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Application of Time-Driven Activity-Based Costing (TDABC) to the Creation of an R&D Service in the Cosmetics Industry

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Abstract

Research and development (R&D) units in the cosmetics sector are traditionally managed as cost centers, and product development and customization services are rarely costed or priced. This study examines how Time-Driven Activity-Based Costing (TDABC) can support the transformation of the R&D unit of a make-to-order (MTO) cosmetics company from a cost center into a results center capable of charging for its development services. An interventionist case study was conducted in the color development laboratory of a nail polish manufacturer, combining interviews, document analysis, and direct observation. The intervention mapped the color development process, introduced a feasibility analysis form, estimated the cost per minute of practical capacity for two professional profiles, and costed the development of two colors of different complexity; the resulting model was implemented in the company in March 2025, and the first development service priced with it was invoiced in August 2025. Using simulated values, TDABC produced differentiated development costs (R$125.24 for a complex color and R$68.80 for a simple one), showed that the timed development activities use about 12% of the laboratory's practical capacity, and made visible the cost of unused capacity and of projects that are rejected or receive no client return. The study extends TDABC to R&D services in an MTO setting and shows how capacity information can underpin the pricing of technical services; the effects of the model on profitability and client relationships remain to be assessed.

Keywords: TDABC; research and development; R&D services; capacity utilization; interventionist research; cosmetics industry; make-to-order

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1. Introduction

The cosmetics industry is among the most profitable and rapidly evolving sectors globally, playing a key role in the international economy, despite occasionally being perceived as trivial by segments of society (Cosmetica Italia, 2022). In this highly competitive environment, innovation has become a strategic requirement, although many companies still treat the Research and Development (R&D) unit merely as a cost center, overlooking its potential for value creation (Kerssens-van Drongelen et al., 2003). Evidence suggests that organizations that embrace innovation as a strategic goal and invest consistently in R&D tend to achieve superior long-term results (Dall'Acqua et al., 2024).

One of the factors contributing to the undervaluation of R&D is the absence of adequate costing methods that allow for precise measurement of the resources applied in

development projects. This gap leads to underestimation of the sector and hinders well-founded managerial decisions, resulting, according to Kaplan and Anderson (2007), in the formulation of inadequate competitive strategies. In this context, Time-Driven Activity-Based Costing (TDABC) emerges as an effective methodology to support decision-making processes in complex and dynamic environments, having already been successfully applied in hospitals, make-to-order industries, and retail companies (Kaplan & Anderson, 2004). The method provides more accurate and agile information, increasing flexibility and enabling clear identification of the profitability of orders, products, and clients. Moreover, by replacing the employee surveys that traditional ABC uses to allocate resource costs to activities with direct estimates of the time each activity requires, TDABC reduces the subjectivity and labor intensity of that allocation step (Kaplan & Anderson, 2004; Schmidt et al., 2009).

This research proposes to analyze how the application of TDABC can contribute to transforming the R&D unit in cosmetics companies operating under the Make to Order (MTO) model into a results center. The study aims to apply the methodology in an R&D unit specialized in colorimetry, developing a costing model that measures the cost of development activities and can support the pricing of these services in a market characterized by high customization, reduced margins, and intense pressure for innovation. Accordingly, the study addresses two research questions. RQ1: How can the application of TDABC support the transformation of the R&D unit of an MTO cosmetics company from a cost center into a results center capable of charging for its development services? RQ2: What does TDABC reveal about the cost of color development services of different complexity and about the use of the laboratory's capacity?

The justification for the study is supported by literature that recognizes innovation as a central factor for sustainability and competitive advantage, especially in dynamic markets such as the cosmetics industry (Nisiyama & Oyadomari, 2012; Tidd, 2001). TDABC presents itself as an effective alternative for cost measurement, allocation, and analysis, considering the variation in time demanded by different activities and products (Kaplan & Anderson, 2004, 2007). Its application is especially suitable in make-to-order environments, where processes vary significantly between projects and clients (Varila et al., 2007). Despite the economic importance of the sector, there is a scarcity of literature applied to the use of cost management models in personalized R&D contexts (Dall'Acqua et al., 2024). Although TDABC has been applied in logistics (Everaert et al., 2008), libraries (Stouthuysen et al., 2010), health care (Keel et al., 2017; Etges et al., 2024), universities (Zaini & Abu, 2023), and small manufacturing firms (Adıgüzel & Floros, 2020), no application to the costing and pricing of R&D development services in the cosmetics industry was identified (Section 2.3).

Recent studies reinforce the relevance of the topic. Huang and Hou (2019), analyzing 15 years of industrial company data in Taiwan, demonstrated the direct relationship between innovation, R&D, and profitability, showing that systematic investment in R&D with intellectual protection generates measurable economic advantages. Kohtamäki et al. (2013), in turn, investigated how R&D services can generate significant profits when accompanied by strong relational capital between supplier and client. The authors concluded that profitability depends less on technical content and more on the quality of relational interactions, suggesting that the focus on technical efficiency and cost control should be complemented by active management of interorganizational relationships.

In light of this, the study proposes the integration of TDABC into R&D management, offering a costing procedure that other MTO firms can adapt to support the transformation of this sector into a results center and to monetize the technical knowledge and services provided. The contribution is twofold: theoretical, by exploring an application still scarcely discussed in the literature, and practical, by providing companies with a management

tool capable of supporting strategic decisions, pricing development services, and making visible the cost of unused capacity and of projects that generate no revenue, in a sector characterized by rapid product obsolescence and high innovation failure rates (Victory et al., 2021).

Furthermore, the study engages with the debate on managerial innovation, related to the adoption of new organizational practices and control methodologies aimed at improving performance and adaptability (Mol & Birkinshaw, 2009; Birkinshaw & Mol, 2006). By proposing structured financial control for an R&D unit, the work examines a management practice through which the area may gain strategic relevance. Due to its interventionist nature, the research not only presents applicable solutions to the organization studied but also contributes to theory by exploring the use of TDABC in sectors with high customization and low process standardization (Oyadomari et al., 2014).

