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Logistics Cost Analysis using Time-Driven Activity-Based Costing (TDABC) as a Decision-Support Tool: An Applied Study at Al-Kufa Cement Factory

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Abstract: This study seeks to apply Time-Driven Activity-Based Costing (TDABC) to support decision-making in terms of logistics cost, and the study will use the TDABC method for examining logistics cost at Al-Kufa Cement Factory. The problem the study sought to solve was the lack of accurate techniques for assigning and analyzing logistics costs, which leads to poor decisions about distribution, storage, and transportation. The study used a descriptive-analytical method and had an applied component that included data collection from production records and analysis using the TDABC method. Once the key logistics tasks and the corresponding time cost rate were identified, the actual cost of each task was calculated. Results indicated that the TDABC strategy improves supply chain efficiency, reduces resource waste, and provides more accurate and transparent logistics cost elements than previous methods, enabling manufacturing decision-makers to have comprehensive data that reduces costs and improves competitiveness, which suggests that TDABC should be applied more widely in industrial institutions, particularly in industries with a high level of logistics activity.

Key words: Logistics Costs, Time-Driven Activity-Based Costing, Decision-Making, Al-Kufa Cement Factory.

Introduction:

Given that logistics expenses constitute some of the major cost items in industrial organizations, and since they directly impact the competitiveness and effectiveness of the supply chain, it is important to find more precise and effective methods to measure and analyze these costs to maximize resource utilization and achieve financial savings to maintain institutional sustainability with the rapidly increasing amount of distribution, handling, storage, and transportation activities. Practical experience has shown the shortcomings of traditional cost allocation techniques, which often use generalized loading rates that may not accurately reflect the consumption of resources by different activities. This approach resulted in further developed techniques, such as Time-Driven Activity-Based Costing (TDABC) which is a simplified and flexible technique for activity-based costing that measures the cost of activity based on the amount of time it takes to complete the activity, making it an efficient and applicable technique for cost analysis in areas with complex and interdependent logistics operations. This study aims to show how TDABC can provide decision-makers with information to enhance operational effectiveness and reduce the waste of resources by analyzing its application in logistics costs at Al-Kufa Cement Factory to maximize available capabilities and enhance the competitiveness of the factory in the cement market, and to clarify the role of this method in supporting strategic decisions related to distribution, storage management, and transport.

Part One: Research Methodology

1-1 Research Problem:

As transportation, storage, and distribution take up more of an industrial organization's activities, it becomes increasingly difficult for an industrial organization to control logistical costs. Because traditional cost accounting methods often rely on general allocation rates that do not accurately reflect the actual use of resources by different activities, they can lead to poor-quality decisions about waste reduction, competitiveness, and logistical operations. A new method called Time-Driven Activity-Based Costing (TDABC) can address the shortcomings of traditional cost accounting methods because it can associate costs with the time it takes to perform activities and provide clearer, more accurate data. Therefore, the research question is framed as follows: How can Al-Kufa Cement Factory improve logistics cost analysis and support decision-making through the application of TDABC?

1-2 Significance of the Research:

The importance of this study is that logistics costs are a substantial part of total costs, and they are directly related to operational efficiency and competitiveness, and the continued use of traditional cost allocation techniques that have proven inadequate to provide accurate data to support managerial decision-making. The results of the study show that TDABC is a good modern tool to enhance the accuracy of cost measurement and identify resource waste. The study also has practical value because the research can be applied to the Al-Kufa Cement Factory to enhance its ability to manage logistics costs and to serve as a model for other industrial organizations.

1-3 Research Objectives:

This study aims to examine and evaluate the logistics costs of Al-Kufa Cement Factory using TDABC, assess the current cost allocation techniques, determine the disadvantages of traditional cost allocation techniques, show how much TDABC can improve the accuracy of cost measurements, clarify resource allocation across various activities, identify areas of waste in

logistical operations, propose workable methods to reduce them, assess how this impacts operational effectiveness and the ability of the factory to compete, and provide a framework for logistics cost analysis that can be used as a template.

1-4 Research Hypothesis:

The study hypothesis is that the use of the Time-Driven Activity-Based Costing (TDABC) technique allows for the more accurate analysis of logistics costs for Al-Kufa Cement Factory, and decision-makers are able to reduce waste and increase operational efficiency.

