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# Mediating Effect of Operational Flexibility on the Relationship between Absorptive Capacity and Performance

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**Abstract**

The objective of this work is to analyze the influence of operational flexibility in the relationship between the capacity to absorb knowledge and business performance, to contribute from dynamic capacities (DC) with the industry. Methodology - The research was positivist, explanatory and not experimental cross-sectional. 75 Colombian companies in the manufacturing sector were analyzed. Data was obtained through a structured Likert-type questionnaire addressed to management. The relationship was verified using modeling with structural equations and the mediation method with support in Smart PLS4. Results -The findings indicate that operational flexibility positively mediates the relationship between absorptive capacity and the performance of manufacturing firms. When opportunities are detected in the market, organizations reconfigure their capabilities, in that sense they adjust their flexibility to take advantage of them, and increase their potential and realized absorption capacity, which allows them to adapt their capabilities disruptively to the demands of the market, obtaining superior performance.

**Keywords:** operational flexibility, absorptive capacity, business performance, dairy sector, manufacturing.

JEL: M10, M11, O14, C38

## Introduction

Customers around the world are increasing the demand for differentiated products, demanding higher standards of quality and reliability, however, the supply in Colombia remains limited, which reflects a challenge for the dairy industrial sector (Minagricultura, 2022). Although this sector has shown some growth in terms of production and exports, it

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still faces significant lags in productivity and scale of production compared to developed countries (DANE, 2021).

The Rural Agricultural Planning Unit (UPRA, 2020) points out that in order to improve efficiency and reduce production costs, it is essential to improve multiple factors such as technology, products, processes, and personnel training in the next 20 years.

However, the sector faces persistent challenges, such as low product diversification, technological backwardness, limited knowledge transfer, low productivity, and high production costs. These challenges demand the formulation of management strategies that strengthen the sector in the domestic and foreign markets (Minagricultura, 2022; National Council for Economic and Social Policy [CONPES], 2017).

In today's dynamic market environment, where product life cycles have been shortened, flexibility in manufacturing has established itself as a key factor for the competitiveness of companies. Implementing flexible manufacturing systems, which incorporate advanced technologies such as artificial intelligence, allows companies to optimize their operations through self-assessment, dynamic reconfiguration, and intelligent decision-making. This adaptability facilitates an agile response to market demands and changes in the environment, improving business performance and providing a significant competitive advantage. (Wan et al., 2021).

In this research, the authors consider that taking on the challenge of managing improvements in operational flexibility and the capacity to absorb knowledge is essential for companies that want to improve their performance and obtain competitive advantages. The issue of flexibility in manufacturing has been studied in advance, however, the current advancement of technology can be considered an unfinished topic, with the possibility of continuously closing technological gaps dynamically in line with the dynamism of the environment.

Initially, a theoretical review of operational flexibility, knowledge absorption capacity and business performance was made, to later establish relationships between the constructs. The objective of this research is to determine that the flexibility adjustment positively mediates the relationship between knowledge absorption and business performance.

## Theoretical Framework

### *Operational Flexibility*

Manufacturing flexibility has been defined as the ability to adapt to changes in products, processes, and resources to maintain efficiency in dynamic environments (Nagarur, 1992; Sethi & Sethi, 1990). Its multidimensionality includes aspects such as operational, strategic, machinery and process flexibility, among others (Tamayo-Torres et al., 2011; Koste & Malhotra, 1999). Slack (1987, 2005) highlights that flexibility connects manufacturing objectives with organizational performance, improving profitability and competitiveness. De Toni and Tonchia (2005) emphasize that operational flexibility allows companies to adjust their processes in the face of uncertainty, strengthening organizational strategy and promoting sustainable advantages.

**Table 1.** *Operational Flexibility (Fope)*

| item | Description |
|---|---|
| **FO1** | The ability of computer systems to process information, distribute it and present it in the right way and at the right time to the person who requests it, is extremely high |
| **FO2** | The number of different tasks that the computer system allows to be performed on the computers or terminals available to the staff is extremely high |
| **FO3** | The computer system allows information to be exchanged between the system's computers and terminals efficiently |

Source: Adapted from Gutiérrez et al. (2010); Sethi and Sethi (1990); Tamayo et al. (2014); Chandra and Tombak (1992); Koste and Malhotra (1999); Larson et al. (2009); Mandelbaum and Brill (1989).

