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Integrated Process for Multiple Product Breakeven Analysis and Limiting Resource Allocation in Profit Planning

Abstract. *Breakeven analysis for multiple products can help managers understand how each product or service contributes to a company's overall profitability and performance. It can help identify the most and least profitable products or services and how to optimize the company's sales mix and pricing strategy. This paper presents a step-by-step process of an integrated multiple product analysis for the derivation of multiple product breakeven point coupled with the process of allocation of limiting factor in multiple product cases. Accordingly, the author used a hypothetical case of the Integrated Juicy Products PTY to demonstrate an integrated process of conducting multiple product breakeven analysis, derivation of multiple breakeven point and separate breakeven point of each product among the multiple products. Additionally, the research presents insight into the procedural allocation of a limiting factor of production to optimize product mix and profit contribution. In this study, the procedural analysis demonstrates the optimum usage of the limiting factor and the attendant optimum production in the multiple mix of products, culminating in the optimum contribution margin. To buttress the optimization implication of limiting factor allocation, it concludes by presenting a comparison of total contribution using equal allocation of limiting factor to accentuate the fact that in times of limiting factor, the optimum contribution is attainable with optimal allocation of limiting factor of production through the prioritizing of the products with higher contribution per unit of limiting factor. The paper offers insights for practical application in multiple product companies and case teaching and research in business schools.*

Keywords: *breakeven analysis, profit planning, multiple products company, optimum production, integrated process, limiting factor allocation, margin of safety, contribution margin.*

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Інтегрований аналіз беззбитковості кількох продуктів та обмеженого розподілу ресурсів у плануванні прибутку

Анотація. *Аналіз точки беззбитковості для кількох продуктів може допомогти менеджерам зрозуміти, як кожен продукт або послуга сприяє загальній прибутковості та ефективності компанії. Такий аналіз може допомогти визначити найбільш і найменш прибуткові продукти чи послуги та надати вказівки як оптимізувати структуру продажів і цінову стратегію компанії. У цій статті представлено покроковий інтегрований процес аналізу кількох продуктів для визначення точки беззбитковості для кожного з них у поєднанні з процесом розподілу обмежувального фактора у випадку виробництва кількох продуктів. Автор використав гіпотетичний випадок на прикладі компанії* Integrated Juicy Products PTY, *щоб продемонструвати інтегрований процес проведення аналізу беззбитковості кількох продуктів, визначення кількох точок беззбитковості та окремої точки беззбитковості кожного продукту серед кількох продуктів. Крім того, дослідження містить уявлення про процедурний розподіл обмежувального фактора виробництва для оптимізації асортименту продукції та прибутку. Процедурний аналіз демонструє оптимальне використання обмежувального фактора та супутнє оптимальне виробництво в різноманітному наборі продуктів, кульмінацією якого є оптимальна маржа внеску. Щоб обґрунтувати оптимізаційні наслідки розподілу обмежувального фактора, аналіз завершується представленням порівняння загального внеску з використанням рівного розподілу обмежувального фактора. Це дозволяє підкреслити той факт, що в умовах існування обмежувального фактора оптимальний внесок досягається за допомогою оптимального розподілу цього*

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фактора через надання пріоритету продуктам з більшим внеском на одиницю обмежуючого фактора. Представлений у статті кейс пропонує ідеї для практичного застосування в багатьох продуктових компаніях, а також може бути використаний під час навчання в бізнес-школах.

Ключові слова: *аналіз точки беззбитковості, планування прибутку, багатопродуктова компанія, оптимальне виробництво, інтегрований процес, розподіл обмежуючих факторів, запас міцності, маржа внеску.*

INTRODUCTION

A business organization is established to make profitable returns to owners and/or investors. Profit returns from business operations may not necessarily be used only by owners as a form of distribution; instead, sufficient profit is also required for *inter alia* to service the borrowed financial capital and to pay government tax obligations expected from every responsible business organization after achieving profit during the fiscal year. In addition, proactive risk management also requires that businesses strategically put aside some undistributed profit as a form of reserve under the owners' capital in the balance sheet or financial statement. This is important because the higher the reserve, the more a business organization can take advantage of sudden profitable business opportunities that require using reserves. Given, therefore, that the sole purpose of every business is to create more wealth over the invested capital, it is therefore of utmost importance that operation managers, purchasing managers, production managers, marketing managers, and cost accounting department work jointly to establish the actual product and/or service levels or volumes, which may be sufficient to provide enough revenue to recover all the business non-fixed costs, albeit no profit or loss at this point. This level of product or service at which the business makes no loss or profit is called the breakeven point. It is a crucial planning point that offers insight to managers about further profit planning strategies, specifically regarding costs, price, volume and tax, which may contribute to additional revenue sufficient enough for the recovery of fixed costs and with surplus revenue left over as profit.

