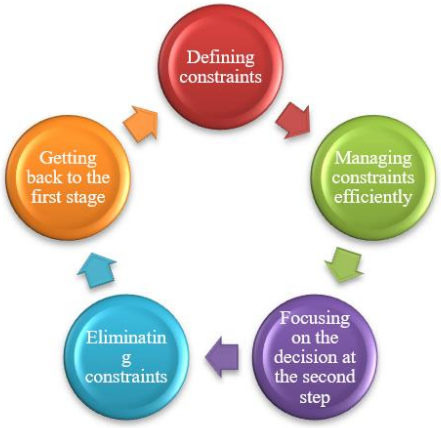

Figure-3 Continuous Development Model

III. APPLICATION

III.I. Production Process of Business

In the practice, the production process of a wine producing enterprise is examined and the constraints of the existing production process were investigated by considelink the existing capacities of each production stage. The company produces red and white wine. The production of these products takes place in six stages. These stages are as follows: Bunch separation, maceration, squeezing, fermentation, residue separation and bottling. The production steps are shown in Figure 4.

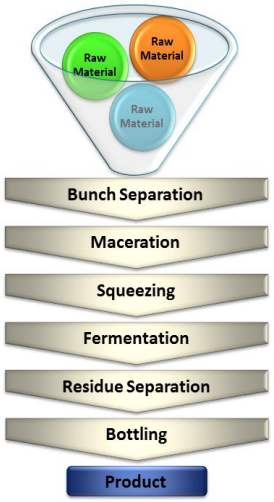

Figure 4: Production Stages

The current capacities of these stages in the production process are given in Table 1.

Table 1: Current Capacity of Each Production Phase

Production Stages		Red Wine	White Wine
1	Bunch Separation	30 Min. / 100 Kg.	30 Min. / 100 Kg.
2	Maceration	60 Min. / 100 Kg.	10 Min. / 100 Kg.
3	Squeezing	50 Min. / 100 Kg.	50 Min. / 100 Kg.
4	Fermentation	40 Min. / 100 Kg.	40 Min. / 100 Kg.
5	Residue Separation	150 Min. / 100 Kg.	100 Min. / 100 Kg.
6	Bottling	50 Min. / 100 Kg.	50 Min. / 100 Kg.

The type, cultivation, collection and transportation type of grapes used in wine production have an important place in the quality of wine and 1 kg on average 0,65 liters of wine is obtained from grapes. Considelink this principle, the wastage rates in each production stage are given in Table 2.

Table 2: Wastage Ratio of Each Production Phase

Production Stages		Wastage Ratio
1	Bunch Separation	% 5
2	Maceration	% 0
3	Squeezing	% 25
4	Fermentation	% 0
5	Residue Separation	% 10
6	Bottling	% 0

The weekly ordelink information of the wine production facility is given in Table 3.

Table 3: Weekly Order Information

Products		Sale Price (TL)	Order Amount (Bottle = 75 cc)
1	Red Wine	50	1000
2	White Wine	40	3000

Table 4 shows the calculation of the amount of grapes required to enter production according to weekly orders. The amount of grapes needed for the production of 1000 bottles of red wine is 1170 kg. In the production of 3000 bottles of white wine, 3510 kg. grapes are needed per week.

Table 4: Calculation Of The Amount of Grapes Needed For Production

Production Stages		Red Wine			White Wine		
		Order Amount	Wastage Ratio	Amount Required	Order Amount	Wastage Ratio	Amount Required
6	Bottling	1000 Bottles 1 Bottle = 0,75 Liter	% 0	0,75 x 1000 **750 lt.**	3000 Bottles 1 Bottle = 0,75 Liter	% 0	0,75 x 3000 **2250 lt.**
5	Residue Separation		% 10	750/(1-0,1) **834 lt.**		% 10	2250/(1-0,1) **2500 lt**
4	Fermentation		% 0	**834 lt**		% 0	**2500 lt**
3	Squeezing		% 25	834/(1-0,25) **1112 lt.**		% 25	2500/(1-0,25) **3334 lt.**
2	Maceration		% 0	**1112 kg.**		% 0	**3334 kg.**
1	Bunch Separation		% 5	1112/(1-0,05) **1170 kg.**		% 5	3334/(1-0,05) **3510 kg.**

After calculating the required grape amounts according to the weekly orders of the wine production company, the actual capacities of the production stages and whether there is a constraint in these stages were investigated.

