USING ATTRIBUTE-BASED COSTING AND THEORY OF CONSTRAINTS FOR PRODUCT-MIX DECISIONS: AN EMPIRICAL STUDY IN IRAQ

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ABSTRACT

The paper seeks to demonstrate the ability of technology cost based on specifications and the theory of constraints (TOC) to help the company decide the optimal product mix. The article aims to allow managers to rationalize and optimize product-mix decisions. The attribute-based costing (ABCII) framework is used to improve the process to create optimal mix decisions. The company needs accurate cost information about its products' cost, and this information can technically be cost based on specifications provided. A range of constraints and limitations influences the company's output, so the theory of restrictions and its ability to address bottlenecks is studied. The case study method was used, applied in the leather industry laboratories in Baghdad. The results show that the cost-based specification technology analyzes the product into a set of characteristics and features and accurately determines each specification's cost. This accurate information helps in making the decisions on the optimal product mix. The theory of restrictions is a crucial method for identifying bottlenecks and constraints, and dealing with them and eliminating their impact on the production process will help achieve maximum return. Therefore, the paper shows that the theory of conditions can be used in production-mix decisions.

Keywords: Attribute-Based Costing, Theory of Constraints, ABCII, Product Mix Decisions

JEL Classification Code: D23, D24, M40, M41, Q56

INTRODUCTION

Mix production is one of the most important decisions taken by the company because of its importance in determining the optimal production-mix size, which maximizes its profitability. The modern technological development in the business environment plays a vital role in increasing competition between companies, expanding industrial projects significantly, and complicating the economic unit's organizational structure. Due to the old cost systems' inability to provide cost information accurately, the need for a sophisticated information system that provides accurate accounting data has been made. This system should be adapted to these developments, and the company needs to make appropriate and timely decisions (Ojah, Malik, & Ali, 2019a). The cost technology appeared to rely on specifications based on measuring each product characteristic's cost and achievement level. Also, it clarifies and interprets the variation and changes in specifications that vary from product to product. Besides, the paper seeks to show the impact of these changes on the production process to accurately allocate costs since the company is subject to internal or external restrictions and constraints. A system helps identify those restrictions and works to address them because they affect the production process and prevent meeting its objectives. Applying the principle of controls would motivate departments to make continuous progress and make several critical product-mix decisions. One of the company's essential things is the product-mix decisions, which products can be produced. Whichever is postponed until another time or the decision to cancel my product line?

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There is no doubt that the production capacity and the supporting activities are fixed in the short term. Therefore, the company needs to decide on a better product mix and for this decision to be highly effective. It requires identifying activities that suffer from restrictions that form the bottleneck so that the production mix's decision reaches the company's objectives. Cost measurement is an essential element (A. H. Almagtome, Al-Yasiri, Ali, Kadhim, & Bekheet, 2020). Therefore, the cost system has a significant impact on the validity of the production mix's decision.

Consequently, this research shows that restrictions are an important way for the company to deal with bottlenecks. It leads to product-mix decisions in the presence of a cost system that provides accurate information to make proper management decisions. The cost based on specifications aims to translate the company's needs and requirements to analyze the prices in the light of those specifications to help make crucial decisions. It also seeks to demonstrate the possibility of theoretical restrictions on bottlenecks' treatment and their use in the production mix's decision-making to achieve its objectives. The research adopted the quantitative approach using a case study applied in the General Company for Leather Products. The unit cost was measured by cost technology based on specifications, applying the theory of restrictions on the stages of the production process, identifying bottlenecks, and eliminating them.

LITERATURE REVIEW

Costs Allocation and Product-Mix Decisions

Many studies have sought to find appropriate solutions to the cost-distribution process of products to improve product-mix decisions. In this context, Walker (1999) aims to create a sophisticated cost system free of defects from old traditional techniques. These modern systems and the information they provide help the administration make important decisions such as pricing decisions, product-mix decisions, demand and purchase decisions (Hameedi, Al-Fatlawi, Ali, & Almagtome, 2021). Cost based on specifications includes accurate information on the cost of products, and this information is the basis for making many administrative decisions. It focuses on the specifications customers desire, considering their needs.