There is a paucity of academic research guidance on integrating multiple-product break-even analysis and limiting resource factor allocation in a single-case scenario. Hence, this paper provides an integrated step-by-step approach for conducting breakeven analysis for multiple products and allocating the limiting factor of production for optimum production and contribution margin.

LITERATURE REVIEW

Manova and Yu (2017) evaluated multi-product firms' operations from a global perspective. They presented a practical case of a heterogeneous firm trading model with a strong or limited scope for implementation differentiation in their quality. They applied custom data from Chinese companies for the period covering 2002-2006 and provided an empirical establishment that these companies apportion operations among products using a product-hierarchy apportionment based on the level of product quality. They further find that companies may produce different products with different qualities based on different input qualities used in producing such products. In addition, they highlight that companies that wish to command high sales focus their competence on using inputs of superior quality, which, although it comes at high costs, will attract higher sales volume for the company (Manova & Yu, 2017). Another finding worth noting is that when companies are faced with a market that requires fewer products, they focus their attention on offering only top products and drop the lower quality products, given that the top products would generate higher profit margins. Accordingly, the above findings by Manova and Yu (2017) corroborate previous research, which suggests that when companies make high sales, it can assist in recouping the input costs and facilitate a faster rate of profit generation (De Mel et al., 2009). Furthermore, the above research by Manova and Yu (2017) also attests to the practical product and profit planning strategy, which emphasizes why companies may not always focus on unprofitable sales of a wider variety of products or services but may need to strategize attention on fewer products that offer maximum profit during times of low market sales or input resources scarcity as such periods may not be able to accommodate all the products or services with reasonable profits.

Therefore, dropping or adding decisions in managing multiple product production and sales is an important operational art, which can be learned from various sources, such as academic training, industry peers, and on-the-job experience. Product dropping and adding is a natural process of adjustment in business scope and assists with resource allocation for optimum efficiency in operations. Manova and Yu (2017) discovered that fifty percent of manufacturing companies in the USA engage in product switching to allocate resources, increase production, and improve performance efficiency. Whether multiple product management and decision-making are in the product development stage or the mature stage, it is important to note that effective and efficient product decisions must be made in consultation with team members of multidisciplinary genres working in an iterative approach (Takeuchi & Nonaka, 1986). Although the process and time required in determining breakeven may be downplayed, the importance of breakeven pervades product planning, product controlling, product innovation, profit optimization and financial stability (Alnasser, Shaban & Al-Zubi, 2014; Ali, Krapfel & LaBahn, 1995; Almansour & Almansour, 2024; Maulana & Saleh, 2023).

Managers may not neglect the importance of the breakeven point as empirical research has shown that its application has contributed to industrial production and revenue growth. For example, Alnasser et al. (2014) evaluated the impact of the breakeven point in controlling, planning and attendant decision-making in the Jordanian industries. Their study showed that many industries in Jordan commit energy and time to determining their product or service breakeven points, providing them with clearer direction in planning and controlling decisions. Their research found a statistical relationship between using the breakeven point and recorded successes in planning and controlling decisions among industries in Jordan. Knowledge of the breakeven point, therefore, assists in product development and helps in planning for quicker product development amid quality, which in turn contributes to assisting companies in experiencing a shorter breakeven point (Ali et al., 1995). Given that breakeven point analysis is based on holding factors constant, companies may do well to first engage in risk analysis to ensure that parameters used in the breakeven analysis (e.g. price, variable costs, fixed costs, production and sales levels) do not fall too far away from the predictions; if the risk is analyzed effectively breakeven analysis can indeed assist in operational optimization and financial stability (Almansour & Almansour, 2024).