In order to determine whether there are any constraints in the production process, the total available capacity should be calculated weekly in terms of time. Total available capacity is shown in Table 5.

Table 5: Total Avaible Capacity (Min.)

	Per Week	Per Day	Per Hour	Total
Total Avaible Capacity	7	8	60	**3360 Min.**
	Day	Hour	Minute	

III.II. Actual Capacities of Production Processes and Determination of Constraints

Actual capacities of production stages and determination of constraint are shown in Table 6. For example, while in red wine production, the actual capacity of the bunch separation stage is calculated in terms of time, the amount of grapes needed for bunch seperation stage for red wine production shown in Table 3 and current capacities of the production stages in Table 1 are used.

For Example: Red Wine Bunch Separation Stage Capacity Usage Calculation:

1170 Kg Grapes x 30 Minutes / 100 Kg = *351 Min.*

(1170 kg of grape cluster are processed for 351 minutes in the separation stage.)

The use of the available capacity in the production stages of an enterprise producing red and white wine is shown in Table-6. A total of 1404 minutes of production is carried out dulink the bunch separation stage, 42% of the available capacity is used and it has a capacity of more than 1956 minutes. A total of 1001 minutes of production is carried out dulink the maceration stage, 30% of the available capacity is used and it has a capacity of more than 2359 minutes. A total of 2223 minutes of production is carried out dulink the squeezing stage, 66% of the available capacity is used and it has a capacity of more than 1137 minutes. A total of 1334 minutes of production is carried out dulink the fermentation stage, 40% of the available capacity is used and it has a capacity of more than 2026 minutes. *A total of 3751 minutes of production is carried out dulink the residue separation stage, 112% of the available capacity is used and it has a capacity of less than 391 minutes***.** A total of 1500 minutes of production is

carried out dulink the bottling stage, 45% of the available capacity is used and it has a capacity of more than 1860 minutes.

Table 6. Actual Capacities of Production Stages

Production Stages		Red Wine (Min)	White Wine (Min)	Actual Capacity (Min.)	Total Available Capacity (Min.)	The Capacity Utilization Rate	Less / More Capacity (Min.)
1	Bunch Separation	1170x30/100 **351**	3510x30/100 **1053**	1404	3360	% 42	- 1956
2	Maceration	1112x60/100 **667**	3334x10/100 **334**	1001	3360	% 30	- 2359
3	Squeezing	1112x50/100 **556**	3334x50/100 **1667**	2223	3360	% 66	- 1137
4	Fermentation	834x40/100 **334**	2500x40/100 **1000**	1334	3360	% 40	- 2026
5	Residue Seperation	834x150/100 **1251**	2500x100/100 **2500**	3751	3360	**% 112**	**391**
6	Bottling	750x50/100 **375**	2250x50/100 **1125**	1500	3360	% 45	- 1860

III.III. Calculation of Production Priorities in Theory of Constraints

After determining the constraint in the production process, production priorities must be calculated according to the constraints theory. Calculation of production priorities is shown in Table 7**.** *The Restricted Time (Min / Bottle)* in Table 7 is calculated as follows:

Semi-finished products needed for the production of 1 bottle of wine (Dulink residue seperation stage) According to Table-2, 5% wastage is given in the residue separation stage. The step after residue separation is the bottling step.

0,75 x (1-0,05) = 0,79 lt. Not Residue Seperated Semi-Finished Products

Residue Seperated Stage's Capacity

For Red Wine : 150 Min / 100 lt.

For White Wine : 100 Min / 100 lt.

Limited Time (For Red Wine):

150 x 0,79 / 100 = 1,185 Min. (In order to produce 1 bottle of wine in 1,185 minutes, semi-finished products are processed in the residue separation stage.)

Limited Time (For White Wine):

100 x 0,79 / 100 = 0,79 Min. (In order to produce 1 bottle of wine in 0.79 minutes, semi-finished products are processed in the residue separation stage.)