2. Theoretical Framework

2.1. Innovation in the Commercial Proposal of R&D

Companies that incorporate innovation as a strategic objective and invest significantly in R&D tend to show substantial improvements in future performance (Dall'Acqua et al., 2024). In this regard, the Innovation Process Theory, proposed by Van de Ven (1986) and collaborators, views innovation as a non-linear, uncertain, and dynamic process developed through multiple cycles of experimentation, learning, and adaptation. Unlike traditional models that describe it as a logical and predictable sequence, this perspective emphasizes its disorganized nature, subject to interruptions and strongly influenced by internal and external contextual factors (Van de Ven, 2017). Success in innovation, therefore, depends less on fixed plans and more on the organization's ability to manage complex interactions among ideas, people, structures, and institutional environments.

Complementing this view, Garud et al. (1997) observe that innovation involves both the creation and reconfiguration of routines, requiring open, flexible structures that are prone to error and experimentation. This helps explain why many innovations fail and how uncertainty management becomes central to the process. Similarly, Tidd (2001) argues that innovation should be managed as a system of inputs, outputs, activities, subprocesses, and resources, and that understanding its enabling or inhibiting factors is essential to stimulate organizational development. Integrating customer feedback also proves crucial in developing products and services, as it ensures user-centered solutions and strengthens company-client relationships. By adopting collaborative practices such as co-creation or systematic feedback collection methods, companies enhance the relevance of their offerings and foster loyalty in competitive markets (Ryynänen et al., 2017).

Managerial innovation involves both the conception and the implementation of new practices (Mol & Birkinshaw, 2009). In the cosmetics sector, product innovation is a critical success factor (Szutowski & Szułczyńska, 2017; Kumar et al., 2006), which increases the pressure on R&D units to respond quickly and at a sustainable cost.

Despite the sector's vitality, risks remain high. A study of 83,719 new products in 31 U.S. packaged consumer goods categories found that about 25% failed within one year and about 40% within two years (Victory et al., 2021), reflecting rapid obsolescence and the uncertainty inherent to the innovation process. This reality underscores the importance of models that integrate R&D and business, balancing basic research with market-oriented demands. Wang (2018) notes that in many organizations, the research center remains focused on proprietary technologies and disconnected from market needs, while business units assume responsibility for competitive product insertion.

Thus, understanding innovation as a dynamic and multifaceted process that requires both flexible organizational structures and integration with the market and customers becomes essential to sustain competitiveness in the cosmetics sector.

In this study, the process view of innovation is used as an analytical lens for the intervention. Van de Ven (1986, 2017) describes the innovation journey as moving, in a non-linear way, through initiation, development, implementation, and outcomes. These stages correspond to the diagnosis, development, implementation and evaluation phases of the intervention described in Section 3.2, and are used in Section 4.9 to interpret the results. Garud et al. (1997) add that innovation requires the reconfiguration of existing routines, which, in the case studied, means changing how development requests are evaluated, recorded and charged.

2.2. TDABC Approach

Unlike traditional ABC, TDABC does not require employees to be surveyed about the percentage of their time spent on each activity in order to allocate resource costs to activities. This first-stage allocation is replaced by two direct estimates: the cost per unit of time of the capacity supplied and the time required by each activity. Activities still have to be identified and mapped, but the subjective and labor-intensive allocation step is avoided (Kaplan & Anderson, 2004; Schmidt et al., 2009).

ABC emerged in the 1980s to address the difficulties of traditional costing systems in allocating indirect costs. Despite its conceptual relevance, its practical application proved limited due to the complexity of continuously collecting and processing information on activities and cost drivers, as well as technological constraints at the time (Dalmácio et al., 2007; Kaplan & Anderson, 2004). These challenges contributed to the low implementation rate and the abandonment of many ABC-based projects.

To overcome these limitations, Kaplan and Anderson (2004) developed TDABC, which simplifies the process by reducing the number of cost drivers to just one: time. This change allows for the incorporation of variations in the demands of different types of transactions without assuming that all orders or processes require the same execution time. Thus, TDABC proves more flexible and suitable for complex and dynamic environments, where multiple work methods and differentiated demands coexist (Varila et al., 2007).

Kaplan and Anderson (2007) emphasize that the model does not require absolute standardization of orders or clients and that, in companies with varied processes and a wide diversity of products, its application tends to yield greater benefits than conventional methods. This adaptability explains its suitability for the present study, which analyzes a small company in the cosmetics sector focused on make-to-order products. As it is a laboratory with a small physical structure, without intensive use of equipment or complex infrastructure, costs are essentially concentrated in personnel, reinforcing the relevance of TDABC application in this interventionist research context.

2.3. Empirical Applications of TDABC and the Pricing of R&D Services

Since its proposal, TDABC has been applied in a variety of service and labor-intensive settings. A literature review by Siguenza-Guzman et al. (2013) shows that early applications concentrated on logistics, libraries, banking and health care, mostly in single-case designs that report the model's ability to reveal unused capacity and to cost heterogeneous transactions through time equations. In logistics, Everaert et al. (2008) used time equations to cost the order-handling activities of a wholesaler, showing how the characteristics of each order drive its time consumption. Stouthuysen et al. (2010) applied the method to the acquisition process of a university library and identified idle capacity and opportunities for process improvement.

Health care has become the most active field of application. Keel et al. (2017) reviewed TDABC studies in health care and found that they were used mainly to identify cost-saving opportunities and process improvements, and Etges et al. (2024) show that technology-supported measurement of time and resources has expanded the scale of such studies. In labor-intensive small firms and knowledge-intensive services, TDABC has been used mainly to measure capacity utilization: Adıgüzel and Floros (2020) analyzed capacity use in a small manufacturing company, Kefe and Tanış (2023) combined TDABC with the theory of constraints in an SME, and Zaini and Abu (2023) measured the unused capacity of academic staff in a university. Ganorkar et al. (2019) proposed a work-measurement procedure to obtain standard times for TDABC time equations. Together, these studies indicate that TDABC is particularly informative where people are the main resource and the time required varies across transactions, conditions that are present in R&D laboratories.