Doss, Trujillo-Rasua, and Piramuthu (2020) measure the cost of products in light of the specifications enjoyed by the product by applying the steps of ABCII, which is to determine the needs and desires of customers. Then, the specifications are determined whether they are primary or secondary, and then select each characteristic measures the cost of each level of achievement. ABCII accurately measures product costs and defines the basic activities of each specification. Sarkar, Jha, and Patel (2021) indicate that old traditional entrances and their inability to allocate costs accurately, i.e., the company needs sophisticated entries. It works to identify expenses accurately. The theory of restrictions contributes to providing information that helps the management make decisions, whether strategic or operational, to achieve its objectives. Simatupang, Wright, and Sridharan (2004) show that the theory of restrictions to the value chain sets the stage for the production process. The results show the importance of applying the theory of constraints to all stages of production and their ability to address bottlenecks and remove their impact to lead to continuous improvement of the production process. Kadhim, Najm, and Kadhim (2020) refer to the significant role of the theory of restrictions in identifying bottlenecks in light of the diversity of products and their ability to address them. It aims to demonstrate the importance of production accounting in providing information to management on the cost of products to reduce costs, reduce the time needed for the production process, and reduce inventory under the theory of constraints. The view of restrictions effectively contributes to eliminating those determinants and bottlenecks that accompany the production process in the light of the information provided by production accounting. As a result, it can assist in evaluating management, increasing efficiency, and achieving targets.

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Previous research on the role of cost technology in product requirements indicates that it provides precise cost information on the cost of goods after classifying the commodity into a range of attributes and determining the price and level of accomplishment for each of the product's characteristics (Al-Fatlawi, Al Farttoosi, & Almagtome, 2021). Previous findings have shown that the knowledge provided by technology is more reliable than that offered by older, more conservative technologies. Numerous reviews have been written on tasks relating to the philosophy of limits, touching on it and examining it from various perspectives. Various studies, whether Arab or international, demonstrate the part they play in resolving bottlenecks. By comparing and contrasting recent studies, we can see that the current analysis is compatible with prior research regarding its primary topic and overall purpose. However, it is significantly different in many ways. This paper establishes a link between the research issue of applying ABCII and TOC and their role in assisting management in making output mix decisions. These quantify the expense of each product characteristic and achievement degree by using the principle of restrictions to the stages of the manufacturing process.

Additionally, this article employs two analytical approaches (quantitative and qualitative) to provide an accurate picture of the study's problem and is not limited to a single commodity but includes several of them. As shown in the introduction, this paper fills a technical gap on several levels by discussing product-mix decisions and their coverage to calculate the cost based on requirements using the principle of constraints and the variety of methods used to solve this issue. What sets the current study apart from previous research is that it used ABCII technology in conjunction with TOC to assist participants in making optimum output mix decisions based on the knowledge given by ABCII about the expense of each commodity characteristic. Since the use of this technology that analyses the demand, detects consumer needs, and stays current with technological advances leads to the quality of the knowledge given by that technology, its use in conjunction with the principle of constraints is justified. Previous research has shown that finding and removing bottlenecks provides the government with accurate data to base various decisions. The General Company of Leather Industries' (ABCI) products will be based on the ABCII and TOC knowledge foundations and adhere to industry-standard requirements. Following that, we will apply the limit theorem to our products to determine the optimum output balance at a superior stage.