Organizational flexibility is essential for business, as it allows it to adapt to changes, foster innovation, and develop sustainable competitive advantages (Bahrami, 1992). A management approach that triggers strategic flexibility is the concept of Dynamic Capabilities, for example the codification, transfer and absorption of knowledge contribute to making manufacturing systems more flexible at different levels (Cordes & Hülsmann, 2013). Volberda (1996) points out that the "flexibility mix" integrates operational, structural, and strategic flexibility, allowing firms to adjust their resource base in the face of external changes. This strategic flexibility is crucial for growth and profitability in competitive environments (Arafa & ElMaraghy, 2012).

**Table 2.** *Strategic Flexibility Fest*

| item | Description |
|---|---|
| **FE1** | In our company, we reformulate strategies quickly when market conditions or the strength of competition require it. |
| **FE2** | When environmental conditions change, we have a variety of strategic measures to cope with that change |
| **FE3** | We use machinery and/or technology to produce goods or the provision of services that allow a large number of operations to be carried out quickly and without incurring high costs of changing tasks |
| **FE4** | The number of modifications to products or services that are introduced each year is high |
| **FE5** | In our company we have the capacity to deliver new products or services (expand the variety) quickly and easily (at relatively low costs) with the consequent changes in production tasks |

Source: Adapted from Volberda (1999) and Gutiérrez et al. (2010).

Shimizu and Hitt (2004) argue that dynamic capabilities represent an essential mechanism for firms to develop the strategic flexibility needed in highly changing environments. They highlight that achieving and maintaining this flexibility remains one of the most complex challenges for managers and organizations. Along the same lines, several researchers agree that operational flexibility is based on the ability to significantly modify and renew fundamental routines and tasks within organizational processes. This reinforces the central role of dynamic capabilities in business adaptation and evolution (Barreto, 2010; Pavlou & El Sawy, 2011; Teece, 2007; Zollo & Winter, 2002).

According to Arafa & Elmaraghy (2011) The conditions that regulate the market determine the configuration of the manufacturing function in any business environment. In this context, it is essential for companies to identify the key variables and their priority levels, allowing them to adjust their strategies according to their capabilities. By achieving this alignment with market demands, organizations can improve their efficiency and, over time, optimize their profitability.

Flexibility in manufacturing systems is a key aspect for several reasons. First, the volatility and uncertainty of the business environment have led many manufacturing companies to reconfigure their production processes, even if this only means reducing the scale of their operations. Second, advances in flexible manufacturing technologies have allowed adaptability to become a fundamental feature of production equipment. Finally, the evolution in production management has broadened its focus beyond cost reduction and increased productivity, incorporating flexibility as a strategic objective within production systems (Arafa & Elmaraghy, 2011).

Machinery flexibility is the ability of equipment to adapt to various functions or produce different products without significant modifications, which allows companies to respond quickly to changes in demand or the market, maximizing efficiency and reducing costs (Volberda, 1999; Gutiérrez et al., 2010). Teece (2016) highlights that this technological adaptability is key to taking advantage of opportunities and maintaining competitiveness in dynamic environments.

**Table 3.** *Flexibility of Fmaq Machinery*

| item | Description |
|---|---|
| **FM1** | Typical machines may use multiple different attachments or tools |
| **FM2** | Machines can perform operations, which are not very similar to each other |
| **FM3** | The machines can perform a wide variety of operations |
| **FM4** | Machines produce equal quality for all operations |
| **FM5** | The machines are equally reliable for all operations |

Source: Adapted from Volberda (1999) and Gutiérrez et al. (2010).

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**Table 4.** *Fmmat Material Handling Flexibility*

| Item | Description |
|---|---|
| **MM1** | The material handling system can transport a wide variety of materials of different size, volume, and weight. |
| **MM2** | The material handling system can transport a wide variety of materials |
| **MM3** | Changing the trajectory in material handling is either inexpensive or low-cost. |
| **MM4** | Changing the trajectory in material handling is fast |
| **MM5** | Choosing the material handling route does not affect the material transfer time |
| **MM6** | Choosing the material handling route does not affect the efficiency of the material transfer |
| **MM7** | Choosing the material handling route does not affect the cost of transferring the material (in $) |

Source: Adapted from Koste and Malhotra (1999); Koste et al. (2004); Larso (2003) and Tamayo et al. (2014).

Process flexibility (Fpro) is the ability of an organization to adjust its production processes to changes in demand or the operating environment, while maintaining efficiency and quality. This flexibility allows operations to be reconfigured, new technologies to be implemented and adapted to market conditions, which is essential in dynamic and competitive contexts (Petroni & Bevilacqua, 2002; Tamayo et al., 2014).

