

Cost Analysis by Absorption in Truck Unloading: A Study on the Use of Manual Labor

Cost Analysis by Absorption in Truck Unloading: A Study on the Use of Manual Labor
Análisis de los costes de absorción en la descarga de remolques: Un estudio sobre el uso de encofrados manuales

Eli Carlos Pereira¹

eli.pereira@fatec.sp.gov.br

Hélio Ribeiro Júnior¹

helio.ribeiro@fatec.sp.gov.br

Rhadler Herculani¹

rhader.herculani@fatebb.edu.br

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Abstract:

This study presents an analysis of absorption costs in the unloading of trucks at a distribution center, focusing on the comparison between manual and mechanized methods. Labor costs, operating costs, and indirect costs associated with each unloading method were considered. The cost theory focused on cost classification and the absorption costing method. The methodology consisted of a quantitative and exploratory literature search. It also used the case study method of a real company in the interior of São Paulo. The results demonstrate that the use of the mechanized method results in lower total costs compared to the manual method, due to the reduction in unloading time and the need for labor. In addition, mechanization brings benefits in terms of safety and operational efficiency. It is recommended that companies consider the transition to mechanized unloading, taking advantage of the resources saved to invest in other strategic areas of the business.

Keywords: Manual unloading; Mechanized unloading; Distribution center; Cost management; Operational efficiency.

Resumo:

Este estudo apresenta uma análise dos custos por absorção na descarga de carretas em um centro de distribuição, com foco na comparação entre a forma braçal e a forma mecanizada. Foram considerados os custos de mão de obra, custos operacionais e custos indiretos associados a cada método de descarga. A teoria de custos focou na classificação dos custos e no método de custeio por absorção. A metodologia consistiu em uma pesquisa bibliográfica de caráter quantitativo e exploratório. Também lançou mão do método de estudo de caso de uma empresa real do interior paulista. Os resultados demonstram que a utilização da forma mecanizada resulta em custos totais inferiores em comparação com a forma braçal, devido à redução do tempo de descarga e da necessidade de mão de obra. Além disso, a mecanização traz benefícios em termos de segurança e eficiência operacional. Recomenda-se que as empresas considerem a transição para a descarga mecanizada, aproveitando os recursos economizados para investir em outras áreas estratégicas do negócio.

Palavras-chave: Descarga braçal; Descarga mecanizada; Centro de distribuição; Gestão de custos; Eficiência operacional.



Resumen:

Este estudio presenta un análisis de los costes de absorción en la descarga de remolques en un centro de distribución, centrándose en la comparación entre la forma manual y la forma mecanizada. Se consideraron los costes laborales, operativos y generales asociados a cada método de descarga. La teoría de costes se centraba en la clasificación de costes y en el método de costes por absorción. La metodología consistió en una investigación bibliográfica cuantitativa y exploratoria. También utilizó el método de estudio de caso de una empresa real en el interior de São Paulo. Los resultados demuestran que el uso del formulario mecanizado resulta en menores costes totales en comparación con el formulario manual, debido a la reducción del tiempo de descarga y la necesidad de mano de obra. Además, la mecanización aporta beneficios en términos de seguridad y eficiencia operativa. Se recomienda que las empresas consideren la transición a la descarga mecanizada, aprovechando los recursos ahorrados para invertir en otras áreas estratégicas del negocio.

Palabras clave: Descarga manual; Baja mecanizada; Centro de distribución; Gestión de costes; Eficiencia operativa.

1. Introduction

Efficient cost management supports strategic decision-making in organizations such as distribution centers (DCs) (Nogueira, 2021). Absorption costing is an essential tool for allocating and measuring the costs involved in business operations.

This study aimed to apply absorption costing to truck unloading at a distribution center, focusing on manual labor. By exploring this topic, the study sought to understand how adopting this method affects the costs of the operational unloading process and its relevance to efficiently managing unloading at a supermarket in the interior of São Paulo state.

2. Theoretical Review

2.1 Cost Classification

Cost classification is essential for accurate financial analysis, as it helps explain the factors that influence financial performance. According to Martins (2010, p. 45), "the correct classification of costs assists in decision-making and in the formulation of business strategies."