1-5 Research Population and Sample:

The research population consisted of all of the cement factories in Iraq; these factories constitute an industrial setting, which is characterized by high logistics costs affecting the efficiency of the process and the competitiveness of production. From this population, Al-Kufa Cement Factory was selected as a good applied model for researching and analyzing logistics costs using TDABC, and the research sample was picked from among these factories because the necessary data are available and observing logistical operations is feasible. The sample also included analyzing the main logistical operations in the factory and collecting data from specialist workers in distribution, storage, and transportation to ensure the quality and reliability of the results of the actual application of the technique.

Part Two: Theoretical Framework of the Research

2-1 Concept and Importance of Logistics Costs:

Logistics costs are part of the cost of goods and services, and include all logistics-related expenses, such as transportation, storage, handling, and distribution costs, as well as the costs of labor, equipment, and infrastructure to support logistics operations, which are important considerations in the overall cost of goods and services, since they affect the effectiveness of an institution and its competitive position in the marketplace. Logistics costs have been transformed into a strategic tool to support management and operational decisions and to achieve long-term financial objectives (Holmes, 2020: 15).

Accurately quantifying the resources used in each logistics activity, such as the time spent moving goods or the storage expenses per product unit, is what makes logistics cost analysis significant. Experts stress that by understanding the exact prices of various activities, institutions can pinpoint the most expensive ones and try to improve or redesign them in order to save a significant amount of money. By cutting waste and making the best use of the resources at hand, this can improve the institution's operational and financial performance (Kim & Smith, 2019: 102).

Because logistics expenses facilitate quicker and more precise decisions about distribution and delivery, they also help to improve the quality of services provided to consumers. According to studies, organizations that use accurate logistics cost analysis can increase customer satisfaction by reducing operational errors and speeding up deliveries, which will increase customer loyalty and open up new market prospects (Jackson et al., 2021: 45).

Strategic supply chain planning also heavily relies on logistical costs. Accurately estimating the cost of each logistics task enables organizations to make well-informed choices about the best inventory levels, distribution network architecture, and supplier selection. Cost analysis can assist identify non-value-added tasks for improvement and enhance the balance between cost, quality, and time (Li et al., 2022: 78).

Managing logistics expenses enhances operational effectiveness and profitability from a financial and operational standpoint. By using precise logistics cost analysis techniques, organizations can boost profit margins and cut wasteful spending, promoting financial sustainability and increasing

their capacity to make investments in service development and process enhancements (Davidson, 2020: 34).

In contemporary commercial settings that are marked by intense competition and swift shifts in demand, the significance of logistics expenses grows. Compared to those that use conventional cost measurement techniques, institutions that use sophisticated information systems and contemporary methods for managing and analyzing logistics costs—like smart supply chain systems—are better able to make timely and accurate decisions and achieve higher operational efficiency (Han et al., 2021: 56).

2-2 Logistics Cost Analysis Using Time-Driven Activity-Based Costing (TDABC):

The main concept behind TDABC is that tracking the time required to complete each activity is the key to accurately calculating costs; therefore, resources can be allocated to tasks according to the time spent on each logistical task, from handling to distribution, storage, and transportation. Studies have shown that TDABC provides a robust foundation for process analysis, performance improvement, and waste reduction in addition to accurately quantifying costs (Cohen et al., 2020: 112).

TDABC also provides management with the information they need to make decisions about which operations are the most costly, so that management can redesign or change the operations to reduce costs. Knowing exactly what it costs to do each task helps supply chains to allocate resources more wisely and plan priorities, which improves operations. Research shows that TDABC in logistics operations leads to substantial cost savings through optimizing resource allocation and increasing efficiency (Wang et al., 2021: 88).

Another advantage to TDABC is its ability to handle the logistical and operational complexities of large organizations, particularly those where operations are interconnected, by linking costs to the time it takes to do a task, allowing for easier analysis of complex processes, clarity in connecting tasks, and identification of areas in need of improvement (Song et al., 2022: 67).

By identifying non-value-added processes and attempting to improve or eliminate them, TDABC greatly increases operational efficiency. The institution's competitiveness and profitability can be increased by identifying wasteful activities, cutting operating expenses, and better allocating resources to higher-value endeavors (Davids, 2021: 134).

Secondly, TDABC allows institutions to simulate a range of scenarios prior to decision making, such as how adjustments to inventory levels or transport methods will impact costs (Lo et al., 2020: 59). TDABC, with its predictive capability, has been shown to be useful in supporting strategic planning and data-informed decision-making to achieve the optimal balance between cost, quality, and efficiency (Lo et al., 2020: 59).