**Table 5**. *Flexibility of the Fpro Process*

| Item | Description |
|---|---|
| **FP1** | The processing requirements for products produced in the plant vary widely from product to product. |
| **FP2** | The materials required for the products produced in the plant vary greatly from product to product. |
| **FP3** | The "product mix" produced by the plant can be easily changed. |
| **FP4** | The manufacturing system can quickly switch to a different "product mix" |
| **FP5** | Productivity levels are not affected by changes in the "product mix". |
| **FP6** | System performance is not affected by changes in the product mix. |

Source: Adapted from Petroni and Bevilacqua (2002) and Tamayo et al. (2014).

Modification flexibility (Fmod) is an organization's ability to adjust existing products or services in response to customer needs or market variations, without significant changes to operational processes. This type of flexibility is key to maintaining competitiveness and adaptability in dynamic environments, allowing adjustments in product design, functionality, and characteristics (Koste et al., 2004; Tamayo et al., 2014; Teece, 2016).

**Table 6.** *Fmod Modification Flexibility*

| Item | Description |
|---|---|
| **FMO1** | The characteristics of existing products are frequently modified |
| **FMO2** | A large number of modified products are produced every year |
| **FMO3** | Existing product lines are frequently modified |
| **FMO4** | Product modifications are made quickly |

Source: Adapted from Koste et al. (2004) and Tamayo et al. (2014).

Workforce flexibility (Fwork) is the ability of employees to perform various tasks and roles, allowing organizations to adapt to changes in demand or operational processes. This flexibility, based on training and versatility, is key to maintaining productivity and continuity in competitive environments (Koste et al., 2004).

**Table 7.** *Fwork Workforce Flexibility*

| Item | Description |
|---|---|
| FW1 | Workers can perform many tasks |
| FW2 | Workers can perform various types of tasks (variety of tasks) |
| FW3 | Short lag times occur when workers move between different tasks |
| FW4 | A small cost (in terms of lost productivity) is incurred when workers move between different tasks |
| FW5 | Workers are equally reliable for all tasks |

Source: Adapted from Koste et al. (2004).

### *Absorption Capacity*

Zahra & Gerorge (2002) they affirm that absorptive capacity is "a dynamic capacity that influences the company's ability to create and deploy the knowledge necessary to build other organizational capabilities"; Zahra and George (2002) highlight that the capacity to absorb knowledge allows companies to generate and take advantage of new ideas, providing them with the necessary flexibility to adapt and compete in constantly changing markets. Cohen and Levinthal (1990) define this ability as the ability to identify the value of external knowledge, integrate it and use it for commercial purposes.

From a broader perspective, absorptive capacity is also conceived as a combination of organizational routines and strategic processes, through which companies acquire, incorporate, transform, and apply knowledge with the purpose of generating value and obtaining a competitive advantage (Zahra & George, 2006).

According to the proposal of Zahra and George (2002), this capacity is structured in four dimensions: acquisition, assimilation, transformation and exploitation of knowledge. These, in turn, are grouped into two categories: potential absorptive capacity (AbsPot), which represents the ability to capture and process information, and realized absorptive capacity (AbsRea), which focuses on its effective application within the organization.

**Table 8.** *Knowledge Absorption (ABS)*

| | AbsPot Potential Absorption Capacity |
|---|---|
| Item | Acquisition |
| AD1 | A level at which management shows an inclination towards reactivity rather than proactivity, by monitoring, recognizing and taking advantage of the possibilities offered by the environment (management orientation towards the acquisition of external knowledge). |
| AD2 | The frequency and relevance of collaborating with research and development institutions as a partner or sponsor, with the aim of generating knowledge and fostering innovation (cooperation in R+D) |
| AD3 | The company's constant ability to obtain relevant and up-to-date information and knowledge about present and future competitors (competitor knowledge). |
| AD4 | The ability of the organization to establish programs focused on the internal development of technological competencies, both in R+D, and in its suppliers and customers (effectiveness in the acquisition of technological knowledge). |
| Item | Assimilation |
| AS1 | The company gains advantages by incorporating the fundamental concepts, essential business knowledge and technologies successfully used by other companies in the same sector, through industrial benchmarking. |
| AS2 | A company's capacity for technological assimilation is defined as its ability to effectively integrate and accept the latest technologies and innovations that are beneficial. |
| AS3 | The ability of the company to take advantage of the knowledge, experience and competence of its employees in the process of assimilating new knowledge. |
| AS4 | The level of participation of the company's employees in scientific and academic conferences, as well as the visit of researchers from other companies to the company, is indicative of the degree of interaction and collaboration in research activities. |
| AS5 | Level of employee participation in training courses (formal and informal assimilation). |
| AS6 | The organization's ability to implement knowledge management programs that ensure employees can thoroughly understand technological knowledge from other companies. |
| | AbsRea Realized Absorption Capacity |
| Item | Transformation |
| TR1 | The ability of the organization to take advantage of computer technology in order to improve the circulation of information, promote the exchange of knowledge and make it easy for the organization's workers to interact easily. |
| TR2 | The level of restriction that the company imposes on workers to voluntarily share scientific and technological knowledge they have acquired. |
| TR3 | The company's ability to adjust the technology developed by third parties to its specific requirements. |
| TR4 | The organization's understanding of its capabilities to innovate, especially in relation to vital technological knowledge, and its ability to discard useless internal knowledge, thus encouraging the search for innovative alternatives. |
| TR5 | The organization's ability to manage and unify all stages of the R&D process, as well as its interactions with engineering, production, and marketing functions. |

