Automation of Activity Based Costing

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***Abstract*— The integration of automation in Activity-Based Costing (ABC) has emerged as a pivotal advancement in contemporary cost allocation and management methodologies. This research paper explores the adoption of automation in ABC costing, investigating its merits, challenges, and transformative impact on modern business operations. The study delves into the fundamental principles of ABC costing, emphasizing the pivotal role of automation in augmenting precision and efficiency. Automation in ABC systems offers several advantages, including heightened accuracy through the reduction of human errors, enhanced efficiency in processing extensive data, real-time data collection and analysis, and the potential for long-term cost reduction. However, it is not without its hurdles, such as initial setup costs, data integration complexities, change management considerations, and ongoing maintenance and updates. To illustrate the practical implications of automated ABC systems, this paper includes real-world case studies and a code developed to perform simple ABC costing. Despite initial challenges and investments, the long-term advantages, in terms of precision, efficiency, and data-driven decision-making, establish it as a valuable progression for present-day businesses.**

Keywords—ABC Costing, Automation.

I. Introduction

Activity-Based Costing (ABC) is a sophisticated approach to cost allocation, particularly useful in today's multifaceted business landscapes. Traditional cost accounting methods often struggle to provide an accurate representation of the true costs associated with products and services, particularly in complex and diversified business environments. This limitation arises from the broad, generalized way in which traditional methods allocate overhead costs, which can lead to imprecise cost figures.

ABC costing, in contrast, offers a more precise approach to cost allocation by meticulously tracking the specific activities that drive these expenses. This method delves into the intricacies of each cost component, providing a clearer and more accurate understanding of the costs incurred during product production or service delivery. However, manual implementation of ABC systems poses significant challenges. It demands time-consuming data collection and analysis, introduces the risk of human errors, and can result in inaccurate cost allocation, potentially impacting critical business decisions. Furthermore, the costs of manually implementing ABC systems, including labor and resources, can be substantial.

To address these challenges, the adoption of automation represents a significant advancement. Automation streamlines the process of implementing and maintaining ABC costing systems. It allows for the efficient collection, analysis, and allocation of costs, reducing the potential for human errors and significantly cutting down on the time and resources required. As a result, businesses can now harness the power of ABC costing without the traditional burdens associated with manual implementation.

In this paper, we have developed a code that leverages automation to perform ABC costing, simplifying the process and making it accessible and cost-effective for businesses of all sizes and complexities. This code is a step forward in revolutionizing cost accounting, enabling businesses to make more informed financial decisions and gain a competitive edge in today's dynamic business environment.