- **Fixed Costs:** These costs remain constant regardless of production or sales volume. According to Horngren, Datar, and Rajan (2015, p. 120), "fixed costs include expenses such as rent for facilities, salaries of administrative staff, and insurance." For example, rent for an administrative building remains the same regardless of how many products the company produces.
- **Variable Costs:** These vary proportionally with the company's level of activity. "Variable costs include raw materials, direct labor, and sales commissions" (Garrison; Noreen; Brewer, 2018, p. 87). As production increases, raw material consumption rises, increasing variable costs.
- **Direct Costs:** These are costs directly attributable to a specific product or service. According to Kaplan and Atkinson (1998, p. 215), "direct costs encompass materials used in the manufacture of a product and the labor directly involved in the production process." For example, the wood used in furniture manufacturing is a direct cost.
- **Indirect Costs:** These cannot be clearly attributed to a specific product or service, but they are extremely important to the company's operations. "Indirect costs include administrative expenses, equipment depreciation, and general factory costs" (Drury, 2013, p. 142). These costs are necessary to maintain the company's infrastructure.
- **Opportunity Costs:** These represent the benefit lost when choosing one alternative over another. According to Mankiw (2018, p. 67), "the opportunity cost of a decision is the value of the best alternative use of

resources." For example, by choosing to use a machine in a specific project, the company may miss the opportunity to use it in a more profitable project.

- **Explicit Costs:** These involve an actual cash outlay. Explicit costs include salary compensation, raw material purchases, and maintenance expenses (Anthony; Govindarajan, 2007, p. 89). These costs are directly included in the company's financial statements.
- **Implicit Costs:** These do not involve an immediate cash outlay but represent resources the company uses. According to Ross, Westerfield, and Jaffe (2016, p. 111), "implicit costs are the value of internal resources used in production, such as the use of production space." For example, the opportunity cost of using production space for something like a cafeteria, instead of renting it to third parties, is implicit.

The figure should be referenced in the preceding text. This may not be observed if a figure does not fit in the space immediately below the paragraph describing it and is automatically moved to the next page; in this case, the text that would follow the figure should be moved forward to avoid leaving blank space at the end of a page preceding the figure.

2.2 Logistics Costs of Unloading Trucks

According to Fleury (2019), unloading trucks is a crucial step in the logistics chain, involving removing products or materials from a truck or trailer for storage or distribution. This process can be carried out in different ways, including manual unloading (manual labor) and mechanized unloading (using equipment such as forklifts and cranes).

According to Lima, Santos, and Oliveira (2018), unloading costs can include labor, operational, and time costs. Labor costs refer to the time and effort of the team involved in unloading, including wages, benefits, and related expenses. Operational costs include indirect costs associated with the operation, such as equipment costs (if applicable), maintenance costs and supervision costs. Time costs depend on the time required to complete unloading and affect total costs, especially labor and opportunity costs.

As Silva (2017) notes, manual unloading involves using only human strength to move and unload products from the truck. Although it may be more affordable in terms of initial equipment investment, it can add costs due to the time and effort required, as well as potential ergonomic and safety risks for workers.

According to Santos and Oliveira (2016), despite the importance of truck unloading in logistics and the costs associated with this process, the literature lacks a specific analysis of absorption costs in manual truck unloading. Most existing studies focus on more mechanized unloading methods and, more broadly, on logistics cost management. Therefore, a detailed study of absorption

costs in manual truck unloading could fill this gap and provide important insights for managing logistics costs effectively.

2.3 Absorption Costing

According to Martins (2020, p. 48):

Absorption costing is a cost accounting method that allocates all direct and indirect production costs to the manufactured products. This method is widely used to calculate a product's total cost, including direct labor costs, direct materials, and indirect manufacturing costs. Absorption cost allocation generally uses a predetermined cost rate, such as a cost rate per labor hour or per unit produced.

According to Herculani (2024), this methodology accounts for all costs incurred in the operation: variable costs, fixed costs, direct costs, and indirect costs.

3. Materials and Methods

3.1 Methodology

The research was conducted through a literature review on costs, with an emphasis on the absorption costing method. The study used quantitative and exploratory approaches to analyze the data. The study included a case study at a distribution center (DC) of a retail company located in the interior of São Paulo.

A company team member collected the data directly on-site. The information collected included unloading time, number of employees involved, salaries, operating costs, and other indirect costs. Data analysis used spreadsheets and the absorption costing method to calculate costs and compare manual unloading with mechanized unloading.

3.2 Data Collection

The data were collected over one month, considering different shifts and cargo volumes. The variables collected included:

- Average unloading time per truck
- Number of employees involved per shift
- Employee salaries and benefits
- Related operating costs (energy, equipment maintenance, etc.)
- Indirect costs (supervision, administration, etc.)

The following section explains the use of Operational Materials: Pallets and stretch wrap tubes.

3.2.1 Pallets

Pallets facilitate the movement and storage of goods. Each pallet allows forklifts to move large quantities of products at once, reducing the time required to load and unload trucks. Furthermore, pallets keep products stable and organized, minimizing the risk of falls and damage and improving worker safety and operational efficiency. In this study, 45 pallets are used per unloading, at a unit cost of R\$ 69.00, for a total cost of R\$ 3,105.00 per unloading.

