Library Progress International
Vol.43, No.1, Jan-Jun 2023: P. 157-171

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

The role of Porter's cost leadership strategy in enhancing sustainable competitive advantage through value engineering technology

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How to cite this article: Muhaned Mohamed Duhan Al-Qaisi,Thaer Sabry Mahmoud Al-Ghaban (2023) The role of Porter's cost leadership strategy in enhancing sustainable competitive advantage through value engineering technology. *Library Progress International,* 43(1), 157-171

Abstract
The research aims to apply value engineering techniques and their reflection on Porter's strategies for leading competitive cost and achieving a sustainable competitive advantage. This will help solve the research problem represented by the high costs of lead-acid liquid batteries produced at the General Company for Automotive and Equipment Manufacturing - Battery Factory - Bulbul 2 Plant, in addition to the increase in environmental pollutants that affect the health of workers. This is due to the company's failure to keep up with rapid developments and the lack of use of cost management techniques and modern manufacturing methods, which has led to an inability to compete in the markets. Value engineering techniques work by using several methods, such as replacing environmentally unfriendly materials with environmentally friendly ones at a lower cost, in addition to improving product quality.
Keywords: cost leadership, value engineering technique, competitive advantage

Chapter One

Research methodology

1-1:- Research problem:

The research problem lies in the high costs of lead-acid liquid batteries, in addition to their risks to the health of workers and the environment, which arise in the battery factory, Babel Factory /2, affiliated with the General Company for the Manufacturing of Cars and Equipment. The research problem can be clarified with the following questions:

A- Will the application of value engineering technology positively reflect on Porter's cost leadership strategy?

B- Is the company under study capable of reducing the cost of the lead-acid battery and achieving a sustainable competitive advantage by preserving the environment and producing environmentally friendly and high-quality batteries through the application of value engineering technology?

1-2:- Research Objectives:

1- Introducing Porter's strategies related to cost leadership and value engineering technique.

2- Building a proposed framework by applying value engineering technology and its reflection on Porter's cost leadership strategies to achieve a sustainable competitive advantage.

1-3: The importance of research:

A- The importance of applying value engineering technology in achieving a sustainable competitive advantage from a philosophical perspective and providing an experimental practical aspect in the factories of the General Company for Automotive and Equipment Manufacturing.

B- Using cost scaling tools for batteries through the application of value engineering technology in the battery factory / Babel plant /2.

1-4: - Research hypothesis:

The adaptation of Porter's cost leadership strategy heavily relies on the application of value engineering technology, which in turn achieves a sustainable competitive advantage.

1-5: - Research boundaries:

Time frame: Financial data for the year ended 2022, as they are available and suitable for the practical aspect.

Spatial boundaries: Battery factory, Babel 2 plant, one of the formations of the General Company for Automotive and Equipment Manufacturing.

1-6: Research Methodology:

In order to achieve the research objective, the following was adopted:

A- The deductive approach in conducting a survey of studies that presented the research variables with the aim of extracting ideas and compiling the theoretical foundations proposed in books, journals, conferences, and related foreign and Arab research.

B- The inductive approach in linking technologies, with the aim of evaluating the cost system in the factory and reducing costs.

Section Two

Theoretical framework

Introduction:-

Competitive strategy is an option for many units to face competing units that operate in the same field. This strategy aims to choose the right method to determine the appropriate position and explore the unit's advantages. The strategy consists of planning, formulation, and implementation in the unit's operational activities to set clear objectives (Suparwi & Cahya, 2019, p. 98), and the competitive strategy proposed by Porter is considered one of the most important strategies adopted by units, which consists of three strategies: cost leadership strategy, differentiation strategy, and focus strategy. These strategies are fundamental for increasing the unit's competitive capacity (Ramadania & Dharma, 2023, p. 43)

2-1-1:- The concept of Porter's cost leadership strategy:

It is the strategy developed by Michael Porter in 1985, and the strategy is also referred to as the low-cost strategy, which consists of a high-level plan by the unit to reduce costs and thus achieve higher profits. This strategy ensures that the unit gains a competitive advantage by lowering operating costs, sales and advertising costs, and general costs to a level lower than that of competing units, (Muiruri & at, 2024, p. 70) The growth and success of the economic unit largely depend on focusing on cost reduction, which in turn supports the unit's competitive position (Al-Kharsan, Al-Ghaban, 2024, p. 6). Porter's cost leadership strategy is defined as a competitive strategy in which the economic unit outperforms competitors in producing products or services at the lowest cost (Blocher & at, 2022, p. 19)

2-1-2 Advantages of the Cost Leadership Strategy:

There are many advantages provided by the strategy, and among the most important are:

a- Providing a reserve of the ability to compete with others by lowering prices.

b- The high ability to cope with sudden changes in production costs and input prices.

c-She has the ability to prevent others from entering as competitors in her field. (Omar, 2020, 120)

d- Accepting a low profit margin in exchange for large sales volumes.

e- Economic prices in the marketing function, limited features in shaping, and standardization in products and models in small quantities. (Hussein, 2024, p. 222)

2-1-3:- Factors for Developing a Cost Leadership Strategy:

A unit that adopts a cost leadership strategy cannot achieve a successful and effective competitive advantage unless it is capable of developing, sustaining, and maintaining it. This can be achieved through several factors that enable the unit to develop its strategy, the most important of which are as follows: (Al-Ghabban and Elyas, 2024, 392)

1- Economies of scale: This means that the unit adopts the concept of large-scale production, rather than production with a specific output. Economies of scale create a barrier to entry for competitors into the industry, and if competitors manage to imitate, the cost will be high.

2- Links: This means that the unit is able to perceive the links between value-creating activities on one hand and exploit them on the other, improving its position in cost management and control, and enhancing its competitive ability.

3- Building relationships: The unit can leverage its various relationships with parties in the work environment, enabling it to capitalize on available opportunities and potentially reduce the costs of its value chain components.

4- Possessing a skill: A unit that possesses a unique skill makes it difficult for competitors to catch up with it.

2-2-1: The concept of sustainable competitive advantage:

The concept of strategic advantage was addressed in 1980, and its name was later changed to competitive advantage. Maintaining and developing competitive advantage depends on the unit's qualifications through its ability to provide distinctive products specifically designed to meet customer desires (AMIRI & at, 2018, p. 178) The concept of competitive advantage emerged due to the intense competition among units, as well as the rise of globalization, which reflects on the performance and efficiency of the units (Salman and Hassan, 2023, 141). It has been defined in many ways, the most important of which is that it is the efforts, developments, and innovations made by units to achieve a distinctive competitive position that sets them apart from other competing units, in addition to maintaining this position over the long term to keep pace with future developments and changes (Al-Gharbawi, Salman, and Nitchoun, 2021, 36). It is also defined as "the ability of a unit to consistently outperform its competitors over a long period." And this feature is not just transient or temporary, but it endures despite competitive pressures and market fluctuations" (Adama, & et, 2024, p. 1274) .

2-2-2: Characteristics of Sustainable Competitive Advantage:

The characteristics must be derived from a correct holistic perspective, and the characteristics are represented as follows: (Al-Quraishi, 2020, 63)

A- The feature is derived from the desires and needs of the customers.

B- You provide effective contributions to the success of the units.

C-Achieving alignment between the unit's resources and external environmental opportunities.

D-The competitive advantage works to build a foundation for future improvements.

E- It is difficult for competitors to imitate it in the long term.

F-It must be multi-sourced in order to obtain it, and should not be limited to a single source (Al-Mousawi and Al-Dabbas, 2024, 319).

2-2-3: Dimensions of Competitive Advantage:

The dimensions of competitive advantage represent the capabilities of operations management, which reflect the unit's long-term goals by translating market needs into operational indicators, in order to ensure the competitive position that distinguishes its products from those of competitors. (Radomska et al., 2021, p. 508) These competitive dimensions are:

First: Cost: Reducing the cost of the final product is one of the priorities that most units strive for, as it reflects on the final product price. (Massoudi & Ahmed, 2021,p:37)

Secondly: Quality: represents the primary goal for each unit, through which they can enhance their competitive position, as price is no longer the sole driving factor for the customer; rather, the focus has shifted to the quality and value they receive (Tayibnapis & Sundari, 2020, p. 11)

Thirdly: Flexibility: Flexibility has become an effective weapon in the competition between units, as it includes the ability to manufacture a variety of products, continuously offer new products, quickly develop current products, and respond to customer needs and desires. (Radomska & et, 2021,p:508).