A second stream concerns the transformation of R&D and other support units into profit or results centers. Kerssens-van Drongelen et al. (2003) compared R&D units organized as cost centers, semi-profit centers, profit centers and independent businesses, showing that profit-oriented units differ in autonomy, project mix, performance evaluation and marketing, and that semi-profit centers face difficulties when they cannot recover their costs through internal or external prices. Kohtamäki et al. (2013) showed that the profitability of R&D services sold to industrial clients depends on relational capital, and the management control literature notes that turning a cost center into a profit center requires a defensible basis for internal transfer prices and external prices (Merchant & Van der Stede, 2017). None of these studies use TDABC to establish the cost base of R&D services, and no application of TDABC to color development services in the cosmetics industry was found. This study addresses this gap by using TDABC to cost the development services of an MTO cosmetics laboratory and to make visible the capacity on which a results-center model could be built.

3. Materials and Methods

Interventionist research produces prescriptive results for the organization under study, offering operational and managerial recommendations. At the same time, its findings are transferable to the professional community, which seeks best practices based on the experiences of other organizations. Unlike consulting—which focuses on solving the client's problem without an explicit commitment to theoretical development—interventionist research also aims to generate scientific and generalizable contributions (Oyadomari et al., 2014). In interventionist research, the researcher participates actively in the organization, working with practitioners to design and implement a solution, while seeking a theoretical contribution beyond the case (Jönsson & Lukka, 2007; Lukka & Suomala, 2014). Because this dual role affects access to data and the interpretation of results, the stages of the intervention and the researcher's position should be reported transparently (Suomala et al., 2014). In this study, the first author worked in the company during the research, which provided access to internal records and to the managers who decided on the implementation of the model.

3.1. The Company Under Intervention

Contemporary society is marked by scientific and technological advances that positively impact various sectors, such as mechanical, textile, food, pharmaceutical, and cosmetic industries. The latter stands out due to its significant expansion across all social classes, as cosmetics are present in daily life—from basic hygiene to beauty practices (Draelos, 1999).

The company analyzed was founded in the late 1970s and is a privately held firm operating in the cosmetics sector. In 2024, it had 60 employees and operated under a make-to-order manufacturing model, supplying products to various brands in the segment.

Approximately 80% of its sales are directed to the domestic market, while the remaining 20% are exported to Latin America.

Regarding competitive strategy, the organization does not prioritize innovation as a central success factor, instead focusing on other operational aspects. This choice limits its ability to add value through the development of exclusive products, reducing its potential for differentiation in the market. Among its most relevant products is nail polish, a widely used item associated not only with aesthetics but also with identity and social status (Draelos, 1999).

3.2. Methodological Procedures

The study addressed the two research questions stated in the Introduction. It started from a working assumption formed by the first author, who was an employee of the company, at the beginning of the research: although the company formally has an R&D unit, the unit is not used strategically, and the cost of its development services is not measured, so that these services are provided without being priced. The diagnosis described below was designed to examine this assumption.

The intervention took place between late 2024 and May 2025. Historical data on development projects cover the years 2021 to 2023 and the period from January to September 2024, and the TDABC model was implemented in the company in March 2025. Subsequently, the first development service priced with the model was invoiced in August 2025, after negotiations with the client that began in January 2025, and the model was formally approved by the company in April 2026.

Following the interventionist research literature (Jönsson & Lukka, 2007; Suomala et al., 2014) and the process view of innovation (Van de Ven, 1986), the intervention was organized in four stages: (i) diagnosis, in which interviews, document analysis and observation were used to understand the role of R&D and the absence of cost measurement (this section and Section 4.2); (ii) development, which comprised the mapping of the color development process, the creation of a feasibility analysis form that did not previously exist in the laboratory, and the construction of the TDABC model (Sections 4.4–4.6); (iii) implementation, in which the model, the process map and the feasibility form were presented to and adopted by the company in March 2025; and (iv) evaluation, based on the cost and capacity information produced by the model (Sections 4.7 and 4.8). Because implementation occurred close to the end of the research period, the evaluation does not include systematic post-implementation measures such as prices charged across projects or client reactions; the only post-implementation evidence is the first invoice issued under the model in August 2025, and this is discussed as a limitation in Section Limitations and Future Research.

Data collection involved interviews, document analysis, and direct observation to ensure triangulation of information. Semi-structured interviews were conducted with key employees of the Projects and Commercial departments, guided by the protocol presented in Appendix A, which contains five questions for each department on the type of demands received by R&D, the existence of processes and indicators for innovation, and the communication between departments. Unstructured interviews with the laboratory staff were used to clarify the development routine. The interviews were held with the main people involved in client projects (the project manager, the quality manager, the R&D manager and the general director, who answered the questions for the Commercial department). The responses revealed that R&D demands are mostly reactive, focused on solving specific problems or operational adjustments, with no structured process for generating, prioritizing, or encouraging innovation. It was also found that the development team has little involvement in strategic decisions and lacks specific indicators to measure innovation-related outcomes.

In the Commercial department, innovation is not perceived as a competitive differentiator, and communication with R&D is informal or nonexistent. This lack of alignment hinders the identification of strategic opportunities, as relevant market and client information does not reach the development sector. Many commercial professionals do not recognize the current portfolio as an expression of the company's creative and technical potential, revealing a gap between internal capabilities and external positioning.

Document analysis included project reports, technical meeting minutes, and strategic documents such as annual plans and corporate goals. This investigation showed that there are no specific objectives related to innovation, nor formal records of new product proposals or continuous improvement initiatives. Records focus on deadlines and operational efficiency, while the R&D sector appears only as a technical executor of specific demands. The absence of formal project evaluation criteria was also noted, making it difficult to identify prioritization patterns and limiting organizational learning. The review of the past three years' portfolio confirmed this scenario: low product renewal rate, no records of intellectual property, and a predominance of incremental versions without significant market differentiation.

Direct observation in the laboratory reinforced these findings. Activities were found to be limited to executing pre-established formulas, restricted to mixing components, with no exploration of new raw materials, process optimization, or pursuit of technical differentials. This characterizes the sector as essentially operational, limiting its strategic contribution to the company.

To ensure greater reliability of the information, data triangulation was adopted, combining the three techniques used. According to Yin (2005), this procedure allows for the comparison of information from different sources, reducing bias and increasing the robustness of conclusions.