3.2.2 Stretch Tubes

Stretch film tubes are rolls of plastic film used to wrap and protect goods stacked on pallets. *Stretch film* helps keep boxes or products firmly attached to pallets, preventing them from sliding or falling during transport. This increases load stability and ensures product safety during handling and storage. In this study, 8 *stretch film tubes* are used per unloading at a unit cost of R\$ 49.38, for a total cost of R\$ 395.04 per unloading.

Therefore, the Operational Material Cost (MO) is calculated by adding the total costs of the pallets and tubes, resulting in R\$ 3,500.00, as shown in Table 1.

Table 1 – Data Collection on Truck Unloading

	Bragal Download	Mechanized Unloading		
Employees by Discharge	4	2		
Time per discharge	6	1		
Hours per month	183.25	183.25		
	Bragal Download	Mechanized Unloading	CID RS	R\$ 50,000.00
Hours per month	183.25	183.25		
Monthly salary for the employee	R\$ 3,200.00	R\$ 3,200.00		
Electrical energy	R\$ 2,000.00	R\$ 333.33		
Operational material cost (MO)	R\$ 3,500.00	R\$ 3,000.00		
CID RS		R\$ 3,125.00		

Source: Prepared by the authors

3.3 Calculation of Absorption Costs

The costs were calculated using the following basic absorption costing formula:

$$\text{Total Cost} = \text{Direct Costs} + \text{Indirect Costs}$$

Direct costs include direct labor and direct materials used in the unloading process. Indirect costs were allocated using a predetermined cost rate, based on the proportion of time and resources used (Table 2).

Table 2 – Data Collection on the Labor Involved in Unloading Trucks

Download	MOD	Download Time	Total Cost of DA	Allocation (%)	CID
Manual unloading	R\$ 69.85	6	R\$ 419.10	92.31%	R\$ 2,884.62
Mechanized Unloading	R\$ 34.92	1	R\$ 34.92	7.69%	R\$ 240.38
Total	R\$ 104.77	7	R\$ 454.02	100.00%	R\$ 3,125.00
Materials	MOD	Production Volume	Total Cost of Raw Materials	Allocation (%)	CID
Pallet	R\$ 69.00	45	R\$ 3,105.00	88.71%	R\$ 2,772.32
Stretch	R\$ 49.38	8	R\$ 395.00	11.29%	R\$ 352.68
Total	R\$ 118.38	7	R\$ 3,500.00	100.00%	R\$ 3,125.00

Source: Prepared by the authors

4. Results and Discussion

4.1 Calculation of Direct Electrical Energy

Electrical energy is essential for discharge operations, whether manual or mechanized.

- **Manual Method:** In manual operation, electrical energy is used for lighting and other auxiliary equipment needed to perform the discharge. The direct electrical energy cost for the manual method is R\$ 2,000.00 per discharge.
- **Mechanized Method:** In the mechanized method, in addition to lighting, electrical energy is used to operate forklifts and other cargo handling equipment. The direct electrical energy cost for the mechanized method is R\$ 333.33 per discharge.

4.2 Calculation of Direct Electrical Energy

4.2.1 Indirect Electrical Energy

Indirect electrical energy refers to energy consumed by operations not directly related to the discharge, such as general warehouse lighting, administrative offices, and other equipment that supports the operation. This cost is distributed among the discharges.

Total Cost per Download: R\$ 1,125.00

4.2.2 Administrative Salaries

Administrative salaries include costs for employees who supervise and manage unloading operations. These costs ensure an organized and efficient unloading process.

Total Cost per Download: R\$ 1,500.00

4.3 Maintenance

Maintenance includes preventive and corrective maintenance for equipment used in unloading operations, whether manual or mechanical. This includes the maintenance of forklifts, lighting systems, and other operational equipment.

Total Monthly Cost: R\$ 500.00

All the calculations above can be summarized in Table 3 below.

Table 3 – Summary Table of Absorption Cost in Truck Unloading

Description	Direct		Indirect	Total
	Manual unloading	Mechanized Unloading		
Materials for operation	R\$ 3,500.00	R\$ 3,000.00	—	R\$ 6,500.00
Labor	R\$ 419.10	R\$ 34.92	—	R\$ 454.02
Electrical Energy	R\$ 2,000.00	R\$ 333.33	R\$ 1,125.00	R\$ 3,458.33
Admin Salaries	—	—	R\$ 1,500.00	R\$ 1,500.00
Maintenance	—	—	R\$ 500.00	R\$ 500.00
Total	R\$ 5,919.10	R\$ 3,368.25	R\$ 3,125.00	R\$ 12,412.35
Products	Direct Costs	Allocation (%)	CID	Total
Manual unloading	R\$ 5,919.10	63.73%	R\$ 1,991.65	R\$ 7,910.75
Mechanized Unloading	R\$ 3,368.25	36.27%	R\$ 1,133.35	R\$ 4,501.60
Total	R\$ 9,287.35	100.00%	R\$ 3,125.00	R\$ 12,412.35

Source: Prepared by the authors

The data analysis showed that manual unloading, including direct and indirect costs, costs significantly more (R\$ 7,910.75) than mechanized unloading (R\$ 4,501.60) because it requires more time and effort and poses ergonomic and safety risks for workers.