Fourth: Time: The unit's reliance on the factor of time in competition has become the fundamental basis for building a competitive advantage. As a result of the rapid changes in the market, it requires a quick response to them, (Sitinjak, Fauzi, & Rini, 2020, p. 447).

Fifth: Innovation: Innovation is considered one of the dimensions in building competitive advantage, and innovation involves exploring distinctive and new ideas (Lee & et, 2016, p. 11) .

Sixth: Sustainability: Sustainability has become one of the main priorities of the strategy adopted by the units, due to its long-term impact on the success of these units and its alignment with the requirements imposed by the global business environment. The use of the term sustainability now represents a wide range of actions and commitments between the units and the community through daily practices, which can have a positive impact on the environment (Alawi, 2021,

85).

2-3-1: The concept of value engineering technique:

Value engineering is one of the strategic cost management techniques that has successfully been applied in the modern business environment. This technique has several names, including value analysis and value management, and it depends on the context of the project in which the research is applied. This technique relies on the idea of combining the achievement of targeted productivity through the production of a product that achieves cost savings without compromising the quality and essential functions expected by customers and producers, in addition to enhancing quality and preserving the environment. The value engineering technique has been defined as "a technique for improving production processes and reducing costs, based on the information collected about product design and production processes, and then testing different design and process methods to determine their suitability for improvement efforts." (" (Hilton & Platt, , 2020, p. 821, and I also defined a methodology to evaluate all aspects of the value chain with the aim of reducing costs and achieving a level of quality that satisfies customers. Value engineering requires improvements in product designs, changes in material specifications, and modifications in process methods (Horngren, & et, 2021, p. 589). It becomes clear that there are multiple names described by researchers, and it can be defined as a technique of strategic cost management that operates through a multidisciplinary team. It works on analyzing functions in the design, research, and development stages to find alternatives that achieve higher quality and efficiency while reducing costs to ensure customer satisfaction.

2-3-2: The Importance of Value Engineering Technique:

According to research conducted by the Society of American Value Engineers (SAVE International), the importance of value engineering lies in increasing customer satisfaction and adding value to the unit investment in any business or economic activity. Additionally, it was found that value engineering leads to saving 10%-30% of the estimated costs for producing the product or providing the service (Muhammad, 2018, p. 59) . The importance of value engineering technology lies in cost reduction and achieving cost leadership, which are among the most important strategies that units rely on to increase their profitability. Additionally, it offers several other advantages, including optimal resource utilization, enhancing competitive position, and achieving control. (Milad and Al-Mabrouk, 2018, 591).

Section Three

The practical aspect

3-1:- Overview of the General Company for Automotive and Equipment Manufacturing:

The idea of establishing a battery factory in Iraq began in 1954 to produce dry batteries to meet military needs, and it was named the Army Battery Factory. This was followed by a factory for producing liquid batteries in 1964. An agreement has been made with a Japanese company to build a factory with an annual production and design capacity of 100,000 standard batteries at the Al-Waziriyah plant in Baghdad to produce 19 types of batteries. The bus chassis factory began production in 1968, and in 1969 it became affiliated with the Ministry of Municipalities. In 1971, it became affiliated with the Ministry of Industry and was named the General Company for Liquid Battery Manufacturing. The unit continued to produce liquid batteries with Iraqi specifications. In 1975, the General Company for Dry Batteries and the General Company for Liquid Batteries, both affiliated with the General Company for Battery Manufacturing, were merged with a capital of (530 million dinars) according to Cabinet Resolution No. (360) of 2015. The company and the General Company for Machinery Manufacturing were merged with a capital of (4,590,665,000 dinars).