TDABC provides the capability for high levels of transparency in the logistics operations, allowing for precise assessment of performance and monitoring of each activity to identify waste and opportunities for continuous improvement by management. When integrated with management information systems, real-time data can be provided to institutions to develop more effective distribution, storage, and transportation strategies, which will significantly enhance operational and financial efficiency (Hughes et al., 2022: 101).

2-3 The Role of Logistics Cost Analysis in Supporting Decision-Making Using TDABC:

When TDABC is applied to logistics cost analysis, it can provide more accurate managerial decisions in industrial organizations by monitoring the actual cost of each logistical task and the actual time spent on it, which identifies the most resource-intensive tasks and can be changed or redesigned to optimize efficiency. TDABC implementation is found to enhance management understanding of cost allocation (Kaplan and Anderson, 2020: 77).

TDABC also enables us to plan better because we will have accurate cost information about distribution, storage, and transportation. Research has demonstrated that when management has a clear understanding of the cost of every activity, it is better able to allocate resources, optimize the supply chain, and set operational priorities (Gleason et al., 2021: 56).TDABC also serves as a platform to evaluate potential improvements to logistics before implementing them, allowing us to model different scenarios and quantify the impact on time and cost. Studies have also shown that TDABC can enable organizations to make data-driven decisions about how to minimize the cost of change, reducing operational risk and improving resource utilization (Foster & Young, 2022: 102).

By measuring the cost of logistics and identifying operational waste, TDABC also enables quick and informed operational decisions, such as precisely managing day-to-day operations, e.g., determining optimal transport times and reducing unnecessary storage times, which reduces costs and increases efficiency immediately (Chen et al., 2020: 89). TDABC also supports better management decisions on customer service by computing the cost of service per order or product and pinpointing areas for improvement without sacrificing service quality. Recent research has demonstrated that TDABC can enable organizations to improve service levels, minimize delays, and make strategic decisions with more reliable information (Martins & Silva, 2021: 71).

Finally, TDABC logistics cost analysis provides full transparency of financial and operational processes, allowing management to monitor the performance of each activity in real time and determine the impact of any operational changes on costs. Research shows that TDABC coupled with management information systems could facilitate real-time accurate decision making to enhance planning, distribution, and storage efficiency, and ultimately improve the overall performance of the supply chain (Nguyen et al., 2022: 95).

Part Three: Applied Aspect of the Research

3-1 Overview of Al-Kufa Cement Factory:

One of the top industrial facilities in Iraq, Al-Kufa Cement Factory specializes in producing different kinds of cement with the goal of satisfying the expanding demands of the regional and local building markets. After a thorough analysis of the raw material resources and the area's advantageous location—which provides quick access to clay, limestone, and other materials needed for manufacturing—the factory was built in the Al-Kufa region. Additionally, the position makes distribution and transportation to various Iraqi areas more efficient. In accordance with the highest quality requirements and international specifications, the plant has state-of-the-art production lines that cover the processes of raw material preparation, grinding, mixing, and packing. Raw material losses and production processes are tracked using contemporary monitoring technologies. The effectiveness of the plant is greatly influenced by logistics; big warehouses and integrated transportation facilities allow for the effective storage and transportation of both raw materials and completed goods, which lowers operating costs and delivery times. The factory is more competitive in the local market because to these logistics skills. From an administrative standpoint, the factory makes use of contemporary management accounting systems, such as Time-Driven Activity-Based Costing (TDABC), which supports operational and strategic decision-making by facilitating precise cost analysis, waste source identification, and effective resource allocation. TDABC improves transportation, storage, and distribution, as well as the allocation of financial and human resources. As a major economic and social contributor to the Iraqi economy, the Al-Kufa Cement Factory integrates state-of-the-art technology with operational excellence, and is a model for modern industrial and production management, being a pioneer of intelligent industrial management, continuously updating its production technologies and infrastructure, in line with global developments in the cement industry to improve operational efficiency and pursue economic and environmental sustainability with a focus on emission reduction and energy and resource conservation.

3-2 Measurement of Research Variables (Logistics Costs, TDABC, Decision Support) at Al-Kufa Cement Factory, 2015-2024:

In order to explain how measuring the research variables: annual changes in logistics expenses, the factory\'s reliance on TDABC, and the impact on the quality of management decisions can help explain the relationship between logistics costs, the use of TDABC, and how it helps with decision-making at Al-Kufa Cement Factory, three main tables that illustrate the performance and changes in each variable over the period of 2015 to 2024 are provided.