The final diagnosis revealed that although the company formally has an R&D sector, it is not used strategically and lacks processes, metrics, and integration with other areas. This finding supports the working assumption stated at the beginning of this section and highlights the urgency of a restructuring oriented toward innovation. In this sense, the implementation of TDABC emerges as a tool capable of contributing to this transformation. By considering time as the central driver, the method allows for the identification of bottlenecks, idle capacity, and optimization opportunities, as well as supporting more accurate pricing aligned with market demands. As a result, R&D can take on a more active role in value creation, fostering the development of innovative, customized, and competitive solutions.

4. Results

4.1. Opportunities for Innovation and Customization in the Company Under Intervention

The consultations conducted revealed a significant opportunity for the development of customized products, leveraging advanced technologies and innovations in pigments applicable to the company under study. Currently, the company adopts a traditional approach in its laboratory, limited to the simple mixing of components. However, a more strategic orientation in R&D would enable the creation of differentiated solutions tailored to the specific needs of clients, adding value to the portfolio and enhancing market competitiveness.

With the implementation of a structured R&D process, combined with more precise costing methodologies, the company could direct investments more assertively toward new inputs and production processes. The integration of technology and customization could become a source of competitive advantage and position the company as a partner in the creation of exclusive products, although these effects were not measured in this study.

4.2. Absence of Cost Measurement and Its Fiscal Implications

During meetings with clients, difficulties were observed in price negotiations, associated with the high tax burden of the sector. One alternative considered by the company was to invoice product development as a service, separately from the sale of goods. Decisions of the São Paulo Tax and Fees Court (Tribunal de Impostos e Taxas, TIT/SP) indicate that such segregation is accepted only when the company can demonstrate that the service was effectively provided, through contracts, records of the service and of the professionals involved; otherwise, the amounts are taxed as part of the goods. A costing system that records the time and cost of each development activity therefore provides part of the substance required to invoice development as a service, which links this fiscal issue to the TDABC model proposed in this study.

Following this initial diagnosis, a detailed investigation of the cosmetic manufacturing process using pigments was conducted to identify intervention opportunities that could enhance the company's competitiveness. The analysis covered all production stages—from initial development to product finalization—seeking points of optimization, cost reduction, and efficiency improvement. It was found that the company, operating on a make-to-order basis according to each client's specifications, does not measure the costs of development projects. The absence of such measurement compromises the preparation of realistic budgets, appropriate pricing, feasibility evaluation, expense control, and managerial decision-making. Moreover, it results in a lack of transparency with clients, hindering the perception of value in the services provided and potentially undermining trust and loyalty.

This scenario also limits the company's capacity for sustainable innovation, as the lack of profitability metrics prevents the identification of inefficiency patterns or improvement opportunities. Without concrete data, it becomes difficult to assess which projects add the most value and which consume resources without proportional returns. Thus, the absence of cost measurement undermines competitiveness and reduces the company's ability to align R&D with strategic market demands.

In the sectoral context, the company faces a highly challenging environment marked by increasing competitive pressure and the need for innovation in services and processes. The company operates under the Make to Order (MTO) model, in which production begins only after order confirmation, focusing on small volumes and specific requirements. Unlike the Make to Stock (MTS) model, which produces for inventory based on forecasts, MTO requires flexibility, customization, and greater client interaction (Li et al., 2014; Asgari et al., 2018). This characteristic makes it more suitable for highly personalized markets but also more vulnerable to inefficiencies and high costs.

Therefore, the creation of a dedicated unit for product development services requires an accurate assessment of the cost of these services. To preserve the confidentiality of the company, all monetary values, activity times, and project volumes reported in this study were simulated. The simulation was performed on the company's records and preserved the proportions observed in them, between the costs of the two professional profiles, between activity times and between categories of projects, so that the ratios on which the analysis relies (cost per minute, relative cost of complex and simple colors, share of complex projects and capacity utilization) are consistent with the observed reality.

4.3. From Average Cost per Project to TDABC

To define the price to be charged for services, it is essential to accurately identify the costs involved in the costing process. In the case of the company analyzed, it is a service with low raw material consumption but high demand for professional time. The literature points to the Activity-Based Costing (ABC) method and its evolution, TDABC, as suitable approaches for this type of context.

Before the intervention, the company did not measure the cost of development projects. The simplest alternative available, shown in Table 1, is to divide the annual cost of the laboratory's professionals by the number of development projects handled in the year. The total employee cost of R$298,044 corresponds to the annual cost of the two professionals described in Table 2 (R$24,837 per month × 12), and the average of 354 projects per year includes approved projects, rejected projects, and projects with no client return. This yields an average cost of R$842 per project. This is a conventional average-cost allocation, not an ABC model: no activities or activity drivers are used, and every project receives the same cost regardless of its complexity.

Table 1. Average Cost per Development Project (Conventional Allocation).

Development	Approved	Rejected	No Return	Total
2021	219	30	48	297
2022	281	32	83	396
2023	250	40	78	368
Average	**250**	**34**	**70**	**354**
Total Annual Employee Cost				R$298,044
Average Cost per Project				R$842

Note: All monetary values are expressed in Brazilian Reais (R$).

Table 2. Cost per Unit of Capacity Time.

Position	Technical Chemical Specialist	Chemical Analyst
Employees	1	1
Theoretical Capacity (minutes)	11,880	11,880
Practical Capacity (80%)	9504	9504
Monthly Cost (R$)	R$16,765	R$8072
Cost per Minute (R$)	R$1.76	R$0.85

Note: All monetary values are expressed in Brazilian Reais (R$).

This approach has significant limitations. Projects differ in scale and complexity, and some are interrupted because the formulation proves unfeasible; the average cost ignores these differences, as well as differences in the qualification and cost of the professionals involved. Moreover, by spreading the whole payroll over the projects, it charges each project with the cost of capacity that was not used, and therefore does not reveal inefficient activities, unprofitable products or clients, or excess capacity.