| Item | Exploitation |
|---|---|
| EX1 | Level of implementation of the knowledge and experience obtained in the field of technology and organization in the firm's strategy, which makes it easier to sustain itself as a leader in the sector. |
| EX2 | The ability of the company to take advantage of new knowledge in the work environment in order to adapt quickly to changes in the context. |
| EX3 | The company's ability to use technological know-how in the creation of patents for products and processes. |
| EX4 | The company's ability to adapt to market or competitive demands rather than seeking innovation as a means to gain a competitive advantage by expanding its portfolio of new products, capabilities, and technological ideas. |

Source: Adapted from Zahra & George (2002).

Several authors describe the capacity for knowledge absorption as a process of "iterative exchange" that generates economic benefits derived from the relationships between strategic partners (Dyer & Singh, 1998); Such income can arise from the effective management of relationships and processes, the result of collaboration between companies, as well as within the organizations themselves.

This perspective highlights the connection between knowledge absorption capacity and organizational performance, suggesting that interaction between firms can translate into significant improvements in performance, evidenced in tangible benefits.

***Business Performance***

Business performance appraisal has generated growing interest in academia, driving advances in the development of performance management systems that seek to balance the traditional profitability-based perspective with more comprehensive approaches (Tangen, 2004). While some studies consider the fulfillment of objectives and the use of operational efficiency routines as key indicators of organizational performance (Protogerou et al., 2012), other authors analyze the relationship between cost and effectiveness, evaluating the efficiency of these routines (Pavlou & El Sawy, 2006).

From this approach, organizational flexibility acts as an intermediate factor in the relationship between knowledge absorption and business performance, which can be measured by quantitative and qualitative indicators. In the quantitative arena, performance is analyzed through financial metrics such as return on assets (ROA), return on sales (ROS), and return on equity (ROE). On the qualitative side, the company's participation in its key markets, the level of employee satisfaction and the organizational capacity to acquire, transmit and apply new knowledge are considered, which strengthens its competitiveness and long-term sustainability.

**Table 9.** *Business Performance*

| Item | Description |
|---|---|
| D1 | The profitability of the company is measured as the profit on assets. |
| D2 | The profitability of the company measured as the profit on its own resources. |
| D3 | The profitability of the company measured as profit over sales. |
| D4 | The company's market share in its main products and markets. |
| D5 | The degree of employee satisfaction (salary satisfaction). |
| D6 | The ability to acquire, transmit and use the new knowledge learned. |

Source: Adapted from García-Morales et al. (2007), Homburg et al. (1999) and Dess and Robinson (1984).

Research in the field of manufacturing strategy argues that while strategy selection remains essential, its approach has evolved significantly. Rather than focusing on static trade-offs between performance dimensions, such as the balance between cost and flexibility, its primary purpose is now to facilitate dynamic adjustments by identifying, developing, and leveraging superior capabilities (Hayes & Pisano, 1996). According to these authors, the strategy based on new manufacturing capabilities not only offers a renewed perspective on traditional challenges but also reinforces the strategic role of production within the company, proposing new ways to contribute to competitive advantage.

Organizational performance can be seen as an indirect result of the development of dynamic capabilities (Drnevich & Kriauciunas, 2011; Shaker Zahra et al., 2006). In this sense, Barreto (2010) highlights that the most evident and consolidated impact of these capabilities is the improvement in flexibility to transform and renew organizational processes, which allows companies to adapt more effectively to changing environments and respond to new competitive opportunities.

Innovation in processes is aimed at optimizing production with the purpose of enhancing organizational performance (Tsai, 2001). This approach seeks to reduce costs, improve operational efficiency, and increase the adaptability of processes, achieving a reduction in delivery times and manufacturing costs, in addition to favoring flexibility in operations (Damanpour, Walker, & Avellaneda, 2009). In contrast, product innovation focuses on tangible results, such as the development of new differentiated goods or services that can be marketed by the organization (Cooper, 1998; Danneels et al., 1999; Prajogo, 2016; Utterback, 1994).