Attribute-Based Costing ABCII

The beginning of the advent of cost-based specifications was in the early 1990s. Since then, the concepts have varied. Walker (1992) defined it as an entry point to accurately segment products' costs and benefits. Such as quality, durability, age, and development (ISO). It is a brief illustration of the set of available requirements in the product that the customer seeks to obtain (Al-Wattar, Almagtome, & AL-Shafeay, 2019). The specifications are classified into those that need to be seen to enter the industrial stages in the final form, such as size or length, i.e., the product's external appearance. Specifications do not enter the industrial steps but require selecting an alternative available such as product offers, price, or after-sales services. MacMillan and McGrath (1996) divided the specifications into three types:

1. Basic Specifications: these are those present in all products and are expected to be seen by customers in the competing units' products.
2. Distinctive Specifications: often, the company is characterized by certain specifications that distinguish its products from other competing products. Those specifications are only present in a particular product and do not exist in other products.
3. Stimulating Specifications: these specifications are strong enough to make the customer seek the product through its availability in the product. They are critical. They are why the product is preferred without other similar products and not necessarily have to be expensive, but contribute significantly to the customer's access to the product.

In the context of the impact of ABCII technology on decision-making, Lunenburg, 2010:2) argues that the decision-making process is an alternative preference process among

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several alternatives to solving a particular problem. To achieve the company's goals depends on three elements:

1. Develop several alternatives to solve a particular problem.
2. Study and analyze other options considering the company's situation.
3. Reach a definitive judgment on the right course of action to achieve the company's objectives

The decision-making process is not easy for the company's management because it is of great importance in determining its success or failure; the wrong decision will lose its market position (Ojah, Malik, & Ali, 2019b; Khaghaany, Kbelah, & Almagtome, 2019). The use of ABCII technology brings many advantages to the economic unit because it measures the cost of each level of achievement. Doing so will help the company choose the appropriate combination of these levels because it can reduce the cost of any level of achievement without affecting its sales. According to Ken (2005), the purpose of deciding the product mix requires the company to do the following tasks:

- Determine the sales of each product
- Determine each product's cost by applying ABCII technology, which identifies primary and secondary activities and activities that add value to the development while excluding activities that do not add value. Through ABCII, each production phase's cost is determined, which helps the optimal mix's decision-making process.
- Extract net income for products before a decision
- Determining net income for products after making a proposal or modification
- Make a comparison between net income and the two cases for decision-making

Theory of Constraints

The theory of constraints emerged in the mid-1970s when Goldratt carried out numerous studies and operations management research. The theory of restrictions, or so-called restriction management, is defined as a philosophy or set of techniques used by the company (M. Ali, Hameedi, & Almagtome, 2019) to manage the activities and operations, which is the most implemented in manufacturing processes. It works to guide management and focus on critical points in the company. It evolved in terms of methodology and application, where it became dealing with the company's system comprehensively and not looking at each activity individually. As applied in traditional methods, it focuses on the weakest link in the system series (Sysma, 2016:5). The concept of TOC can be summarized as follows:

1. Each system has at least one restriction, i.e., there is no system without limitation, as these restrictions will make the process of making profits very difficult.
2. Restrictions can contribute positively to economic unity by introducing continuous improvements to the system to eliminate those restrictions.

The theory of restrictions seeks to provide a careful and continuous focus to improve the current constraint. Goldratt believes that stress is at the heart of the idea of constraints and that the way to deal with the restriction to improve the system should be to follow the correct removal methods (Goldratt & Cox, 2014). TOC applies to for-profit organizations and non-profit organizations such as health services or social organizations (Amusawi, Almagtome, & Shaker, 2019; Ali, Almagtome, & Hameedi, 2019). The TOC idea embodied a new view of current issues related to the implementation of production processes.

The production manager's main task is to control manufacturing processes to achieve the company's main objectives. It is to generate profits and establish its place in the markets. Therefore, the theory of restrictions has become a standard tool to support the production manager's decisions. Their ease of understanding has contributed to solving many organizational nature problems (Wojakowski, 2016). Mishra (2020) believes that using the theory of restrictions broadly vastly improves manufacturing processes and that its application shows the

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extent of the company's ability to manage its industrial operations. Hence, the idea of restrictions embodied many objectives, the most important being:

1. Continuous Improvement: TOC theory helps bring continuous economic unity improvements by focusing on restricted activities and improving them in the long term (Ali, 2019).
2. Increase Productivity: One of the goals of TOC is to maximize output units by identifying areas of imbalance during the manufacturing phase and using the principle of constraints to analyze the causes of the problem and work toward resolving them by the application of suitable solutions (Sagitta, Gozali, & Daywin, 2020).
3. Increase Operating Profit: TOC seeks to maximize operating profit by identifying bottlenecks. Recognizing that the choking resource determines the plant's productivity contribution, the backup can be found by identifying operations with large accumulated stocks and waiting to work on them. It also aims to increase achievement contribution while reducing investment and operating costs by focusing on choking resources (Union, Kadhim, & Ali, 2020).
4. Reducing the Completed Unit's Cost: Many operations and departments within the company may not operate at their total capacity. It means that fixed costs associated with these operations or divisions have not been used efficiently. When the company increases the flow rate, most of the fundamental constraints are excluded. Fixed costs can be distributed over the large production volume, leading to reduced fixed costs per unit (Kbelah, Amusawi, & Almagtome, 2019).
5. Encouraging Working People: There are motivations among employees to increase the output of the restricted resource and make an effort and creativity and make improvements because this will help improve the rewards and raise the standard of living for them.

By focusing on the five steps known as POOGI, we find the basis of these steps: identify system restrictions where the available information must be highly reliable, and the administration can address these restrictions (A. Almagtome, Khaghaany, & Önce, 2020). The next step is developing appropriate methods to handle and manage conditions to move them to the next stage. According to Li, Zhao, and Zheng (2020), these methods or procedures are applied to ensure that the restriction is eliminated and that improving the system will continue. There is no repetition of another limitation.

Step 1: Identify the restriction.
Step 2: Exploit the constraint.
Step 3: Support the previous step.
Step 4: Lift the restriction.
Step 5: Avoid another limitation.

Integration of TOC and ABCII for Efficient Product-Mix Decisions

The decision-making process is an essential matter for the company. It conducts a comprehensive study of each resolution alternatives and analyzes them to suit its objectives and capabilities. The production-mix decisions are one of the administration's main choices to achieve a specific strategy in the long term. Many factors influence the productive mix's findings, including the scarcity of resources that do not meet the production process requirements. They need to find a compelling blend that optimizes the use of its resources and performs better. Modi, Lowalekar, and Bhatta (2019) indicate the restrictions that accompany the production process, whether from within the company or outside. Or it may relate to the level of completion or demand for the product by the market in addition to the time spent in the production process (Mills, Denison, & Gearity, 2020). Making a better decision for a product mix that maximizes its profitability requires more accurate information about bottlenecks that limit its decision-making ability.

Applying the theory of restrictions contributes to providing the company with precise information about the constraints that accompany the production process by using that theory's steps. The first and second steps are the most critical steps that address the product mix's problems (Chen, Wang, & Du, 2020). So, TOC theory is used in making production-mix

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decisions. It seeks to maximize the contribution return using the lowest level of available resources and the management for information regarding the product's type of product considering the market's requirements. Such information is provided by ABCII cost technology, which offers accurate cost information on each specification's cost and completion level and the minimum and maximum price (Becker & Gaivoronski, 2018). It can therefore be said that ABCII technology helps management make decisions by providing appropriate information. The product is analyzed into a range of qualities by identifying customers' wishes (Azeez, Kadhim, & Kadhim, 2020). TOC theory is supported by accurate cost information on each product's cost and information on the product mix that achieves an integrated model and maximizes profitability. TOC's role in removing restrictions on that information makes it easier for the administration to decide.

Accurate information is the critical factor in making the right decision to make a profit or loss. Using more precise information to determine the optimal product mix of available resources to achieve high productivity and desirable specifications by customers, ABCII and TOC work together to assist management in the optimal product mix decision-making process. The decisions will be about studying and analyzing several alternatives, maximizing the contribution return, and achieving the highest profits.

RESEARCH METHODS AND MATERIALS

The research adopted the quantitative approach using as the case study the General Company for Leather Products. The cost of a single unit was measured according to cost technology based on specifications, applying the theory of constraints to the stages of the production process, identifying bottlenecks, and working on getting rid of them by using the steps of the idea of constraints to arrive at the optimal production mix decision.