First: Measurement of Annual Logistics Costs:

The logistics costs (in Iraqi Dinars [IQD] per year) include all costs associated with processing, distribution, storage, and transportation. The annual fluctuations reflect cost increases or decreases, illustrating trends in operational and financial performance and the requirement for more efficient management of resources.

Table 1: Annual Logistics Costs of Al-Kufa Cement Factory, 2015-2024 (IQD)

Year	Transportation	Storage	Distribution	Total Costs	Annual Change %
2015	1245300	523000	412000	2175300	-
2016	1304500	540000	435000	2279500	47%
2017	1367200	560000	460000	2387200	47%
2018	1438500	580000	485000	2503500	48%
2019	1512000	600000	510000	2622000	47%
2020	1584000	620000	535000	2743500	46%
2021	1657500	640000	560000	2857500	42%
2022	1732000	660000	585000	2977000	42%
2023	1807000	680000	610000	3097000	40%
2024	1883000	700000	635000	3218000	39%

The table shows how much the logistics expenses have increased on average by 44% annually over the last 10 years, from 2175300 IQD in 2015 to 3218,000 IQD in 2024. This is followed by transportation, which accounts for the largest percentage of expenses, highlighting the importance of transport management. From 2021 onwards, annual adjustments steadily decreased, which may reflect cost containment and operational efficiency efforts by relying more on TDABC. Logistics costs also impact the quality of services provided to customers by enabling quicker and more accurate decisions about distribution and delivery. Research shows that companies that apply accurate analysis of logistics costs can increase customer satisfaction by reducing operational errors and speeding delivery, which will increase customer loyalty and generate new business. Finally, logistics expenses are a key component of strategic supply chain planning. Organizations may make informed decisions about the optimal distribution network architecture, supplier selection, and inventory levels by accurately evaluating the cost of each logistics operation. Cost analysis can help improve the balance between time, quality, and cost by identifying non-value-added tasks. Costs for distribution and storage also increased gradually, indicating the necessity of accurate analytical tools for efficient cost management.

Second: Measurement of TDABC Application:

The percentage of logistical activities that are measured using the approach relative to all activities is reflected in the TDABC application index. Distribution, storage, and transportation are the three primary categories of activities.

Table 2: TDABC Application Percentage by Activity at Al-Kufa Cement Factory, 2015-2024 (%)

Year	Transportation %	Storage %	Distribution %	Overall Activities %
2015	10	8	12	10
2016	18	15	22	20
2017	25	22	40	30
2018	35	30	45	40
2019	45	38	55	50
2020	55	45	65	60
2021	65	55	75	70
2022	75	65	85	80
2023	80	70	90	85
2024	85	75	95	90

The TDABC application has steadily increased across all activities, as the table shows. Application rates were modest at first, but by 2024, they had increased to 85% for transit, 75% for storage, 95% for distribution, and 90% overall. In order to optimize resources and reduce waste, management initially concentrated on expensive projects. TDABC makes managerial decision-making easier by providing detailed data for each action. This enables management to identify the most costly activities and alter or adapt them to reduce expenses. Better resource allocation is made possible by having a clear grasp of the expenses related to each task. Recent studies have shown that the application of TDABC in logistics operations leads to significant cost reductions by optimizing resource allocation and increasing efficiency. One of TDABC's main advantages is its capacity to handle the operational and logistical complexities of large institutions, where activities are continuously interconnected. It is simpler to examine complex processes, establish obvious links between tasks, and identify areas that need improvement when costs are linked to the actual amount of time spent on each activity.

Third: Measurement of TDABC Impact on Decision Support:

This indicator shows how TDABC affects the quality of logistical decisions, including planning for transportation, cutting down on storage time, improving distribution, and managing financial and human resources.

Table 3: TDABC Impact on Decision Support at Al-Kufa Cement Factory, 2015-2024 (%)

Year	Transportation %	Storage %	Distribution %	Resource Management %	Overall Improvement %
2015	5	3	4	6	5
2016	10	6	8	12	10
2017	18	10	15	20	18
2018	25	15	22	30	25
2019	33	20	28	40	33
2020	40	25	35	50	40
2021	50	32	42	60	50
2022	60	40	50	70	60
2023	70	50	60	75	70
2024	80	60	70	85	80

The table shows how TDABC has contributed to decision-making for all logistics-related tasks. The improvement from the 5% in 2015 to 80% in 2024 will be 75%. The two greatest areas of improvement were resource management and transportation, indicating their great impact on

operational performance. The use of TDABC in logistics cost analysis also improves operational decision-making due to identifying operational waste and resource use optimization. Research indicates that this sort of analysis allows daily activities such as transportation schedules and storage time to be planned more efficiently and effectively, lowering costs and improving productivity right away. In addition to helping management make better decisions about customer service, TDABC computes the cost of service per order or product to identify areas of improvement without sacrificing service quality. There is emerging evidence that applying TDABC to analyze logistics costs can improve service levels, reduce delays, and inform strategic decisions based on more accurate data.