TDABC addresses these limitations. Instead of surveying employees about the percentage of their time spent on each activity, which is the first-stage allocation of traditional ABC, it estimates the cost per minute of the practical capacity supplied and the time each activity requires (Kaplan & Anderson, 2004). Activities still need to be identified and mapped, as done in Section 4.4; what TDABC simplifies is the allocation of resource costs to those activities. Because only the time actually consumed is charged to services, the difference between the capacity supplied and the capacity used becomes visible (Adıgüzel & Floros, 2020; Zaini & Abu, 2023).

4.4. Mapping and Standardization of Activities in Color Development

The first step of the study was to map all activities related to the provision of color development services, including client interaction, laboratory formulation, data analysis, communication, documentation, and other associated tasks. This mapping proved essential to ensure consistency and quality, as it documents each stage of the process—from pigment selection to final formulation—allowing for the rapid identification and correction of deviations that could compromise product uniformity. Such control is particularly relevant in a market where color fidelity is a decisive factor for customer satisfaction.

Beyond standardization, activity mapping enhances the company's capacity for innovation. The systematic recording of procedures enables the replication of successful experiments, the adjustment of inefficient formulations, and the acceleration of new color development based on empirical data. In this way, the company could launch products within shorter timeframes and maintain competitiveness in a sector characterized by rapid changes and high demand for novelty. Mapping also proves essential for regulatory compliance and sustainability practices, as it facilitates adherence to safety and quality standards and allows for the identification of waste and efficiency improvements in processes.

According to Figure 1, in the initial phase, the client presents their chromatic references, which undergo a technical and economic feasibility analysis. This stage assesses the required resources—inputs, equipment, time, and labor—as well as potential risks, such as pigment stability and chemical compatibility. The evaluation also considers strategic impact, analyzing consumption trends, commercial viability, and the company's distribution capacity. To systematize this process, a specific feasibility analysis form was created, previously nonexistent in the R&D laboratory. This form ensures consistency in evaluating critical variables and strengthens decision-making robustness. In cases of infeasibility, the chemical engineer issues a technical justification, such as the example involving heavy glitters that compromise nail polish viscosity, rendering its application as a cosmetic product unviable.

Once feasibility is approved, the required inputs are separated, and the colorist prepares a pre-formula based on the client's reference. The sample is then compared to the standard, and if approved, a 500 g batch is produced for validation. Subsequently, the formula is registered in the system, including all details regarding pigments and proportions used. In parallel, samples are subjected to performance analyses after 24 h, evaluating parameters such as viscosity, gloss, drying time, and solids concentration—critical variables for the applicability and quality of the nail polish.

The process then advances to the stability testing phase, which lasts between 7 and 30 days depending on the complexity of the formulation. During this period, samples are exposed to controlled temperature and humidity conditions to simulate usage and storage. Whenever adjustments are necessary, the testing period is restarted to ensure reliability of the results. Additional tests for adhesion and resistance may also be conducted to ensure the durability and suitability of the nail polish in meeting consumer expectations. Stability testing consists mainly of elapsed time, during which samples are stored under controlled conditions; it consumes little professional time and is therefore not included in the unit times of Tables 3 and 4.

This set of practices—mapping, feasibility analysis, procedural standardization, and rigorous testing—not only strengthens the technical reliability of developments but also creates the conditions to align the R&D sector with innovation, sustainability, and regulatory demands, consolidating its strategic importance for the company's competitiveness.