II. Principles of ABC Costing

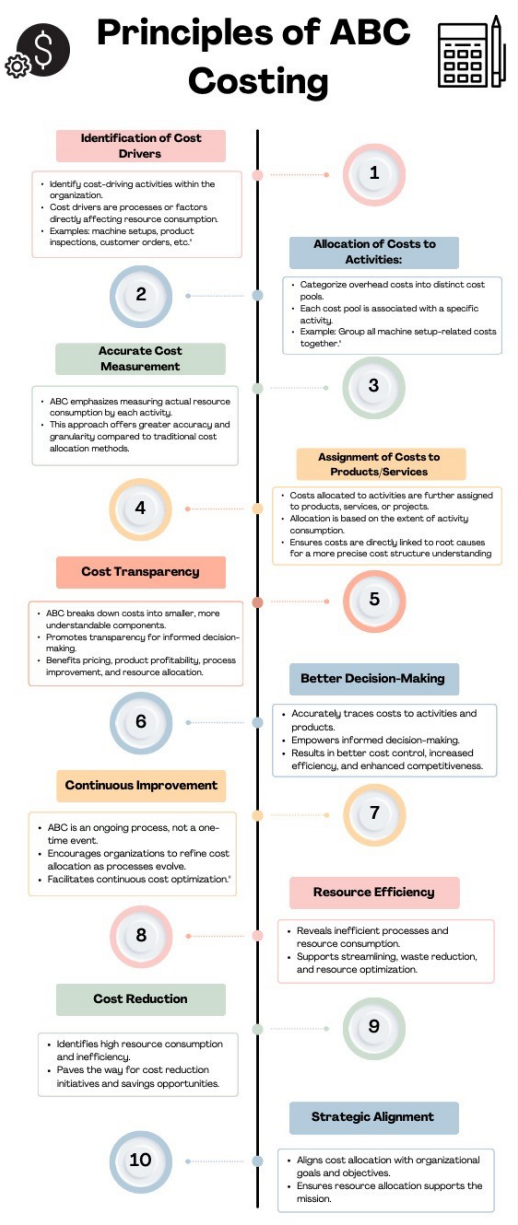

Fig. 1. Principles of ABC costing

III. PYTHON CODE

This code is designed to automate and streamline the cost allocation process, making it more accessible and efficient for businesses seeking to harness the advantages of this methodology:

```
import prettytable import
numpy as np
import panda as pd

# Function to calculate cost per unit def
calculate_cost(activities, overheads):
    total_machine_hours = sum(activities.values())
cost_per_unit = {activity: overheads[activity] /
activities[activity] for activity in activities}
return cost_per_unit

# Function to create cost sheet def
create_cost_sheet(products, cost_per_unit):
    cost_sheet = prettytable.PrettyTable()     headers =
["Product", "Units", "Total Cost", "Revenue",
"Profit Margin"]
    cost_sheet.field_names = headers

    for product in products:
        product_name = input("Product name: ")
product_units = float(input("Units produced: "))
product_activities = {}

        print("Enter activity units:")
for activity in cost_per_unit:
            units = float(input(f"Units of {activity} used in
{product_name}: "))
            product_activities[activity] = units

        product_cost = sum(cost_per_unit[activity] *
product_activities[activity] for activity in cost_per_unit)
revenue = float(input(f"Revenue for {product_name}:
"))
        profit_margin = revenue - product_cost

        row = [product_name, product_units,
f"{product_cost:.2f}", f"{revenue:.2f}",
f"{profit_margin:.2f}"]
cost_sheet.add_row(row)

    return cost_sheet

print("Welcome to the ABC Costing Calculator")
print("Follow the instructions to calculate ABC costing for
your products.")
```

```
# Get activity inputs
print("\nEnter activity details:") activities
= {}
overheads = {}

num_activities = int(input("Number of activities: ")) for
i in range(num_activities):
    activity = input(f"Activity {i + 1} name: ")     hours =
float(input("Total machine hours for this activity:
"))         overhead  =  float(input("Overhead  cost  for  this
activity:
"))     activities[activity] =
hours
    overheads[activity] = overhead

# Calculate cost per unit cost_per_unit =
calculate_cost(activities, overheads)

# Display ABC costing values
print("\nABC Costing Values:") for
activity, cost in cost_per_unit.items():
    print(f"{activity}: {cost:.2f}")

# Create cost sheet
choice = input("\nDo you want to create a cost sheet
for your products? (yes/no) ").strip().lower() if choice
== "yes":
    num_products = int(input("Enter the number of products:
"))
    products = range(1, num_products + 1)
    cost_sheet = create_cost_sheet(products, cost_per_unit)
print("\nCost Sheet:")     print(cost_sheet) else:
    print("No cost sheet created. Thank you for using the
ABC Costing Calculator.")
```

A. Logic of code using example

1) Libraries Used:

The code uses the prettytable library for creating formatted tables. It imports numpy and pandas *2)* Functions: calculate_cost(activities, overheads): Calculates the cost per unit for each activity based on the total machine hours and overhead costs. create_cost_sheet(products, cost_per_unit): Creates a cost sheet for multiple products, including their units produced, costs, revenues, and profit margins. *3)* User Interaction:

The user can choose to create a cost sheet for multiple products. If chosen, the script prompts for details for each product and displays the cost sheet.

The script guides the user through inputting activity details and overhead costs.
It displays the calculated ABC costing values for each activity.

4) Output:

The ABC costing values for each activity are printed to the console.

If the user chooses to create a cost sheet, it is displayed in a tabular format using the prettytable library.

B. Output of code using the example

```
Welcome to the ABC Costing Calculator
Follow the instructions to calculate ABC costing for your products.

Enter activity details:
Number of activities: 2
Activity 1 name: utilities
Total machine hours for this activity: 50000
Overhead cost for this activity: 200000
Activity 2 name: quality control
Total machine hours for this activity: 15000
Overhead cost for this activity: 300000

ABC Costing Values:
utilities: 4.00
quality control: 20.00
```

```
Do you want to create a cost sheet for your products? (yes/no) yes
Enter the number of products: 2
Product name: paperback
Units produced: 500000
Enter activity units:
Units of utilities used in paperback: 42500
Units of quality control used in paperback: 2500
Revenue for paperback: 1600000
Product name: hard bound
Units produced: 350000
Enter activity units:
Units of utilities used in hard bound: 7500
Units of quality control used in hard bound: 12500
Revenue for hard bound: 1400000

Cost Sheet:
+------------+----------+------------+------------+---------------+
|  Product   |  Units   | Total Cost |  Revenue   | Profit Margin |
+------------+----------+------------+------------+---------------+
| paperback  | 500000.0 | 220000.00  | 1600000.00 |   1380000.00  |
| hard bound | 350000.0 | 280000.00  | 1400000.00 |   1120000.00  |
+------------+----------+------------+------------+---------------+
```