RESULTS AND DISCUSSION

The leather industries company was established in 1976 and currently operates three factories in Baghdad/Eastern Karrada. It manufactures a variety of shoes for men, women, ladies, and infants. The manufacturing process is divided into four production sections and supporting tasks, with three categories of items chosen for the test study to evaluate the lab sections' constraints. Following discussions with technical personnel, it was agreed to categorize the product into four distinct requirements, emphasizing industry preferences to stay current with supply and demand patterns. Following each classification, the organization determines the expense of the associated commodity. Since some goods need different materials than others, Table 1 details the overall cost of each pair of each type of shoe manufactured using Kroll raw materials, which were classified into four requirements and priced accordingly.

Table 1
PRODUCTION DATA SUMMARY

Costs	Men's closed shoes.	Men's Shoes	Shoe Service
Specifications:			
1. Durability	1960	10400	1235
2. Design	695	1230	775
3. Measurements	2285	960	410
4. Packaging	216	900	900
The total cost of production volume	5156	13490	3320
Wage	290	590	380
Industrial costs	275	550	300
Administrative	65	135	150
Marketing	350	700	400
Total costs	980	1975	4550
Sale Price	10000	18000	9000

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Number of produced units	430	240	300

The time management department determines the time required to produce one pair and each product as the available time for the production of the three types is 11,520 minutes per month (8 hours per day) × 60 minutes) = 480 minutes per day. Still, during the month (480 minutes × 24 days), the total time available 11520, and Table 2 shows the time taken, and each section passes through production. Table 2 also compares the time spent in the production process by multiplying the number of units produced for each type of shoe in the specified team for each section and finding the difference, and detecting bottlenecks in the production process.

Table 2
THE COMPARATIVE ANALYSIS OF TIME CONSUMPTION

Section	Closed shoes	Qatan Shoes	Shoe Service	Time completed	Time available	Difference
Separation	12×430=5160	13×240=3120	8×300=2400	10680	11520	840
Configuration	10×430=4300	8×240=1920	5×300=1500	7720	11520	3800
Stitching	15×430=6450	15×240=3600	10×300=3000	13050	11520	
Drag	4×430=1720	4×240=960	4×300=1200	3880	11520	7640

We note that the sewing department suffers from asphyxiation because the time taken is more significant than the available time, so it is necessary to use the theory of constraints to eliminate this restriction and apply the five steps. Based on the sewing section's regulation, which does not rely on modern tools, we separate the contribution of each of the following: outputs, types, and price, as shown in Table 5, from the cost of raw materials and each of the different manufactured shoe types. To extract the product contribution rate for the department's time, it suffers from a restriction where the contribution margin of each kind of shoe is divided by the time of the sewing section and according to Table 3.

Table 3
THE RATIO OF TIME MARGIN

	Closed shoes	Qatan Shoes
Selling price per pair	10000	18000
- Cost of raw materials	5156	13490
= Contribution margin	4844	4510
Margin of contribution	4844	4510
÷ time of enrollment		15
= Contribution margin rate	322.9	300.6

Table 2 and Table 3 show that the highest contribution margin is for the service shoes of 445. We are working by applying the theory of constraints to extract the optimal mix area by subtracting 3,000 minutes from 11,520 at the service shoes' sewing section; the result is 8,520 minutes. After that, we take the minimum contribution margin for closed shoes by subtracting 8,520-6,450 times the sewing section of the fast shoe. The number of units remaining to be extracted from the manufacturing plant is 1,900. There are 138 pairs of shoes to be gained, and 2,070 minutes remain, only two of which are dedicated to the Qatan project; time left is not nearly enough for everything. We argue that the optimum production-mix area was formed when producing 300 pairs of service shoes and 430 pairs of closed shoes. They have the highest contribution margin compared to the qatan shoe, whose output dropped to 138, and the income disclosure of the three types.