***Relationship Operational Flexibility, Absorptive Capacity and Performance - Hypothesis***

Absorptive capacity is considered a strategic asset that influences the creation of organizational competencies and provides multiple sources of competitive advantage, thus improving business performance (Zahra & George, 2002; Barney, 1991). Its impact is reflected in the improvement of operational flexibility, allowing companies to adapt quickly to changes in the competitive environment through the efficient management of information, technologies and resources such as machines, labor and materials (Cohen & Levinthal, 1989). In addition, firms with higher absorptive capacity respond proactively to technological innovations and environmental uncertainty, while those with limited levels face constraints in managing flexibility in manufacturing (Wesley M. Cohen & Levinthal, 1994; Narasimhan et al., 2006).

Empirical evidence supports that strategic flexibility, as part of dynamic capabilities, improves business performance by renewing organizational routines in the face of uncertainty (Teece, 2007; Grewal & Tansuhaj, 2001; Patel et al., 2012).

Absorption capacity strengthens the relationship between manufacturing flexibility and business performance, and even environmental uncertainty. This capability allows companies to adapt to demand, competitiveness, and technological changes by quickly analyzing their environment and implementing necessary operational adjustments. In addition, flexibility acts as a mediator in the relationship between absorptive capacity and performance, highlighting its importance to respond effectively to uncertainty by improving organizational results (Patel, Terjesen, & Li, 2012). From the above theoretical arguments, supported by empirical research, the following hypotheses are formulated below:

*H1: The absorption of knowledge has a positive impact on performance.*
*H2: Absorption has a positive impact on flexibility and flexibility has a positive impact on business performance (there is an indirect relationship).*
*H3: The effect of knowledge absorption on business performance is positively mediated by flexibility.*

## Methodology

The research, with a quantitative, non-experimental and cross-sectional approach, aimed to determine the mediating effect of flexibility in the relationship between absorptive capacity and performance in the dairy manufacturing sector of Colombia. Structural equations were used using PLS-SEM, using SmartPLS4, with an effective sample of 75 responses from companies with at least 5 years of managerial experience. The instruments were designed by adapting recognized scales, evaluating operational and strategic flexibility (Volberda, 1999; Gutiérrez et al., 2010), absorptive capacity (Zahra & George, 2002) and business performance (García-Morales et al., 2007, 2008).

## Results

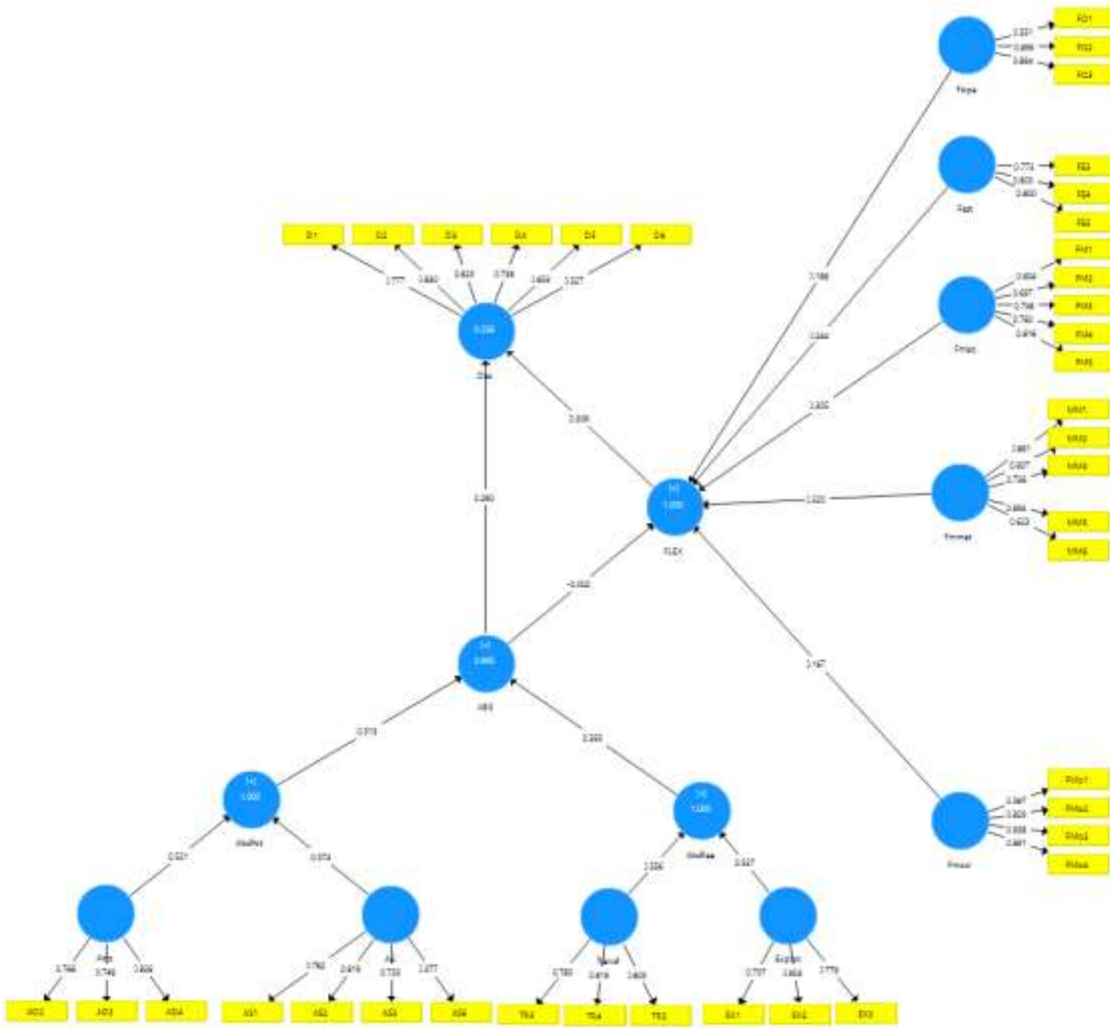
### Mediating effect of flexibility in the relationship between knowledge absorption and business performance