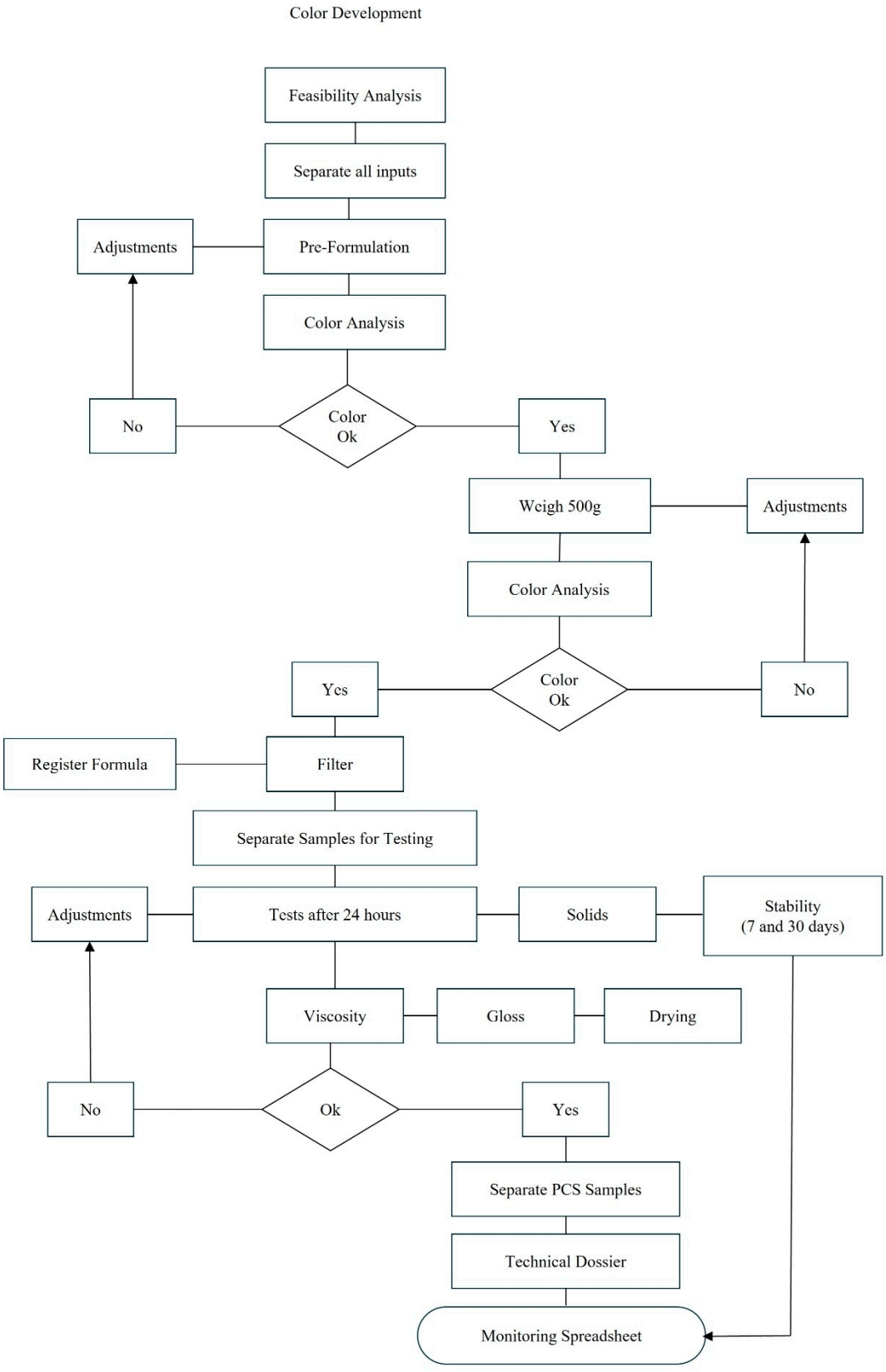

Figure 1. Color Development Process Flow.

Table 3. Unit Times—Color "Lua".

Activity	Time Spent (min)	Cost per Minute (R$)	Total Cost (R$)
Feasibility Analysis	7	R$1.76	R$12.35
Separation of All Inputs	6	R$1.76	R$10.58
Pre-Formulation	16	R$1.76	R$28.22
Color Analysis (1st Round)	8	R$1.76	R$14.11
Weighing 500 g of Color Sample	5	R$1.76	R$8.82
Color Analysis (2nd Round)	7	R$1.76	R$12.35
Formula Registration	4	R$1.76	R$7.06
Filtering	2	R$1.76	R$3.53
Sample Separation for Testing	3	R$1.76	R$5.29
Performance Tests (Gloss/Drying/Viscosity)	5	R$1.76	R$8.82
Sample Preparation	3	R$1.76	R$5.29
Technical Dossier	5	R$1.76	R$8.82
Total	71		R$125.24

Note: All monetary values are expressed in Brazilian Reais (R$).

Table 4. Unit Times—Color "Capuccino".

Activity	Time Spent (min)	Cost per Minute (R$)	Total Cost (R$)
Feasibility Analysis	8	R$0.85	R$6.79
Separation of All Inputs	5	R$0.85	R$4.25
Pre-Formulation	20	R$0.85	R$16.99
Color Analysis (1st Round)	10	R$0.85	R$8.49
Weighing 500 g of Color Sample	5	R$0.85	R$4.25
Color Analysis (2nd Round)	10	R$0.85	R$8.49
Formula Registration	5	R$0.85	R$4.25
Filtering	2	R$0.85	R$1.70
Sample Separation for Testing	3	R$0.85	R$2.55
Performance Tests (Gloss/Drying/Viscosity)	5	R$0.85	R$4.25
Sample Preparation	3	R$0.85	R$2.55
Technical Dossier	5	R$0.85	R$4.25
Total	81		R$68.80

Note: All monetary values are expressed in Brazilian Reais (R$).

4.5. Application of TDABC

According to the new activity-based costing approach, it is possible to directly estimate the resource demand generated by each activity, and even by product or client. Kaplan and Anderson (2004) describe five fundamental steps for implementing the TDABC model. The first involves estimating the cost per unit of time of capacity, taking into account the difference between theoretical capacity and the practically available capacity. As the authors emphasize (2004, p. 4), this calculation "forces the company to incorporate estimates of the practical capacity of its resources," thereby avoiding resource overvaluation or underutilization.

The second step consists of determining the unit time required to perform each activity, estimated through interviews or direct observation. With this information, it becomes possible to calculate the cost driver rates, obtained by multiplying the cost per unit of time by the time required for each activity. Once these rates are established, costs can be applied in real time, increasing the model's accuracy.

Next, managers must analyze and report the calculated costs, highlighting not only the supplied capacity but also the effectively used capacity and the cost of idle capacity. This perspective enhances transparency and allows for the identification of bottlenecks and improvement opportunities. Finally, the model must be continuously updated. Kaplan and Anderson (2004, p. 5) point out that variations in the unit time of activities mainly result from changes in resource prices and the level of efficiency achieved, so revisions should occur whenever significant events take place, rather than at fixed calendar intervals.

Among the advantages reported by companies that have implemented the model are the reduction in the number of activities monitored, the incorporation of greater complexity without overloading the accounting system, cost estimation based on real characteristics and direct observations, and the ease of model validation. Other benefits include the need for fewer personnel to operate and disseminate results, reduced processing time, and the ability to obtain cost and profitability information quickly and accessibly (Kaplan & Anderson, 2004). Thus, TDABC is considered a transparent, scalable methodology that is easy to implement and update, providing managers with a robust decision-support tool without the high costs and implementation complexity associated with traditional costing systems.

4.6. Results of TDABC Application

The application of TDABC began with the estimation of the cost of the resources supplied to the color development laboratory. Because the laboratory has a small physical structure and makes no intensive use of equipment (Section 2.2), the cost base considered in this study comprises the personnel costs of the two professionals, who are the main resource consumed by development services. Other laboratory costs, such as testing materials, space and utilities, were not included, which is acknowledged as a limitation. Based on the process mapping developed in the intervention, each stage of development was then identified and quantified for a real client scenario.

The first step consisted of estimating the cost per unit of time of capacity. To this end, the practical capacity of the human resources available in the laboratory was calculated, comprising one technical chemical specialist and one chemical analyst. Both work nine hours per day over 22 working days, totaling 198 h (11,880 min) of theoretical capacity per month. According to Kaplan and Anderson (2004, p. 3), practical capacity corresponds to 80% to 85% of theoretical capacity; in this study, an index of 80% was adopted.

The complexity of color formulation was also considered a relevant variable for cost allocation. Thus, the technical chemical specialist was assigned responsibility for developing more complex colors—such as those incorporating glitters or pearls—while the chemical analyst was designated to handle less complex colors, such as milky tones. This distinction allowed for the allocation of capacity costs to be associated with the technical demands of each activity, more accurately reflecting resource utilization in the development process.