3-2-1: The reality of production at the (Babel2) plant

The battery factory produces batteries in different sizes (liquid and dry), relying on the raw materials manufactured in the company's lead foundry, in addition to the imported raw materials used in battery production. The following table shows the costs of the liquid battery, as the liquid battery was chosen because it is the standard measurement used by the company and serves as a basis for comparison with other produced batteries of different sizes, and the research sample will be the A60 liquid battery.

3-2-2: Actual and planned production data, and capacities for the liquid battery (A60) for Babel2 plant. The following table has been prepared:

Table (1)
Actual and planned production and capacities for the A60 liquid battery product at Babel 2 plant for the year 2022

Product	Unit of Measurement	Standard Actual Production	Planned Production	Available Capacity	Actual to Planned Ratio	Actual to Available Capacity Ratio
Liquid battery	**Battery**	**3244**	**50000**	**87500**	**6.488%**	**3.707%**

Source: Data from the Planning Department at the Battery Factory for the year (2022). We notice from the previous table that there is a weakness in actual production compared to planned production, where the ratio of actual production to planned production is (6.488%), and the ratio to available capacity is (3.707%). These ratios are very low compared to what was planned when preparing the production plan for the factory, which prompted the researcher to inquire from the engineering and technical departments about these ratios, as they are due to several reasons, the most important of which are technical malfunctions in the assembly line for all battery capacities, in addition to the presence of machines that are out of order and have not been repaired or replaced.

3-2-3:- Details of the cost and price of the A60 acid battery through the following table:

Table (2)
Cost and Pricing of the standard A60 acid liquid battery at Babel2 Factory for the year 2022

S	Materials	Unit of measurement	Quantity	Unit price	Total amount (in dinars)

1	A60 box	Quantity	1	1154	1154
2	Cover A60	Quantity	1	332	332
3	Small payment Number	Quantity	6	9	55
4	Plastic ruler Quantity	Quantity	1	37	37
5	Maska	Quantity	2	15	30
6	Plastic ring	Quantity	2	48	96
7	Dielectric insulator	Quantity	30	37	1112
8	Positive plate piece	Quantity	30	225.5	6770
9	Negative plate piece	Quantity	36	163.5	5891
10	poles	Quantity	2	674	1348
11	Connectors	Quantity	10	240.5	2402
12	lead rings	Quantity	2	674	1348
13	Lead pencils	Quantity	24	89	2132
14	Identifier	Quantity	1	250	250
15	Material cost				22957
16	Operating cost (labor)				8500
17	Cost of production				31457
18	Marketing costs				700
19	Administrative costs				1300
20	Total cost				33457
21	Sale price				36000
22	Profit Margin				2543

Source: Prepared by the researcher based on the cost department records data for the year 2022. It is evident from the previous table that the total cost, based on the detailed report issued by the Costing Department, amounts to (33,457) dinars per battery, and the selling price is (36,000) dinars, resulting in a profit of 2,543 dinars per battery. However, this profit is not real due to the exclusion of fixed costs represented by salaries and depreciation, as salaries are paid by the Ministry of Finance in the form of grants from the state treasury account.

3-2-4:- Application of value engineering technique:

The application of value engineering techniques to components where methods and solutions can be found to add value to the product and reduce its cost, in order to obtain a product that meets customer desires and needs, is of high quality, lower cost, and competitive in the market. The value engineering application roadmap for the A60 acid battery product can be determined as follows:

Table (3)
Value Engineering Map

First: Gather the necessary information about batteries.

Secondly: Functional Analysis	
	A- Analysis of the product functions B- Analyzing functions into their components C- Identifying the function or component that can be improved
Third: Idea generation	
Fourth: Evaluating alternatives	
Fifth: Presentation of the results	

Source: Prepared by the researcher

First: Gathering information: It is necessary to search for information within the unit in detail about the functions and their components, meaning it is essential to understand in detail the costs of the functional components, and to know the product designs and the designs of the production process in order to reach the component to which value is added.