RESEARCH METHODOLOGY

This paper applies a hypothetical case illustration scenario to provide a step-by-step process of integrating multiple product breakeven analysis with the limiting resource factor allocation. Examples, where hypothetical case illustrations have been applied, include *inter alia* business non-performing loan default, contractual legal obligation and insolvency proceedings (UCC, 2020); development of a research project (Farmer & Farmer, 2014); a hypothetical case illustration of carbon-constraint energy generation (Lee et al., 2017); a hypothetical illustrative project on carbon accounting methods for carbon capture and storage (Mota-Nieto et al., 2024). Therefore, adopting the hypothetical case illustration scenarios of the extant research, this paper uses a hypothetical case to provide a procedural illustration of an integrated multiple product breakeven and limiting factor analysis. This procedure offers a seamless guide for managers in multiple product companies and for the academia – for teaching and research in business schools.

Accordingly, in the subsequent method sections, the paper provides a case context of multiple product companies with multiple products, as well as their costs, revenues, and limiting factors. Thereafter, a step-by-step analysis approach is presented in tabular format. The currencies used in the hypothetical case are indicated in South African Rand (R).

RESULTS

Business Imperative for Breakeven Analysis and Limiting Factor Allocation

Companies operate in business environments which are fraught with constant changes that may affect production resource availability. Such changes may include, *inter alia*, the political environment, economic environment, social environment, natural disasters, conflicts (national and international), etcetera.

Accordingly, during times of limiting production resource availability (production resource constraint), management's wisdom in using the limited resources to achieve optimum production and revenue contribution becomes pertinent. Limiting factors of production may include, among other factors, labour hours, machine hours, kilowatt hours of electricity, raw materials, flaw space, etcetera.

Such wisdom would require a careful analysis of the contribution margin per unit of limiting factor from each product within the chain of the company's multiple products. The contribution margin per unit of the limiting factor is calculated after deriving each product's contribution margin per unit (which is sales price per unit less variable cost per unit). Thereafter, the contribution margin per unit of limiting factor may be analyzed by dividing the contribution margin by the units of limiting factor required to produce a unit of a product type (Table 1 and Table 2).

Table 1. **Contribution Margin per Unit (CMPU)**

	Lemon Juice Product	Apple Juice Product
Sales Price per unit (SPPU)	R5	R6
Variable cost per unit (VCPU)	R2	R4
Contribution margin per unit (SPPU – VCPU)	R3	R2

Source: Author's illustration.

Lemon Juice product uses 5 kg of sugar to produce one unit of Lemon Juice Products, and Apple Juice Product uses 2 kg of sugar to produce one unit of Apple Juice Products. Therefore, each product's contribution margin per unit of limiting factor (CMPULF) will be as follows (Table 2).

Table 2. **Contribution Margin per Unit of Limiting Factor (CMPULF)**

	Lemon Juice Product	Apple Juice Product
Contribution margin per unit (CMPU)	R3	R2
Limiting factor per unit (LFPU)	5 kg	2 kg
$\text{CMPULF} = \frac{\text{CMPU}}{\text{LFPU}}$	R2	R1

Source: Author's illustration.

Case Presentation: Integrated Juicy Products South Africa PTY (Hypothetical Case)

The Integrated Juicy Products South Africa PTY, hereinafter referred to as IJP PTY, operates its head office in Pretoria, South Africa, with four regional offices that manufacture specialized fruit drinks in each division. Accordingly, the head office incurs some fixed costs amounting to R40 000. The head office holds each division responsible for the head office fixed costs. Given that the company wants to retain central control but with semi-autonomy regarding divisional controllable costs, the management decided to name each divisional plant as Orange, Apple, Lime, and Mango Divisions. These divisions have been well known for their unique names with some strategic marketing and sales value in the four South African provinces where they are located.

Based on past historical experience, the production manager estimated the planned production for the coming period as follows:

Orange: two thousand units (2000 units);

Apple: one thousand units (1000 units);

Lime: one thousand, four hundred units (1400 units);

Mango: eight hundred units (800 units).

Furthermore, the sales price and variable cost per unit are Target Sales Price: Orange: R40; Apple: R20; Lime: R15; Mango: R30.

Target Variable Cost: Orange: R20; Apple: R12; Lime: R5; Mango: R20.