IV. ANALYSIS OF CODE

A. Impact on cost accuracy and efficiency

1) Cost accuracy:

a) Positive Impact: The calculator calculates the cost per unit for each product based on activity usage and overhead costs. This approach is consistent with ABC costing principles and can lead to more accurate cost assignments for products.

b) Improvement: It reduces the likelihood of overestimating or underestimating costs, providing a more precise understanding of the cost structure.

2) Efficiency:

a) Positive Impact: The automation of the ABC costing process through the script improves efficiency compared to manual calculations. It streamlines the data entry and calculation process.

b) Improvement: Efficiency gains result from automating repetitive tasks, reducing the chances of human error, and providing a clear, structured output.

B. Improvements in real-time data insights

1) Positive Impact: While the code does not provide real-time data, it does offer the potential for real-time insights in the following ways:

-Quick adjustments: Users can make on-the-fly changes to activity usage and overheads to see how they affect product costs.

-Immediate visibility: Users can see the profit margins for each product as they input data.

2) Improvement: Real-time data insights can be further enhanced by integrating the script with real-time data sources, databases, or ERP systems to provide instant access to updated information.

C. Influence on resource allocation and profitabilty

1)Positive Impact: ABC costing helps in identifying the true cost drivers for products. By having a more accurate understanding of costs, organizations can allocate resources more efficiently.

2)Improvement: Integration with other systems can allow for better resource allocation. For example, if the ABC costing data is linked to an inventory management system, it can help in optimizing stock levels based on actual product costs.

D. Profitability

1)Positive Impact: Accurate ABC costing can lead to improved profitability by:

-Identifying unprofitable products, allowing for pricing adjustments or discontinuation.

-Highlighting high-profit margin products, enabling focused marketing efforts.

2)Improvement: To further enhance profitability, the calculator can be integrated with sales data, enabling more sophisticated profitability analysis and dynamic pricing strategies.

V. INDUSTRY TRENDS AND CASE STUDIES

The following section presents case studies and industry experiences that showcase the practical implementation and impact of automation in Activity-Based Costing (ABC) systems. These real-world examples highlight how businesses from various sectors have successfully adopted automated ABC costing methods to improve their cost allocation processes. Through these case studies, we gain valuable insights into the transformative potential of automated ABC costing in diverse business environments:

A. Hewlett and packard

Hewlett Packard (HP) is a global technology company that offers a wide range of products and services, including hardware, software, and consulting services. Activity-Based Costing (ABC) is a cost accounting method that is used to allocate costs to products, services, or activities based on the resources consumed by those products or activities.

Automation in ABC costing at Hewlett Packard (HP) involves the use of software and technology solutions to streamline the process of collecting and analyzing cost data. Here are some ways in which HP implement ABC costing:

1) Data Collection: Collects information on resource usage, direct and indirect costs, and other relevant financial and operational data.

2) Allocation of Costs: Automation simplified the allocation of costs to products, services, or activities for HP by using algorithms and predefined rules

3) Integration with Other Systems: Automation integrated with other systems used in the organization, such

as Enterprise Resource Planning (ERP) software, to access relevant data seamlessly and keep the ABC model up to date.

4) Real-Time Reporting: Automated ABC systems provides real-time or near-real-time reporting, allowing managers to make timely decisions based on accurate cost information.

5) Resource Optimization: With automation, HP identifies areas where resources are underutilized or overutilized, helping the company optimize resource allocation.

6) Cost Transparency: Automation enhances cost transparency by providing detailed insights into the cost drivers for different products, services, or projects. This information can be used for pricing decisions and cost reduction efforts.

7) Forecasting: Automated ABC systems can be used for cost forecasting, helped HP anticipate future costs and plan accordingly.

8) Scalability: Automation can handle large volumes of data and scale as the organization grows, making it suitable for a global company like HP.