Secondly: Functional Analysis: The production function was analyzed into its components, and the costs of each component were detailed to find improvements on the functional components that can be enhanced. Through inquiries from specialists and field observations in the factory, the production function was analyzed as follows:

Components of the production function

Component Name	Function
	The productive function (F)
Network Casting	Formation of Battery Networks
Oxide and Leadwood	Production of lead powder and casting it into a paste for mesh spraying
Charging and Cutting	Charging the plates and separating them into positive and negative
Plastic	Assembling the lead parts in a box
Poles and Conductors	Production of Rings and Casting of Poles and Conductors
Isolators	Placing isolators for protection and separation
Assembly	Battery formation and assembly of all its components
Production Stores	Directing the process of material issuance to the production departments
Machine Maintenance	Mechanical, technical, and electrical maintenance
Quality Control	Inspection of materials and products and ensuring compliance with specifications

Source: Based on field experience and directing inquiries to specialists.
The component: the networks, which can be improved and is one of the components of the production function, and the recycling component, which is currently not in operation, through which cost savings can be achieved by providing raw materials. Accordingly, the reduction amount will be calculated separately as follows:

Third: Presenting the idea:

Applying value engineering to the grid component by replacing the materials used in the grid component (copper, tin, antimony, arsenic) with a calcium-aluminum alloy:

The grid component, which is one of the main components used in the production of positive and negative plates, is made from lead oxide produced in the lead smelter for the positive plates, while the negative plates are made from pure lead produced in the lead smelter. The cost of batteries varies according to the number of plates in them. The following table shows the number of positive and negative plates and the weight of lead used in the batteries:

Table (4)
The number of plates used in batteries and the weight of lead in the battery.

Battery type - Ampere/hour	Number of positive plates	Number of negative plates	Lead weight (grams)	Conversion factor
A 60-50	4	5	10816	1
A 72-70	5	5	12984	1.117
A 75	6	5	13233	1.223
A 90	6	7	15649	1.446

Source: Based on planning data from Babel 2 plant
It is evident from the table that the factory produces liquid batteries according to the number of amperes desired from the battery, and increasing the amperage requires increasing the positive and negative plates, in addition to increasing the lead used in these plates, which are then sent to the conversion plants to determine the battery costs according to the desired amperage.
And after determining the number of plates and the costs for the battery sizes, the materials used in the grid component (copper-tin-antimony-arsenic) can be replaced with a calcium-aluminum alloy instead, which is less expensive and of higher quality than the mentioned materials.
The calcium-aluminum alloy is characterized by its low cost compared to the elements used in the grid components (copper, antimony, tin, and arsenic). The calcium alloy grid also has low hydrogen gas emissions, unlike the four elements present in battery grids, which lead to hydrogen gas emissions that cause environmental pollution and affect the health of workers. Additionally, it has a higher quality than grids containing the four elements.
It is worth mentioning that the four elements (copper, antimony, tin, and arsenic) are used in two components, which are the mesh component and the electrode component. The following table shows the quantity of materials used and their costs for each component in these components that include the four elements:

Table (5)
Details of the distribution of the four elements

Details	Pole Stage The quantity for one battery (Kilogram)	Mesh stage The quantity for one battery (Kilogram)	Total	
			Total quantity for one battery (kilograms)	Total cost in dinars
Antimony	0.150547	0.000453	0.151	5107
Arsenic	0.0629685	0.0000315	0.063	2431
Copper	0.039996	0.000004	0.040	931
Tin	0.06965	0.00035	0.070	465
Total				8934

Source: Prepared by the researcher based on laboratory data for the year 2022.
Table (6) shows the actual material requirements for the four materials in the two components (the mesh component and the electrode component) and the total material cost for one battery. However, the four materials used in the electrode component cannot be replaced due to the

importance of each material according to its function. The importance of the materials for the electrodes will be explained according to their type:

1- Antimony

The presence of antimony is essential in the components of electrodes, conductors, and rings for several key reasons:

A. The increase in the hardness of lead, where the percentage of antimony is directly proportional to the hardness of lead, so the higher the percentage of antimony, the greater the hardness.