Table 4
PRODUCT INCOME LIST ANALYSIS

Details	Production and sale of (430) closed men's shoe	Production and sale (138) units of men's	Production and sale (300) men's shoe service	Total

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	units	shoes	units	
Sales	4300000	2484000	2700000	
Poses: Cost of direct materials	(2217080)	(1861620)	(996000)	
Return on output contribution	2082920	622380	1704000	
Poses: Operating costs				
Wage	(124700)	(81420)	(114000)	
Industrial	(118250)	(75900)	(90000)	
Administrative	(27950)	(18630)	(45000)	
Marketing	(150500)	(96600)	(120000)	
Total costs	((421400))	((272550))	((369000))	
Net income	1661220	349830	1335000	3346050

The restriction is lifted by the company management's decision to replace the old machines with advanced ones. The plant can produce the planned units of 240 pairs of shoes and 1,500 working minutes during the month, as described in Table 5.

Table 5
THE DIFFERENCE BETWEEN AVAILABLE AND CONSUMED TIME

Section	Closed shoes	Qatan Shoes	Shoe Service	Time completed	Time available	Difference
Separation	12×430=5160	13×240=3120	8×300=2400	10680	11520	840
Configuration	10×430=4300	8×240=1920	5×300=1500	7720	11520	3800
Stitching	15×430=6450	15×240=3600	10×300=3000	13050	14550	1500
Drag	4×430=1720	4×240=960	4×300=1200	3880	11520	7640

Table 6 shows the net income after the disposal of the registration and the production of the three types of shoes.

Table 6
INCOME STATEMENT AFTER REMOVING THE CONSTRAIN

Details	Production and sale of (430) closed men's shoe units	Production and sale (138) units of men's shoes	Production and sale (300) men's shoe service units	Total
Sales	4300000	4320000	2700000	
Poses: Cost of direct materials	(2217080)	(3237600)	(996000)	
Return on output contribution	2082920	1082400	1704000	
Poses: Operating costs				
Wage	(124700)	(141600)	(114000)	
Industrial	(118250)	(132000)	(90000)	
Administrative	(27950)	(32400)	(45000)	
Marketing	(150500)	(168000)	(120000)	
Total costs	((421400))	((474000))	((369000))	
Net income	1661220	608400	1335000	3604620

We note that the net income generated from the production and sale of products has become 3604620, increasing (258,570) through the above income statement. It has helped to apply the theory of restrictions to identify the bottleneck of the production process and help management make optimal production mix decisions and achieve a higher level of net income.

CONCLUSION

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Attribute-based costing (ABC) contributes to accurately measuring the cost of each specification after the specifications of the product are determined according to the wishes of customers and market developments. Besides, it also maximizes the profitability of the company and achieves a good position in the markets. The availability of this accurate cost information about its products helps the administration know the minimum and maximum cost and each achievement level. It uses the theory of constraints to identify the production process stages, determining the products that contribute to its overall profitability and five different restrictions. Diverse solutions are critical to remove the bottleneck of restricted resources.

Furthermore, ABC improves the system's performance to achieve the company's goals by using the information provided by the cost technology based on specifications and the cost of each product characteristic and each level achievement. The theory of restrictions removes bottlenecks from the production process. This information becomes vital for the economic unit to make the right decisions about the optimal product mix to achieve maximum output return. The leather industry lab can use cost-based technology with constraints because it will accurately cost each product. Simultaneously, it can locate bottlenecks, work to remove them, and achieve a production mix that maximizes the contribution yield. Therefore, this paper recommends adopting attribute-based costing instead of traditional cost systems. It works to measure the cost accurately and for each product's characteristic by analyzing those specifications to contribute to the appropriate decisions. The commitment to apply the theory of restrictions and all stages of production is essential. It is crucial to decide on the cost structure where all costs are considered fixed except for direct materials, which they believe variable costs. Finally, it is vital to determine the time needed. Each activity is strictly allocated, and advanced machinery and equipment do not cause loss and waste in the time allotted for each production stage.

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