Separable fixed costs are R1000 for each of the four divisions.

Additional information:

The COE of IJP PTY identifies a short supply of sugar for the second quarter of 2025 and thinks that the short supply will not be corrected until the end of the second quarter of 2025. The production runs for each product are designed to use some quantities of sugar to produce every unit of its product as follows:

Orange: 4 kg of sugar to produce a unit of Orange;

Apple: 2 kg of sugar to produce a unit of Apple;

Lime: uses 5 kg of sugar to produce a unit of Lime;

Mango: uses 1 kg of sugar to produce a unit of Mango.

However, the marketing manager has conducted a forecast and indicates that only 15000 kg will be available during the second quarter of 2025. Management is therefore worried that the sugar might not be sufficient for producing all the products to full capacity during the second quarter and needs some advice on two key issues to enhance the period decisions:

- Advice on multiple product breakeven point;
- Advice on how to allocate the anticipated limited supply of sugar to optimize production and contribution to profitability.

The following procedure provides a step-by-step approach to the two advisory issues required by management.

Table 3. **Multiple Product Breakeven Analysis**

	Orange	**Apple**	**Lime**	**Mango**	**Total**
Planned production	2000 units	1000 units	1400 units	800 units	5200 units
%mix of Production	2000/5200	1000/5200	1400/5200	800/5200	1 or 100%
From each product	= 0.3846	= 0.1923	= 0.2692	= 0.154	
Sales price per unit	R40	R20	R15	R30	
Variable cost per unit	R20	R12	R5	R20	
Contribution margin: CM	SP-VC= R20	R8	R10	R10	
WACM=(CM x % Mix)	(20X0.3846)	(8X0.1923)	(10X0.2692)	(10x0.154)	
∑WACM =	7.692	1.5384	2.692	1.540	13.4624
MPBEPU = TFC/∑WACM					3268.362 U
Allocation of MPBEPU MPBEPU= MPBEPR =	(3268.362 x0.3846) 1257.01 U R50 280.40	(3268.362x0.1923) 628.506 R12570.12	(3268.362 x0.2692) 879.84 13 197.60	(3268.362 x0.154) 503.32 15 099.60	3268.362 U 3268.362 U R91 147.72
Margin of Safety (MOS): MOS in units =1931.638U MOS in % = 37.15%					=1931.638U = 37.15%

Source: Author's Step-by-Step Illustration to the Hypothetical Case.

Where:

MPBEPU = Multiple product breakeven point in units;

MPBEPR = Multiple product breakeven point in Rand;

TFC = Total fixed costs;

∑WACM = Summation of weighted average contribution margin;

U = Units;

R = Rand;

%mix of production from each product = a single product's production as a percentage of total production = $\frac{Production\ of\ Orange=[2000\ units]}{Total\ production\ of\ four\ products=[5200\ units]}$ = 38.46% of the 4 multiple products;

Contribution margin (CM) = Sales price per unit – Variable cost per unit;

WACM (Weighted average contribution margin) = CM per unit x %mix of production;

Allocation of MPBEP = Allocation of multiple product breakeven point in units = total multiple breakeven point in units x %mix of production for each product;

MPBEPU = Multiple product breakeven point in units = Total fixed costs / ∑WACM = $\frac{TFC}{\sum WACM}$;

Total Fixed Costs = Head office fixed costs + Separable fixed costs = 40 000 + 4 000 = R44 000;

$$\text{MPBEP in Units} = \frac{40000+4000}{13.4624} = 3268.362 \text{ units;}$$

MPBEPR = Multiple product breakeven point in Rand = BEP per product x Sales Price per unit of each product;

MOS = Margin of safety for the multiple products in units = Planned production – Multiple product breakeven point in units = 5200 units – 3268.362 units = 1931.638 units;

MOS = Margin of safety for the multiple products in % = $\frac{Planned\ production - MPBEP\ in\ units}{Planned\ production} = \frac{5200\ units - 3268.362\ units}{5200\ units}$ = 37.15%

The margin of safety for a company may be expressed in units, monetary terms or percentage terms. Hence, margin of safety is a measure of units or amount by which the company's sales would decrease as a precedent to the occurrence of loss. Experts recommend that a company should strive to keep a higher margin of safety as a higher margin of safety is less risky than a lower margin of safety (Drury, 2016). Hence, the higher the percentage margin of safety, or the unit's or monetary margin of safety, the better for a company. This is because where the margin of safety is higher, the company breaks even faster, hence making a profit faster as few products will need to be sold and break even, and profit occurs. However, if the margin of safety is high, it follows that more products will be sold before the occurrence of break even and profit.