Table 7. Calculation of Production Priorities

Product	Sale Price	Raw Material Expenses	Process Contribution	Limited Time (Min./Bottle)	Process Contribution / Limited Time	Priority
Red Wine	50	8	42	1,185	35,44	2
White Wine	40	6	34	0,79	43,04	1

According to the Theory of Constraints, the production priority should be given to white wine and in the residue separation phase, which is the stage where the constraint exists, the semi-finished product should be processed first for the production of white wine. In residue seperation stage, semi-finished products should be produced for all white wine orders and if the current capacity is not completed after the production of semi-finished products required for the order of white wine, the remaining capacity should be used for red wine production. The optimum production according to the available capacity is calculated as follows:

White Wine:

3000 bottles x 0,79 Min = 2370 Min. (The first priority for the production of white wine, which has priority, has been met with the current capacity.)

Remaining Capacity: 3360 – 2370 = 990 Minutes.

Red Wine:

For red wine production, the remaining time for optimum production of the semi-finished product to be processed in the residue seperation stage is 990 minutes.

990 Min / 1.185 Min / Bottle = 836 Bottles

Consequently, according to the constraints theory, the optimum production for the company to obtain maximum profit;

3000 Bottles White Wine

836 Bottles Red Wine

The cost calculation table used in the production of red and white wine of the wine production company is shown in Table 8.

Table 8. Wine Production Cost Chart

	Red Wine	White Wine
Direct Materails	**8**	**6**
Grape	4	2
Others	4	4
Direct Labor Expenses	**5**	**3**
Variable General Production Expense	**6**	**3**
Constant General Production Expense	**5**	**4**

The profit to be obtained by the enterprise according to the optimum production figures is shown in Table 9. According to the constraints theory, the existing capacity of the wine production enterprise was investigated and it was found that there is a limitation in the residue separation stage. According to

the weekly order, it is necessary to determine the optimum production and which product should be produced in order to obtain maximum profit. According to the theory of constraints, priority is given to 391hite wine. After completing the processing of the semi – finished product required for 391hite wine in the residue separation stage, the available capacity obtained according to the optimum production was determined. Thus, the semi-product which can be processed at the residue seperation stage for red wine is calculated and the amount of red wine that can be produced is determined. As a result, according to the constraints theory, the optimum production was calculated as 3000 bottles of 391hite wine and 836 bottles of red wine. According to the results obtained, the profit of the enterprise is calculated in Table 9 and as a result the profit of 93736 TL is obtained.

Table 9. Enterprice Income According to Constraint Theory

	RED WINE	**WHITE WINE**	**TOTAL**
Sales	836 X 50 = 41800 TL	3000 X 40 = 120000 TL	161800 TL
Direct Materails (-)	836 X 8 = 6688 TL	3000 X 6 = 18000 TL	(24688 TL)
Direct Labor Expenses	836 X 5 = 4180 TL	3000 X 3 = 9000 TL	(13180 TL)
Variable General Production Expense	836 X 6 = 5016 TL	3000 X 3 = 9000 TL	(14016 TL)
Constant General Production Expense	836 X 5 = 4180 TL	3000 X 4 = 12000 TL	(16180 TL)
Profit / Loss			**93736 TL**

III.IV. Calculation of Production Priorities According to Traditional Approach

After determining the constraint in the production process, production priorities according to the traditional approach are calculated in Table 10.

Table 10. Calculation of Production Priorities

Product	**Price**	**Raw Material Expense**	**Period Expenses**	**Contribution Margin (Bottle)**	**Priority**
Red Wine	50	8	16	26	1
White Wime	40	6	10	24	2

According to the traditional approach, the production priority should be given to red wine in the wine production facility and the semi-finished product should be processed first for red wine production in the residue separation stage where the constraint exists. In the residue seperation stage, semi-finished products must be produced for all red wine orders, if the available capacity is not completed after the completion of the semi-finished production required for the red wine order, the remaining capacity should be used for the production of white wine. The optimum production according to the available capacity is calculated as follows:

Red Wine:

1000 bottle x 1,185 Min = 1185 Mins. (The first priority for the production of red wine was met with the current capacity.)

Remaining Capacity: 3360 – 1185 = 2175Mins.

White Wine:

For white wine production, the remaining time for optimum production of the semi-finished product to be processed in the residue seperation step is 2175 minutes.