To operationalize the application of the TDABC method, it was necessary to calculate the practical capacity and the cost per unit of time of the human resources allocated to the R&D department. Table 2 presents a comparison between the Technical Chemical Specialist and the Chemical Analyst, highlighting significant differences in monthly cost and cost per minute for each professional. While both have the same theoretical work capacity (11,880 min/month), practical capacity is adjusted to 80%, resulting in 9504 min effectively available. This measurement allows costs to be directly associated with the complexity of

the activities performed, as the specialist has a higher cost per minute than the analyst, reflecting greater technical qualification and, consequently, higher added value in complex formulations.

Based on Figure 1, the unit times of the activities performed in each color development were estimated through direct observation of the professionals executing the activities, complemented by interviews with them to validate the estimates. The times were recorded during one real client development of each color, so each value is a single measurement rather than an average of repeated observations. The unit times refer to one complete development round without adjustment loops: the additional adjustment rounds shown in Figure 1, the solids test, and the adhesion and resistance tests were not timed and are therefore not included in Tables 3 and 4.

In the case studied, the color "Lua", characterized as highly complex due to the use of special pigments and visual effects, was developed by the technical chemical specialist, because such formulations require deeper technical knowledge to manage potential chemical instabilities.

Conversely, the color "Capuccino", classified as less complex due to its simpler formulation and lower risk of component incompatibility, was developed by the chemical analyst.

Tables 3 and 4 show that the complex color required less recorded time (71 min) than the simple color (81 min), because it was developed by the more experienced professional, who performed the pre-formulation and color analysis steps faster. The higher cost of the complex color (R$125.24 versus R$68.80) therefore results from the higher cost per minute of the specialist, not from a longer development time. In this laboratory, complexity affects cost mainly through the allocation of colors to professionals of different qualifications, and two examples cannot capture how the time of each activity varies with the characteristics of the color. A natural extension of the model is the use of time equations (Kaplan & Anderson, 2004; Everaert et al., 2008), in which the time of a development is expressed as a base time plus increments for each adjustment round and for the presence of glitter or pearl pigments, estimated from a larger number of observed developments (Ganorkar et al., 2019).

4.7. Analysis of Historical Development and TDABC Results

The analysis of the color development history over the past three years reveals continuous and significant activity within the R&D department. In 2021, 219 colors were developed; in 2022, this number increased to 281; and in 2023, a total of 250 developments were recorded. Considering the period, an annual average of 250 colors developed is observed, confirming the relevance and consistency of this activity for the company. These figures refer to approved developments; including rejected projects and projects with no client return, the laboratory handled on average 354 projects per year (Table 1).

Of the total historical developments, 78.7% of the colors were classified as non-complex, while 21.3% corresponded to complex colors, reflecting the predominance of simpler formulations in the laboratory's portfolio. However, the consistent presence of more complex projects reinforces the need for a costing method that adequately captures the differences in effort and resources applied.

In 2024, by 30th September, 251 colors had already been developed, surpassing the annual average observed in the previous period. This result suggests a growing trend in demand and reinforces the importance of structuring cost measurement methodologies capable of tracking the intensification of activities, ensuring operational efficiency and competitiveness in the sector.

The results obtained align with the core propositions of TDABC by demonstrating that the use of time as a cost driver simplifies costing, enhances transparency, and enables the estimation of practical capacity and idle cost in a managerially useful way (Kaplan &

Anderson, 2004, 2007). The differentiation of costs by the professional profile assigned to each level of complexity shows that the method captures the heterogeneity of resource consumption across projects, supporting evidence that time/process-oriented costing improves the traceability of inefficiencies (Varila et al., 2007).

In MTO (Make to Order) and highly personalized contexts such as the one analyzed, this temporal granularity supports pricing and portfolio prioritization decisions, in line with studies that emphasize the relevance of fine-grained metrics for coordination and performance in MTO chains (Li et al., 2014; Asgari et al., 2018). Finally, the need for continuous updating of time estimates and cost rates—due to fluctuations in input prices and efficiency gains—was also observed in this case and is emphasized in the literature as a condition for preserving the model's accuracy (Kaplan & Anderson, 2004).

4.8. Capacity Utilization and the Cost of Unused Capacity

Table 5 combines the unit times of Tables 3 and 4 with the volume of projects to estimate the capacity used by the timed development activities. Applying the historical mix of 21.3% complex and 78.7% simple colors to the average of 354 projects per year results in about 75 complex projects developed by the specialist and 279 simple projects developed by the analyst. At 71 and 81 min per project, respectively, these developments consume 27,920 min per year, against an annual practical capacity of 228,096 min.

Table 5. Capacity Used by the Timed Development Activities and Cost of Unused Capacity per Year.

Item	Technical Chemical Specialist	Chemical Analyst	Total
Projects per year	75.4 (complex)	278.6 (simple)	354
Minutes per project	71	81	–
Minutes used per year	5354	22,566	27,920
Practical capacity per year (min)	114,048	114,048	228,096
Capacity utilization	4.7%	19.8%	12.2%
Cost of unused capacity per year (R$)	R$191,736	R$77,698	R$269,434

Note: Simulated values in Brazilian Reais (R$). Projects per year apply the historical mix of 21.3% complex and 78.7% simple colors to the average of 354 projects (Table 1). Practical capacity = 9504 min per month × 12. Cost of unused capacity = unused minutes × cost per minute (Table 2). Times cover one development round without adjustment loops.

The timed activities therefore use about 12% of the practical capacity supplied (4.7% for the specialist and 19.8% for the analyst); considering only the 250 approved projects per year, utilization falls to 8.6%. Two non-exclusive explanations should be considered. First, part of the capacity is genuinely idle, which supports the proposal of offering development services to clients and using the available capacity to generate revenue. Second, the unit times cover a single development round and exclude adjustment loops, additional tests, client interaction, and other tasks performed by the professionals, so the capacity actually consumed by development projects is higher than the timed figures indicate. Distinguishing between these explanations requires timing the activities not yet measured, which is a priority for the next update of the model.