By running the PLSc algorithm, the values of the correlations between the observed variables (VO) and the latent variables (VL) were obtained, together with the coefficient of determination $R^2$ and the coefficients of the regression paths between the VLs. Some variables (FE1, FE2, MM4, MM7, FP1... 5, FW1... 4) presented low factor loads, affecting the quality of the model. A construct was developed to analyze the relationship between knowledge absorption and business performance, considering in the midst of the relationship, the positive mediation of operational flexibility. VL scores were calculated using a two-step approach (Henseler & Chin, 2010).

In the first stage, the repeated-indicator method was applied to estimate lower-order constructs (LOCs), which were subsequently used as manifest variables in the higher-order measurement (HOC) model (Hair et al., 2014). The quality of the data was verified using the PLS algorithm and the Bootstrap procedure, adjusting the loads of the measured variables during the first executions.

After running the PLSc algorithm, the factor loads were analyzed to evaluate the reliability of the indicators. Variables with loads lower than 0.4 and those between 0.4 and 0.7 were eliminated if they impaired the fit of the model, being retained only when their elimination did not improve the composite reliability or the mean variance extracted (Hair et al., 2022).

Figure 1. *MEE ABS _FLEX_DES obtaining the scores of the latent variables*



Note: Figure 1 shows that all factor loads exceed the value of 0.4. The main purpose of station 1 was to calculate the VL scores, which will be used in station 2 (Hair et al., 2014).
Source: own elaboration

The adjustment of the model was carried out in two stages: first, the measurement model was evaluated and, after making the necessary adjustments, the structural model was analyzed (Götz et al., 2009; Henseler et al., 2009).

**Convergent Validity**

To ensure Convergent (VC) validity, with the Fornell and Larcker (1981) criterion, it was verified that the variance extracted means AVE, complying with the criterion of (AVE > 0.50), with the exception of performance (DES) and (Thus) which present values of 0.49 and 0.488 respectively, which are acceptable for their approximation to the threshold of 0.50 (Fornell and Larcker, 1981; Henseler et al., 2009).

**Cronbach's Alpha Internal Consistency and Composite Reliability**

In the second stage, internal consistency indicators were evaluated, such as Cronbach's alpha (AC), composite reliability (CC) and Dillon-Goldstein's ρ-rho. According to Hair et al. (2014), a CA between 0.60 and 0.70 is acceptable for exploratory research, while values between 0.70 and 0.90 in CC are considered satisfactory. The results, presented in Table 10, show that the values of CA and WC are adequate, since they exceed 0.70 in most cases. However, some constructs, such as Acquisition (AC: 0.678), Assimilation (AC: 0.621), and Flexibility of Operations (AC: 0.693), although slightly below 0.70, are still considered acceptable within the established criteria. These were maintained, since their elimination did not contribute substantially to an improvement in the indicators of reliability and construct validity, nor in the average variance extracted.