B. Ford

Ford Motor Company, a global automotive leader, recognized the need for precise cost management to maintain competitiveness. To address this, Ford implemented automation in its ABC costing processes.

Challenges:

1) Complex Manufacturing: Ford's intricate production lines required time-consuming manual cost allocation.

2) Diverse Product Range: With various vehicle models, understanding costs was vital.

3) Global Operations: Ford needed standardized cost allocation across regions and plants. *Ford's steps in automating ABC costing:*

1)Advanced Software: Ford invested in cutting-edge ABC software for automated cost allocation.

2)Integration: The software was linked with manufacturing and ERP systems for real-time data access.

3)Cost Drivers: Ford identified cost drivers (e.g., machine hours, labor, materials) and configured them within the software.

4) Real-time Cost Allocation: Automation allowed precise, real-time cost allocation based on cost drivers.

Benefits:

1)Real-time Insights: Immediate data-driven decisions at model and plant levels.

2)Global Consistency: Standardized cost allocation across global operations.

3)Product Profitability: Enhanced analysis for model prioritization.

4)Efficient Resource Allocation: Cost savings and improved manufacturing efficiency.

5) Competitive Pricing: Precise cost insights for competitive pricing while maintaining profitability.

Ford's automation in ABC costing improved cost management, decision-making, and profitability. The company maintained competitiveness, prioritized highmargin models, and optimized manufacturing.

C. ABC costing in machine learning

While ABC offers enhanced accuracy, it's also associated with drawbacks, including high costs due to labor-intensive setup and maintenance, as well as the potential for human errors and delays in the cost study process. To mitigate these challenges, a concept called Machine Learning ActivityBased Costing (MLABC) has been explored. MLABC has the potential to surpass ABC in terms of accuracy without the need for costly and time-consuming cost studies. This holds true under specific conditions, which include the presence of longitudinal correlations between cost drivers and cost resources, interactions between cost drivers and cost resources, and the absence of a significant cost driver that would be overlooked without an ABC cost study.

In the development of the MLABC neural network, the author utilized Python, specifically version 3.7, and imported the numpy and keras modules. The neural network architecture comprises three hidden layers and an output layer with three nodes representing the allocation of cost resources to cost objects. Each node employs a linear activation function, aligning with the objective of estimation rather than classification. The model is trained on 90% of the dataset and tested on the remaining 10% to evaluate its accuracy.

Therefore, MLABC introduces a promising approach to cost allocation by leveraging machine learning techniques to enhance accuracy while reducing the costs and human errors associated with traditional ABC methods. This innovation holds significant potential for companies seeking a more efficient and precise means of distributing overhead costs to various cost objects..

D. Coca-cola

Coca-Cola, a prominent global company, utilizes automated Activity-Based Costing (ABC) to refine its pricing strategies. The company boasts a diverse product portfolio and manages substantial inventory levels, which can represent a substantial portion of production costs often underestimated in traditional costing methods. By implementing automated ABC costing, Coca-Cola has been able to dissect the distinctions between its well-established, global product lines and its specialized, region-specific offerings that may not have a global presence. This enhanced understanding of how production costs vary between these two categories has empowered the company to establish tailored price points in each market, ensuring not only competitiveness but also significant profitability.

E. Automation problem of ABC costing in Russia

The limited technical capabilities for automating information processing and organization hindered the adoption of Activity-Based Costing (ABC) in Russian companies. However, with the digitalization of the economy, the cost of processing accounting information has decreased, making it more feasible for companies to employ advanced costing methods.

The author conducted a survey involving 30 enterprises that use ABC costing for managerial decision support. The survey results revealed that the most used partial ABC costing tool among small and medium-sized businesses is Microsoft Excel. Approximately 23% of the surveyed organizations utilize the Process Cost Analyzer product, while some individual companies opt for OROS ABC, AllFusion Process Modeller, and IDEF0.EM TOOL, although these are less

common due to their relatively higher costs. The survey results have highlighted key requirements that Russian companies place on their Activity-Based Costing (ABC) software:

1. *Purposefulness*: This pertains to the alignment of generated information with the specific objectives of decision-making.
2. *Completeness and Reliability:* It underscores the need for information to be available in the necessary and trustworthy quantity for effective management.
3. *Concreteness:* This involves eliminating extraneous and redundant information to maintain focus and relevance.
4. *Efficiency:* This implies streamlining the time involved in collecting, processing, organizing, and presenting information.
5. *Cost-Benefit Balance:* It involves striking a balance between the costs associated with software implementation and maintenance and the quality of information derived from its usage.