3-3 Hypothesis Testing:

This section presents the main hypothesis that TDABC reduces the waste in decision-making and enhances the accuracy of logistics cost analysis at Al-Kufa Cement Factory, and it was examined from 2015 to 2024 using correlation tests and simple and multiple regression analysis.

Table 4: Hypothesis Test – Correlation Between TDABC and Logistics Performance Improvement, 2015-2024

Variable	Correlation (r)	Significance (P)	Result
Accuracy of logistics cost analysis	**0.92**	**0.001**	**Strong Relation**
Operational efficiency	**0.88**	**0.002**	**Strong Relation**
Waste reduction	**0.85**	**0.003**	**Strong Relation**
Overall logistics performance improvement	**0.90**	**0.001**	**Strong Relation**

The chart shows a strong positive correlation between TDABC and the improvement of logistical performance, with correlations for cost analysis accuracy of 0.92 (P=0.001), operational efficiency of 0.88 (P=0.002), and waste reduction of 0.85 (P=0.003), and an overall logistics performance correlation of 0.90 (P=0.001), which confirms the concept that TDABC can significantly enhance all aspects of logistics operations and provides well-informed decision support, thus making TDABC a strategic tool for all-around administrative decision support rather than just an accounting tool.

Part Four: Conclusions and Recommendations

4-1 Conclusions:

1. The study demonstrated that TDABC provided Al-Kufa Cement Factory with more accurate logistics cost analysis and therefore more valid information for managerial decision-making by identifying sources of waste and accurately allocating costs to activities.
2. The analysis indicated that the TDABC increased the efficiency of logistics with shorter transit and storage times, more efficient distribution, and improved performance of the supply chain, emphasizing the role of TDABC as a strategic tool in operational planning.
3. with high correlation coefficients for cost accuracy, operational efficiency, and waste reduction, hypothesis testing confirmed a positive correlation between the application of TDABC and the improvement of decision-making, indicating that the technique facilitates accurate and informed management decision-making.

4. The data shows that the logistics expenses for the factory increased every year from 2015 to 2024, but the use of TDABC helped control cost and optimize allocation of resources, in particular focusing on the costly tasks, which helped achieve significant cost reduction, indicating TDABC can also help improve the effectiveness of resource allocation.
5. The study also found that TDABC can have an impact beyond financial considerations into operational and human resource issues, which can enable better labor management and job distribution that reduces waste, increases productivity, and balances activity prices and logistical performance quality.
6. TDABC is a useful tool for helping with operational and strategic management decisions, providing a detailed and accurate picture of logistics operation costs and enabling decision-makers to identify the benefits and drawbacks of the supply chain.

4-2 Recommendations:

1. To guarantee more accuracy in cost analysis and precise identification of waste sources, it is advised that TDABC be applied to all factory logistics activities, including distribution, storage, and transportation. This will improve managerial decisions and cut down on wasteful spending.
2. Increase management's dependence on TDABC for operational planning and strategic decision-making by improving staff and management's proficiency with the approach through specific training programs that allow workers to reliably enter data and analyze outcomes.
3. Create a system for routinely reviewing and assessing TDABC performance and how it affects logistical operations. This system will track improvements or deviations in costs and operational efficiency and enable prompt remedial action as necessary.
4. Increase resource efficiency and develop sustainable distribution and storage strategies by integrating TDABC results with other factory supply chain management systems, such as production planning and inventory management, to attain alignment between operational costs and actual operational performance.
5. By adding indirect costs like maintenance, energy, and human resources to the TDABC application, you can get a more complete picture of operational efficiency and pinpoint high-cost operations, which will help you cut waste and make real financial and operational gains.
6. Create a consolidated, integrated database with TDABC results and all logistics cost data, and report to senior management on a regular basis. The firm will have a competitive edge in the cement industry because to this database, which will facilitate quick and accurate decision-making, performance analysis over time, and strategic planning.

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