This analysis also explains the gap between the average cost of R$842 per project (Table 1) and the TDABC costs of R$68.80 and R$125.24 (Tables 3 and 4). Weighted by the mix of complex and simple colors, the TDABC cost of a development round is R$80.82, and the cost of the time used by all projects in a year is about R$28,610. Adding the cost of unused capacity (R$269,434) reconciles this figure with the annual payroll of R$298,044. The average-cost method spreads the entire payroll over the projects and therefore loads

each project with the cost of unused capacity and of untimed activities, whereas TDABC charges each project only with the time it consumes and reports the remaining capacity separately (Kaplan & Anderson, 2004).

The model also allows the cost of projects that do not generate revenue to be estimated. On average, 34 projects per year were rejected, and 70 received no client return (Table 1), together 29.4% of all projects. If these projects went through a complete development round, their TDABC cost would be approximately R$8400 per year (104 × R$80.82); projects rejected at the feasibility stage cost much less, since feasibility analysis takes 7 to 8 min. These are the unrecoverable costs referred to in the Introduction, and their measurement provides a basis for decisions such as charging a development fee or requiring a deposit for types of projects with high non-return rates.

These results provide the basis for pricing development services, which the company did not do before the intervention. A cost-based price for a development can be formed from the TDABC cost of the activities it requires, including adjustment rounds when they occur, plus a margin. The cost of unused capacity, in turn, should be managed separately, by redeploying capacity or by attracting additional development demand, rather than being loaded onto the price of each project (Kaplan & Anderson, 2004).

4.9. Discussion in Light of the Innovation Process

The intervention can also be read through the process view of innovation adopted in Section 2.1. Consistent with Van de Ven (1986, 2017), the change did not follow a linear plan: the initial focus on pricing and tax difficulties (Section 4.2) led to the diagnosis that development costs were not measured, which in turn required mapping the development process before any costing was possible. The intervention reconfigured existing routines, as described by Garud et al. (1997): a standard form was introduced to assess feasibility before formulation work starts, development steps were documented in a fixed sequence, and each activity was given a time and a cost. These routines are a precondition for treating development as a service that can be priced, and show that the costing innovation depended on changes in how the laboratory works, not only on a new calculation.

5. Conclusions

This interventionist study examined how TDABC can support the transformation of the R&D unit of an MTO cosmetics company from a cost center into a results center (RQ1), and what TDABC reveals about the cost of development services and the use of the laboratory's capacity (RQ2).

Regarding RQ1, the study shows that TDABC provides the cost information that a results-center model requires and that the company did not have: a cost per minute for each professional profile and a cost for each development activity, which together allow development services to be quoted and charged. The intervention also showed that costing depended on prior organizational changes, namely the mapping of the development process and the introduction of a feasibility analysis form. The resulting model was implemented by the company in March 2025. After the end of the research period, the first development service priced with the model was invoiced in August 2025, after negotiations with the client that began in January 2025, and the model was formally approved by the company in April 2026. The transformation of R&D into a results center is therefore enabled, but not completed, by the model: it also depends on management decisions on prices and on client acceptance. The first invoice shows that this process has started, but a single transaction does not establish client acceptance.

Regarding RQ2, TDABC produced differentiated costs for a complex and a simple color (R$125.24 and R$68.80, respectively), showing that, in this laboratory, the difference results

mainly from the profile of the professional assigned to each color rather than from longer development times. It also showed that the timed development activities use about 12% of the practical capacity supplied, and that the average-cost allocation previously available (R$842 per project) loads each project with the cost of unused capacity. Making this capacity visible, together with the cost of projects that are rejected or receive no client return, is the main managerial contribution of the model.

From an academic perspective, the study extends the application of TDABC, so far concentrated in logistics, health care, libraries and manufacturing (Siguenza-Guzman et al., 2013; Keel et al., 2017; Adıgüzel & Floros, 2020), to R&D development services in the cosmetics industry, and connects it to the literature on R&D units organized as profit or results centers (Kerssens-van Drongelen et al., 2003; Kohtamäki et al., 2013). Rather than a replicable model, it offers a procedure that other MTO firms can adapt: map the development process, estimate the cost of practical capacity by professional profile, time each activity, and report used and unused capacity.

Limitations and Future Research

The study has limitations. It is a single case study based on two examples of color development, and all values were simulated to preserve confidentiality, which limits the generalization of the figures. Unit times cover a single development round, were measured once for each color, and exclude adjustment loops and some tests, and the cost base includes only personnel costs. Because the model was implemented shortly before the end of the research period, apart from the first invoice issued under the model in August 2025, the study does not report post-implementation evidence on prices charged, client reactions, profitability, or changes in the share of projects without client return; statements about these effects should be read as expected implications rather than findings. Future research could time the activities not yet measured and estimate time equations from a larger number of developments; follow the company after implementation to assess the effects of charging for development services on revenue, client relationships and the share of non-returning projects; and replicate the procedure in other MTO firms and in other types of technical services.

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Abbreviations

The following abbreviations are used in this manuscript:

ABC	Activity-Based Costing
MTO	Make to Order
MTS	Make to Stock
R&D	Research and Development
TDABC	Time-Driven Activity-Based Costing

Appendix A. Interview Protocol

Questions for the Projects department:

(1) What types of demands usually reach the development area? Are they mostly reactive (problem solving) or proactive (new ideas, improvements, innovations)?
(2) Is there a structured process for capturing and prioritizing innovative ideas within projects?
(3) How is R&D involved in projects from the initial phase to final delivery? Does it participate in strategic decision-making?
(4) Are there performance indicators that measure innovation in projects (e.g., development time, percentage of innovative launches, financial return)?
(5) Does the development area have the autonomy to propose solutions not directly requested by clients or other areas?

Questions for the Commercial department:

(1) What do clients value most in the company's products and services: price, lead time or innovation/differentiation?
(2) In commercial negotiations, do you perceive that the company stands out by offering something new to the market, or does it only follow trends?
(3) Is there a formal communication channel between the Commercial department and R&D to share feedback, needs or opportunities identified with clients?
(4) Do you feel that the current portfolio reflects the company's creative and technical potential? Why?
(5) In your view, is the company recognized by the market as innovative? What would be necessary to achieve (or strengthen) this perception?

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