The primary challenges encountered by Russian organizations when implementing ABC costing are related to modeling ongoing business processes to allocate costs effectively. In response to this issue, the author has devised a conceptual approach to enhance the implementation of this stage.

VI. CHALLENGES AND FUTURE DIRECTIONS

A. Challenges

1)Data Security and Privacy: As automation in ABC costing involves handling sensitive financial data, ensuring data security and privacy will be an ongoing challenge. Protecting confidential information from unauthorized access and breaches is of paramount importance.

2)Integration Complexity: Integrating automated ABC systems with existing enterprise systems, such as ERP and accounting software, can be complex. Compatibility issues and data synchronization challenges may arise.

3)Initial Implementation Costs: The initial setup costs for implementing automation can be significant. Small and medium-sized businesses may face budget constraints and resource limitations when transitioning to automated ABC costing.

4)Change Management: The introduction of automation may require employees to adapt to new processes. Managing change and ensuring that employees are comfortable with the new system is crucial for a smooth transition.

5)Technical Expertise: Automation systems often require technical expertise for maintenance and troubleshooting. Access to skilled personnel and resources for system maintenance is essential.

6)Data Accuracy and Quality: Automation relies heavily on data accuracy. Poor data quality can lead to inaccurate cost allocations, making data validation and cleansing critical.

7)The code does not have error handling for user input, so adding input validation would make it more robust.

8)It lacks data validation, which is crucial for real-world applications.

9)The code could be modularized into functions for better code organization.

10)It currently requires manual input for each product; automating or reading this data from external sources would enhance efficiency.

B. Future Directions:

1)Advanced Machine Learning Integration: Future developments could involve the integration of machine learning algorithms to improve the accuracy of cost predictions and the identification of cost drivers, making ABC costing even more precise.

2)Real-time Analytics: Implementing real-time analytics and dashboards that provide instant insights into cost allocations and profitability could be a key focus. This will enable organizations to make immediate decisions based on the latest data.

3)Cloud-based Solutions: Moving towards cloud-based ABC costing solutions can reduce the burden of system maintenance and improve scalability. Cloud solutions can offer flexibility and accessibility from various locations.

4)Sustainability Costing: The integration of sustainability and environmental factors into ABC costing could become a growing trend. As businesses focus on sustainability, automated ABC systems may incorporate environmental cost analysis.

5)User-Friendly Interfaces: Improving the user interface of automated ABC costing systems to make them more userfriendly can enhance adoption, especially among nontechnical users.

6)Cost Reduction Analysis: Future research may focus on utilizing automated ABC costing to identify opportunities for cost reduction and process optimization in a more comprehensive manner

This code can be a useful tool for small-scale ABC costing calculations and cost sheet generation, but for largerscale applications, you might consider further improvements, such as automating data input and handling more complex cost structures.

VII. CONCLUSION

This research paper underscores the significant role that automation plays in Activity-Based Costing (ABC) and its profound impact on contemporary business practices. Automation within ABC costing offers numerous benefits, including heightened precision, improved efficiency, realtime data collection, and the potential for long-term cost reduction. Nevertheless, it also introduces challenges, such as initial setup expenses, complexities related to data integration, considerations for managing organizational changes, and the ongoing need for system maintenance.

The Python script provided in the paper serves as a practical illustration of the implementation of automated ABC costing, rendering it accessible and cost-effective for businesses. The script streamlines the process of cost allocation, diminishes the likelihood of human errors, and delivers immediate insights. It holds the potential to substantially enhance the precision of cost assessment, optimize resource allocation, and bolster profitability.

Real-world case studies drawn from companies like Hewlett Packard, Ford, Coca-Cola, along with insights gleaned from the adoption of Machine Learning ActivityBased Costing (MLABC), shed light on the advantages and real-world applicability of automation within ABC costing. These instances clearly demonstrate how

automation can result in more precise cost allocation, improved decisionmaking, and heightened profitability.

The paper also underscores the challenges inherent in implementing automation within ABC costing, encompassing technical limitations in specific regions, the necessity for purposeful, comprehensive, and efficient software, and the critical importance of striking a balance between costs and benefits.In essence, the integration of automation within ABC costing represents a valuable step forward for businesses aiming to refine cost accuracy and operational efficiency in the ever-evolving landscape of modern business.

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