**Table 10.** *Construct reliability and validity (all external loads included)*

| | **Cronbach's alpha (AC)** | **rho_A** | **Composite reliability (CC)** | **Mean extracted variance (AVE)** |
|---|---|---|---|---|
| Adq | 0,678 | 0,684 | 0,823 | 0,608 |
| Asi | 0,621 | 0,676 | 0,783 | 0,490 |
| DES | 0,795 | 0,838 | 0,848 | 0,488 |
| Explode | 0,713 | 0,739 | 0,841 | 0,641 |
| Fest | 0,704 | 0,708 | 0,835 | 0,628 |
| Fmaq | 0,773 | 0,782 | 0,847 | 0,528 |
| Fmmat | 0,800 | 0,809 | 0,863 | 0,561 |
| Fmod | 0,822 | 0,850 | 0,888 | 0,671 |
| Fope | 0,693 | 0,755 | 0,835 | 0,637 |
| Transf | 0,724 | 0,727 | 0,844 | 0,644 |

Note. Most of the AC, **rho_A**, CC and AVE indicators exceeded the corresponding threshold. Although some are slightly below, they are considered acceptable within the established criteria. Source: own elaboration

## Discriminant Validity

The third stage was the evaluation of the Discriminant Validity (VD) of the MEE, which is understood as an indicator that the constructs or VL are independent of each other (Hair et al., 2014). It was possible to verify by the criteria of Fornell and Larcker (1981) that the factor loads of the OV in the original VLs constructs are always higher than the loads of other constructs (Table 11).

**Table 11**. *Values of the correlations between VL and square roots of the values of the AVE on the main diagonal (highlighted).*

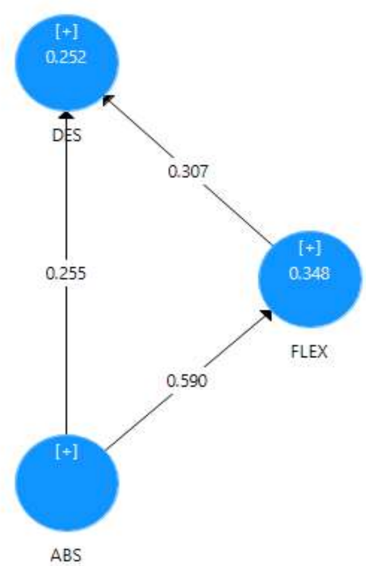
| | **Adq** | **Like this** | **DES** | **Explode** | **Fest** | **Fmaq** | **Fmmat** | **Fmod** | **Fope** | **Transf** |
|---|---|---|---|---|---|---|---|---|---|---|
| Adq | 0,780 | | | | | | | | | |
| Like this | 0,668 | 0,700 | | | | | | | | |
| DES | 0,175 | 0,339 | 0,699 | | | | | | | |
| Explode | 0,434 | 0,507 | 0,473 | 0,800 | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fest | 0,360 | 0,442 | 0,559 | 0,685 | 0,792 | | | | | |
| Fmaq | 0,388 | 0,402 | 0,340 | 0,430 | 0,783 | 0,727 | | | | |
| Fmmat | 0,429 | 0,492 | 0,319 | 0,602 | 0,764 | 0,824 | 0,749 | | | |
| Fmod | 0,076 | -0,012 | 0,161 | -0,019 | 0,361 | 0,378 | 0,365 | 0,819 | | |
| Fope | 0,275 | 0,442 | 0,478 | 0,515 | 0,647 | 0,421 | 0,545 | 0,104 | 0,798 | |
| Transf | 0,522 | 0,544 | 0,390 | 0,672 | 0,529 | 0,340 | 0,473 | 0,014 | 0,361 | 0,803 |

Note. The table shows that the square roots of the variances extracted mean AVEs are greater than the values of the correlations between the VLs, guaranteeing discriminant validity by the criterion of Fornell and Larcker (1981).
Source: own elaboration

After confirming the discriminant validity, the adjustment of the measurement model was completed and the structural model was analyzed. In this second phase, the new database was imported, and an updated model was designed that included only latent variables (VLs). Figure 2 presents the representation of the structural model, where the explained variances and the route indicators obtained in the analysis can be observed.

**Figure 2.** *MEE obtaining the scores of the latent variables ABS_FLEX_DES*




Note. The variances explained can be seen: R2 = 25.2 % for DES performance and R2 = 34.8 % and for FLEX flexibility. In addition, the route indicators are observed.
Source: own elaboration

The total variance explained was R2 = 25.2 % for DES and R2 = 34.8 % for FLEX. The main routes from ABS to DES were significant

**Table 12.** *Total Effects*

| | Original Sample (O) | Sample mean (M) | Standard Deviation (STDEV) | Statistics t (\|O/STDEV\|) | P Values |
|---|---|---|---|---|---|
| **ABS -> DES** | 0,436 | 0,427 | 0,107 | 4,087 | **0,000 ****** |
| **ABS-> FLEX** | 0,590 | 0,580 | 0,094 | 6,292 | **0,000 ****** |
| **FLEX -> DES** | 0,307 | 0,317 | 0,128 | 2,397 | **0,017 **** |

Note. Table 13 shows that the direct effect of ABS to DES was significant.
Criteria: ABS -> DES: **** p < 0.001, *** p < 0.01, ** p < 0.05
Source: own elaboration

In addition, when checking the significance of the individual indirect effect Bootstrapping, it can also be seen in table 13 that it is significant.