2175 Mins. / 0,79 Mins. / Bottle = 2753 Bottles.

As a result, the optimum production for the enterprise to achieve maximum profit compared to the traditional approach;

2753 Bottles of White Wine

1000 Bottles of Red Wine.

The cost calculation table used in the production of red and white wine of the enterprise is shown in Table 8 and the profit to be obtained by the enterprise according to the optimum production figures is given in Table 11. According to the traditional approach, optimum production was calculated as 2753 bottles of white wine and 1000 bottles of red wine. According to the results, the profit of the enterprise is 92072 TL.

Table 11. Enterprise Income According to Traditional Approach

	RED WINE	**WHITE WINE**	**TOTAL**
Sales	1000 X 50 = 50000 TL	2753 X 40 = 110120 TL	160120 TL
Direct Materails (-)	1000 X 8 = 8000 TL	2753 X 6 = 16518 TL	(24518 TL)
Direct Labor Expenses	1000 X 5 = 5000 TL	2753 X 3 = 8259 TL	(13259 TL)
Variable General Production Expense	1000 X 6 = 6000 TL	2753 X 3 = 8259 TL	(14259 TL)
Constant General Production Expense	1000 X 5 = 5000 TL	2753 X 4 = 11012 TL	(16012 TL)
Profit / Loss			**92072 TL**

As a result, the constraint of the wine production company was determined, according to the constraints theory, the priorities of the enterprise were determined and the production of 3000 bottles of white wine and 836 bottles of red wine emerged as the optimum production. In this way, the wine production enterprise generates a profit of 93736 TL. However, when the same processes are performed according to the traditional approach, the optimum production of the enterprise is 1000 bottles of red wine and 2753 bottles of white wine. According to this result, the profit of the enterprise is 92072 TL and loss is 1664 TL according to the constraint theory approach.

CONCLUSION

Today's companies are increasingly competing on time and quality. They can't survive if they fail to obtain competitive advantages by producing high quality products and services in shorter throughput time and quicker inventory turnover.

Since the beginning 1970s, some important approaches have improved for companies to achieve competitive advantages. These are Materials Requirements Planning (MRPI and MRPII), Just-In-Time

(JIT), and Theory of Constraints (TOC). TOC was evolved from Optimized Production Timetables (OPT) and developed in the mid-1980's by Goldratt. The working principle of TOC provides a focus for a continuous improvement process. Goldratt summarised the concept of TOC as:

- Every system must have at least one constraint.
- The existence of constraints represents opportunities for improvement.

The goal of cost management is to enhance the profit of the business up to the maximum level. In order to achieve this goal, first of all, having high competitive skills and keeping up with every change are inevitable in tough market conditions.

In this study, the theory of constraints has been examined in terms of management accounting. The basic concepts and the structure of the theory of constraints were researched. With the application made in a manufacturing company, the current capacity constraint in the production process of the company was determined and its effect on the profit of the company was revealed by removing the restriction determined. Besides, the advantages and disadvantages of the theory of constraints were addressed. Following this goal, the studies about the theory of constraints in the literature were examined and in the end, it was specified that the theory of constraints presents more effective solutions to detect the problems hindering the achievement of the goals and to eliminate them rather than classical approaches.

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Etik Beyanı : *Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara uyulduğunu yazarlar beyan eder. Aksi bir durumun tespiti halinde ÖHÜİİBF Dergisinin hiçbir sorumluluğu olmayıp, tüm sorumluluk çalışmanın yazarlarına aittir.*

Yazar Katkıları : *Theory of Constraints: The Application of Wine Production Facility çalışmada. 1. yazarın katkı oranı: %50, 2. yazarın katkı oranı: %50.*

Çıkar Beyanı : *Yazarlar arasında çıkar çatışması yoktur.*

Ethics Statement : *The authors declare that ethical rules are followed in all preparation processes of this study. In case of detection of a contrary situation, ÖHÜİİBF Journal has no responsibility and all responsibility belongs to the authors of the study.*

Author Contributions : *In this study 1st author's contribution rate: 50%, 2nd author's contribution rate: 50%*

Conflict of Interest : *There is no conflict of interest between the authors*