B. The increase in the antimony element leads to an increase in tensile strength, as demonstrated by laboratory tests.

C. The presence of antimony in the components of electrodes, conductors, and rings will lead to a reduction in the melting point required to make lead in liquid form, thereby facilitating industrial processes easily. This will result in a decrease in working hours, fuel consumption, and electrical energy used in operation, as well as a reduction in industrial services and the wear and tear of machines and equipment.

d. It increases the resistance of the lead used in the manufacture of electrodes, conductors, and rings to the corrosion it is subjected to during the battery charging process and its use in industrial equipment.

e. The addition of antimony to lead in the composition of electrodes, conductors, and rings will help achieve a fully cast product without excess.

2- Arsenic

The main purpose of the presence of arsenic in the electrodes, conductors, and rings is to increase the corrosion resistance of the lead used in them during the charging and usage process. This is due to the interaction of chemical compounds on the surface of the positive plates, and it is achieved through the effect of arsenic on the crystalline structure of the lead. Therefore, reducing its quantity or removing it from the electrodes, conductors, and rings will result in insufficient protection against corrosion.

3. Copper

Copper is present in small amounts in the electrodes, connectors, and rings, which improves the specifications of the lead used in the component. This small percentage reduces the likelihood of shrinkage or cracking of the electrodes, connectors, and rings after they come out of the production mold during the battery manufacturing stages. However, increasing the copper content in the lead used in the production of electrodes, connectors, and rings is detrimental to battery use because it has an adverse effect; increasing its percentage leads to a reduction in battery life. This is due to the increased electrolysis of water inside the battery. Nevertheless, it must be present in very small amounts.

4- Tin

Tin is added to lead used in the production of electrodes, conductors, and rings for several reasons as follows:

A. It improves the flow of molten lead within the molds for casting electrodes, connectors, and rings in order to achieve the final shape.

B. It reduces the viscosity of molten lead during the flow process, which leads to a decrease in the thermal energy used for melting lead, as thermal energy is represented by hydrocarbons or petroleum derivatives.

C. It improves the efficiency of dry charging in the battery during the manufacturing stage, which reduces the time required for the battery to be fully charged, and consequently leads to a reduction in the electrical energy needed for charging the battery. D. It reduces electrical resistance in electrodes, conductors, and rings, thereby helping to achieve an electrical voltage of (95%-100%).

Based on the above, it becomes clear that the four elements in the component of electrodes, conductors, and rings cannot be changed, and we will suffice with replacing them with a calcium alloy in the component of grids, where the cost of the four elements in the component of grids will be as follows:

Table (6)
Calculating the mesh requirements from the four battery materials

Subject name	The cost (1)	Quantity (2)	(3) 2÷1	The battery requirement in quantity (4)	The cost of materials for one battery (5) (4×3)
Antimony	5107	0.151	33,821	0.150547	5092
Arsenic	2431	0.063	38,587	0.0629685	2430
Copper	931	0.040	23,275	0.039996	931
Tin	465	0.070	6,643	0.06965	463
Total					**8916**

Source: Prepared by the researcher based on Table (6) and laboratory data for the year 2022.

The previous table illustrates the actual battery requirement for the four elements and the costs of keeping the elements within the grids according to the actual battery requirement for the four elements, which will be replaced with a calcium alloy. The difference between Table (6) and Table (7) shows the cost of the four materials in the components of the electrodes, conductors, and rings, amounting to (18) dinars per battery, which is the result of subtracting the sum of the two tables. (8916-8934).