4.4 Data Provided

Arm Form:

- Average unloading time per truck: 6 hours
- Number of employees: 4
- Average salary per employee: R\$ 3,200.00

- Number of hours worked per month: 25 days x 7.33 hours/day = 183.25 hours/month
- Number of discharges per year: 16

Mechanized Form:

- Average unloading time per truck: 1 hour
- Number of employees: 2
- Average salary per employee: R\$ 3,200.00
- Number of hours worked per month: 25 days x 7.33 hours/day = 183.25 hours/month
- Number of discharges per year: 16

4.5 Calculation of Labor Cost per Hour

Cost of labor per hour = Monthly salary / Hours worked per month.

- Cost of labor per hour = R\$3,200.00 / 183.25 = R\$17.46

4.6 Calculation of Labor Cost per Unloading

Arm Form:

- Labor cost per unloading = 6 hours x 4 employees x R\$17.46 Labor cost per unloading = $6 \times 4 \times 17.46 = \text{R\$}419.04$

Mechanized Form:

- Labor cost per unloading = 1 hour x 2 employees x R\$17.46
- Labor cost per unloading = $1 \times 2 \times 17.46 = \text{R\$}34.92$

4.7 Calculation of Indirect Costs per Discharge

- Annual indirect costs: R\$ 50,000.00
- Number of discharges per year: 16
- Indirect costs per unloading = $\text{R\$}50,000.00 / 16 = \text{R\$}3,125.00$

Table 4 below shows the absorption cost calculations, based on the equations performed above in sections 4.1 to 4.4.

In it, the value of R\$ 40,818.79 appears in red, which corresponds to the difference between the annual cost of manual unloading and its mechanized equivalent.

This cost is related to only one supplier, but the company has five suppliers, resulting in an annual cost of R\$ 204,093.97.

However, over ten years, this cost rises to R\$ 2,040,939.70, as shown in Table 4.

Studies like this one could help avoid this loss over a decade by improving the company's logistics management.

Table 4 – Comparative Chart of Manual vs. Mechanized Discharge (Over 10 years)

Unloading a truck manually vs. mechanically		
Item	Arm Form	Mechanized Form
Direct Labor Costs		
Monthly working hours	183.25	183.25
Average discharge time (hours)	6	1
Number of employees	4	2
Average salary per employee (7:20 hours per day, 25 days per month)	R\$ 3,200.00	R\$ 3,200.00
Cost of labor per hour	R\$ 17.46	R\$ 17.46
Total labor cost per unloading	R\$ 419.10	R\$ 34.92
Direct Operating Costs		
Operating cost per discharge	R\$ 5,500.00	R\$ 3,333.00
Indirect Costs		
Annual indirect costs (16 discharges)	R\$ 50,000.00	R\$ 50,000.00
Indirect costs per unloading	R\$ 3,125.00	R\$ 3,125.00
Total Cost per Unloading	R\$ 9,044.10	R\$ 6,492.92
Difference between manual and mechanized (discharge) methods.	R\$ 2,551.17	
Total Annual Cost (16 discharges)	R\$ 144,705.59	R\$ 103,886.80
Difference Between Manual and Mechanized Production	R\$ 40,818.79	
Total number of suppliers using manual unloading.	5	Economy in 10 years
Difference Between Manual and Mechanized Production (Annual Cost - 5 Suppliers)	R\$ 204,093.97	R\$ 2,040,939.70

Source: Prepared by the authors

5. Conclusion

This study showed that implementing a mechanized unloading system in a distribution center can deliver significant cost savings, improved operational

efficiency and better safety. Absorption cost analysis showed that, despite a higher initial equipment investment, the long-term benefits outweigh the costs of traditional manual labor.

The results show a significant difference in the total costs of unloading trucks between manual and mechanized methods. Using forklifts and pallets not only reduces unloading time from six hours to one hour but also decreases the required labor from four to two employees. This implies substantial savings in terms of wages and benefits.

Beyond financial benefits, mechanizing unloading improves safety and operational efficiency. By reducing workers' exposure to physically demanding and potentially dangerous activities, the company can lower the risk of injuries and occupational diseases, while increasing employee satisfaction and productivity.

The slightly higher operating costs of mechanized unloading are more than offset by reduced labor costs and the indirect benefits of improved efficiency and safety.

The company should consider transitioning to mechanized unloading and reinvesting the resources saved in other strategic areas of the business. Future studies could also explore other areas of the logistics chain where mechanization could deliver similar benefits, supporting more efficient cost management.

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