Tables 4 to 6 present a columnar analysis to indicate the complete process of allocating the limiting factor of production and show the optimum mix of production considering the shortage of the production resource (sugar). After the limiting factor allocation, Table 6 shows a revised contribution using the revised mix of production during the limiting factor period.

Table 4. **Contribution per Unit of Limiting Factor of Each Product and Ranking**

	Orange	Apple	Lime	Mango
Sales Price (SP)	R40	R20	R15	R30
Variable Cost (VC)	R20	R12	R5	R20
CM (SP – VC)	R20	R8	R10	R10
Limiting factor per unit (LFPU)	4 kg	2 kg	5 kg	1 kg
CPULF: (contribution per unit of limiting factor) = CM / LF	20/4 = R5	8/2 = R4	10/5= R2	10/1 = R10
Ranking	2nd	3rd	4th	1st

Source: Author's Step-by-Step Illustration to the Hypothetical Case.

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Table 5. **Optimum Allocation of Limiting Factor for Optimum Production**

Products & Maximum Units to be Produced	Limiting Factor Usage at Maximum Units of Production	Balance of 15000 kg of Limiting Factor After Allocation
Mango: 800 units	800 kg	14 200 kg
Orange: 2000 units	8000 kg	6 200 kg
Apple: 1000 units	2000 kg	4 200 kg
Lime: 4 200 kg / 5 kg = 840 units	4200 kg	-0-

Source: Author's Step-by-Step Illustration to the Hypothetical Case.

Table 6. **Total Contribution after Optimum Allocation of Limiting Factor**

Products & Units of Production After Factor Allocation	CM Per Unit of Product	Total Contribution After Optimum Allocation
Mango: 800 units	R10	R8 000
Orange: 2000 units	R20	R40 000
Apple: 1000 units	R8	R8 000
Lime: 840 units	R10	R8 400
Total contribution per unit of product under optimum allocation of resource		**R64 400**

Source: Author's Step-by-Step Illustration to the Hypothetical Case.

Table 7. **Comparing Total Contribution by Equal Allocation of Limited Resource**

Equal Limiting Factor Allocation = 15 000 / 4 = 3750 kg to each Product	CM per unit	Total Contribution
Mango: 800 units	R10	R8000
Orange: 3750 kg / 4 kg = 937.5 units	R20	18 750
Apple: 1000 units	R8	8 000
Lime: 3750 kg / 5 kg = 750 units	R10	7500
Total contribution under equal allocation of resources		**R42 250**

Source: Author's Step-by-Step Illustration to the Hypothetical Case.

Table 7 indicates that equal allocation of limiting factor may lead to sub-optimization since R64400 total contribution under optimum allocation is greater than R42250 total contribution under equal allocation of limiting factor.

CONCLUSION

This paper is motivated by the core objective of presenting a step-by-step process of an integrated multiple product analysis for the derivation of multiple product breakeven point coupled with the allocation of limiting factor in a multiple product company. Therefore, using a hypothetical case of the Integrated Juicy Products PTY, the paper provides a solution to management in the process of determining the joint and separable breakeven point for multiple product companies. Furthermore, the paper provides advice on how to allocate the limited supply of factor of production (in this case sugar) to optimize production and contribution to profitability. In the end, the analysis demonstrates the optimum allocation of the limiting factor and how this translates to optimum production in the multiple chain of products and the eventual culmination of an optimum contribution to profitability. A comparison of total contribution is presented using equal allocation of limiting factor, which highlights that during periods of limiting factor, the optimum contribution is reached with optimal allocation of limiting factor of production by prioritizing the products with higher contribution per unit of limiting factor. This paper thus provides a practical guide for operations managers, production managers, supply chain managers and other managers to enhance their planning and decision-making regarding the production and sales of products and the management of costs. The paper is also useful as a teaching case reading for business schools and research in managerial accounting.

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