**Table 13**. *Individual indirect effects*

| | **Original Sample (O)** | **Sample mean (M)** | **Standard Deviation (STDEV)** | **Statistics t (\|O/STDEV\|)** | **P Values** |
|---|---|---|---|---|---|
| **ABS -> FLEX -> DES** | 0,181 | 0,179 | 0,073 | 2,472 | **0,014 **** |

Note. Statistical significance: **** p < 0.001, *** p < 0.01, ** p < 0.05
Source: own elaboration

According to the criteria of Zhao et al. (2010), this indicates that there is a significant positive effect or direct relationship between knowledge absorption and performance (ABS →DES) (H1); there is also a significant indirect relationship (H2) between knowledge absorption, flexibility and performance (ABS→FLEX→DES). Both relationships go in the same direction, and the product of the three is positive ($axbxc \rightarrow 0.255x0.307x0.590$), therefore, it can be said that there is "complementary mediation". In conclusion, flexibility (FLEX) positively mediates the relationship between knowledge absorption (ABS) and business performance (DES), confirming the hypothesis (H3). Table 14 summarizes these results.

**Table 14**. *Results ABS_FLEX_DES*

| **Hypothesis** | **Std. indirect** | **Std. direct** | **Conclusion** |
|---|---|---|---|
| **ABS -> FLEX -> DES** | 0,17 | 0,255 | Complementary mediation |
| P < 0.001*** P < 0.1* | | | |

Source: own elaboration

## Discussion

The present study confirms the mediating role of operational flexibility in the relationship between knowledge absorption capacity and business performance in the dairy manufacturing sector in Colombia. The results obtained through the analysis of structural equations (PLS-SEM) also show that knowledge absorption positively influences flexibility (H2) and business performance (H1), while flexibility acts as a significant mediator between both variables (H3), which confirms a complementary relationship.

The direct coefficient between knowledge absorption and flexibility ($\beta = 0.590$, $p < 0.001$) reaffirms that companies with a greater capacity to acquire, assimilate, and exploit external knowledge achieve greater adaptability in their operations, coinciding with previous studies (Zahra & George, 2002; Cohen & Levinthal, 1990). This adaptability allows manufacturing companies to modify their processes and products efficiently in the face of changes in demand and the competitive environment.

Likewise, the absorption of knowledge has a significant and positive impact on business performance ($\beta = 0.436$, $p < 0.001$). This finding is consistent with research that highlights knowledge absorption as a key determinant for innovation and improved organizational performance (Tsai, 2001; Patel et al., 2012). Companies with a high absorption capacity can integrate external knowledge effectively, optimizing their productive structure and strengthening their competitiveness.

The results confirm that flexibility operates as a partial mediator in the relationship between knowledge absorption and business performance ($\beta = 0.181$, $p < 0.05$). This complementary mediation suggests that flexibility not only enhances the impact of knowledge absorption but is also an essential mechanism for the effective implementation of knowledge in daily operation, which is in line with what is postulated by (Teece, 2007). In this sense, companies with flexible structures can respond more quickly to changes in the environment and improve their financial and operational results.

**Implications and Contributions**

These findings have relevant implications for organizational management, as they reinforce the importance of operational flexibility as a strategic factor to maximize the impact of knowledge absorption on business performance. In the context of dynamic markets and high uncertainty, manufacturing companies must invest in technologies and strategies that improve their absorptive capacity, as well as in flexible production mechanisms that facilitate continuous adaptation.

From the theoretical point of view, the study provides empirical evidence on the interaction between flexibility, knowledge absorption and business performance, contributing to the development of explanatory models in the field of operations management and organizational strategy.

**Conclusions**

Hypothesis H3 is confirmed: there is a positive mediation of flexibility adjustment in the relationship between knowledge absorption and business performance; once this mediation has been verified, it can be stated that when flexibility (operational flexibility, strategic flexibility, machinery flexibility, material handling flexibility, etc.) is increased in dairy companies. process flexibility, modification flexibility and labor flexibility), the adjustment of knowledge absorption capacities (assimilation, acquisition, transformation and exploitation) is generated in response, and consequently improves business performance.

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