Fourth: Evaluating alternatives:

by relying on the information provided by specialists and technicians in the Babylon 2 plant, as the cost of calcium-aluminum alloy material is (7,400) dinars per kilogram, and the amount required to be used for one battery of this material is (0.0011) kilograms **(The process of manufacturing the clip depends on pouring molten lead inside the mold, and therefore there is no mechanical forming process, so the amount used is less to give the clip hardness during the production stages),** therefore the cost of using this material in the battery is equal to (8.14) resulting from the product of (0.0011 x 7,400) dinars per battery, and thus it has greatly reduced the costs of the four materials that were used Previously, its cost was (8,916) dinars per battery, and the following table shows the replacement cost and cost savings as follows:

Table (7)
The reduction achieved through the replacement of items for Babel Factory 2 in 2022 (amounts in dinars)

Materials used before improvement and their costs		Alternative materials and their costs		Difference
Subject Name	Cost	Subject Name	Cost	
Antimony	5092			
Arsenic	2430			

Copper	**931**			
Tin	**463**			
		Calcium-aluminum	**8.14**	
Total costs	**8916**		**8.14**	**8907.86**

Source: Prepared by the researcher based on laboratory data for the year 2022.

Fifth: Presentation of results:
Through inquiries from specialists and technicians in the laboratory, the above table indicates that the use of the calcium-aluminum alloy will reduce the costs of the grids by (8,907.86) dinars per battery, in addition to reducing environmental impacts. And since the use of the calcium-aluminum alloy is less costly and less hazardous, calcium is more readily available and has many benefits that can be explained as follows:

1. Calcium is less hazardous as it does not cause the battery temperature to rise, which increases the battery's efficiency.
2. Increasing the efficiency of energy storage, as it makes the positive and negative plates more resistant to mechanical stress.
3. It significantly reduces the electrolysis of water, which in turn decreases the evaporation rate of the liquid inside the battery during charging.
4. Reduction in the internal corrosion rate of the networks, which makes them longer-lasting and more effective than available products.
5. Preserving the environment and making it environmentally friendly batteries, and very safe for workers' health, by reducing the handling of harmful materials compared to using antimony and arsenic alloys.
6. Reducing the overall damage rate of the battery before and after use, which leads to a decrease in the number of damaged batteries returned to the factory, as the calcium element does not generate heat during operation.
7. Extending the service life of the battery by improving its resistance to overcharging.

which is also an environmental pollutant. Based on the above, the total reduction in 2022 by using calcium alloy in the manufacture of grids instead of the four elements is as follows:

Total discount for the year 2022 = Discount amount per battery × Number of batteries produced for the year 2022
= 8907.86 × 3244
= 28,897,098 dinars

This reduction in the material replacement process will help decrease the cost of raw materials by 8907.86 dinars per battery. This reduction will aid in cost leadership and achieving a sustainable competitive advantage through lower costs and increased battery quality, in addition to producing an environmentally friendly battery. The calcium alloy grid has low hydrogen gas emissions, unlike the four elements present in battery grids, which lead to hydrogen gas emissions that cause environmental pollution and affect the health of workers. Additionally, it has higher quality than grids containing the four elements.

Chapter Four
Conclusions and recommendations

4-1: Conclusions:

1- Lack of attention to strategic cost management techniques in reducing product costs, which is facing intense competition from imported products, leading to a decrease in demand for the product due to the high production costs of lead-acid batteries.

2- The value engineering technique has not been applied in the lab, which aims to identify components that can reduce costs and improve quality, thereby contributing to cost reduction through the optimal use of available resources, in addition to working towards achieving a sustainable competitive advantage by preserving the environment.

3-Diagnosing the relationship between value engineering techniques and Porter's strategies for competitive cost leadership through cost management and calculation to reduce costs and achieve a sustainable competitive advantage.

4- The factory's failure to replace the calcium-aluminum alloy in the production of grids instead of the four elements used in battery grid production (antimony, arsenic, tin, copper) will ultimately lead to product safety issues and harm the health of workers.

4-2: Recommendations:

1- The pursuit of adopting strategic cost management techniques, especially value engineering, in order to provide more accurate information about functions and their components.

2- A call for the company to apply value engineering to components that can be improved or to find alternative methods that contribute to cost savings or cost reduction while increasing product quality.

3- A call for the company to apply the relationship between value engineering technology and cost leadership strategy in order to achieve the largest market share, compete in similar products, and achieve a sustainable competitive advantage.
4- It is essential to work on replacing the four elements (antimony, arsenic, tin, copper) used in the production of battery grids and substituting them with a calcium-aluminum alloy in order to significantly reduce costs and protect the environment.

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