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ASSESSMENT OF ACTORS THAT INFLUENCE STUDENT ABSENTEEISM IN AN EDUCATIONAL PLATFORM THAT USES MACHINE LEARNING

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Abstract
The current document analyzes how the dynamics of student absenteeism occur, through the strategic approach provided by the MACTOR method. The main objective is to identify the power, influence, and dependency relationships between the actors and their degree of commitment to institutional objectives. In this way, it was a mixed-type research, which used the techniques of valued position matrices and graphs of convergence and divergence to assess possible conflicts, alignments, and capacities for action. The results show that the most influential actors are the administrative ones, with a high commitment to strategic objectives, while students and parents have less capacity for action and are shown to be very dependent. Critical objectives were identified such as the early detection of absenteeism and the strengthening of the family environment. The conclusions highlight the importance of collaboration between actors, the strategic allocation of resources, and the implementation of technological systems to monitor and mitigate absenteeism. This work offers practical tools that help decision-making in the educational field and offers a methodological basis that can be replicated by similar educational centers.

Keywords: strategic analysis, key actors, influence and dependency, higher education, school absenteeism.

Introduction
School absenteeism is a serious and common problem in the educational system, which is not only negatively correlated with students' academic performance, but also with the quality and efficiency of educational programs (Klein et al., 2022). Throughout the world, educational systems have implemented various types of strategies ranging from direct intervention to the implementation of new technologies to control and predict the nature of students' absences (Newman-Ford et al., 2008). In this regard, the use of educational platforms based on the use of Machine Learning allows the analysis of attendance data and

the prediction of absences in the future, becoming a key resource for educational institutions and teachers that combat school absenteeism (Bowen et al., 2022).

However, for this to be possible, the interrelationship between the various actors involved in the educational process must be known. The scientific literature maintains that school absenteeism is influenced by factors of various kinds involving students, family, teachers, and other actors in the educational system (Keppens & Spruyt, 2017); in addition, other more recent research works using educational technologies created from artificial intelligence and Machine Learning discuss how they can be implemented to identify attendance patterns and predictive factors of low attendance with very high levels of prediction (Alam & Mohanty, 2022).

The MACTOR methodology has been used in previous research to analyze the influence and dependencies of actors in the dynamics of complex systems. The methodology has been shown to be a useful tool for calculating interaction in the context of the analysis of the interaction of actors in educational processes (Godet & Durance, 2011). In the context of the phenomenon of absenteeism in smart educational platforms, the combination of the application of MACTOR and Machine Learning has been very little explored, constituting an opportunity to specify the phenomenon and for educational interventions.

This study is pertinent first of all because it presents a comprehensive view of school absenteeism, a problem that affects both the academic and emotional development of schoolchildren and that directly influences future school dropout rates. By applying a mixed methodology that combines the MACTOR model with the Machine Learning methodology, a multidimensional view is obtained through which predictive patterns of student absenteeism can be identified, as well as relationships of influence between the actors. The results of the study can be used to improve educational interventions and policies, as well as to apply smart platforms in the detection of absenteeism, and the suggestion in the implementation of strategies for its prevention, based on the analysis of those.

The main objective of this study was to analyze, in the context of an educational platform using the Machine Learning methodology, the factors and actors that directly influence student absenteeism, as it was assumed as a hypothesis to be able to predict school absenteeism in educational platforms in an effective way through Machine Learning models, as long as the interactions and dependencies of key actors were taken into account, as well as the identification of patterns of influence and conflicts of interest between actors in the context of the MACTOR model, considered an advantage for the generation of effective intervention strategies.

This paper focuses on analyzing data from a specific teaching platform, which, with the help of Machine Learning, manages data to predict attendance patterns. This analysis is aimed solely at the internal actors of the educational system (students, teachers, and administrators of the platform) without leaving aside factors external to the educational system (family and socioeconomic, among others, not contemplated in the platform). Finally, even though Machine Learning models have a certain predictive capacity based on the patterns established by historical data, the predictive capacity is limited by the predictability and quality of the data obtained, as well as by the difference in the behavior of the actors themselves. Despite these limitations, the findings of this work could be extended to other educational platforms and provide the necessary bases for future research in the field of preventing school absenteeism.

Methodology

This research was classified as descriptive and exploratory, which allows, in addition to identifying and characterizing the actors involved in the phenomenon of student absenteeism, to understand their interactions, influences, and dependencies. The above is based on what Thomas (2021) stated about descriptive research and what Swedberg (2020) stated about exploratory research. In this type of research, situations, events, or phenomena are described to offer a clear and complete overview of the topic, which can serve as a basis for other subsequent research (Lim, 2024).

The approach is mixed as it allows for combining quantitative and qualitative data to obtain a more complete view of the problem (Baray, 2006). Quantitative data were collected by analyzing records from the educational platform and the influence and dependency matrices that make up the MACTOR technique (Arcade et al., 2014). In parallel, qualitative data were obtained from interviews and surveys of the identified actors, providing a detailed context of their motivations, perceptions, and objectives.

The methodological design is non-experimental and transversal. By not intervening directly in the behavior of the actors and collecting data at a single point in time (Hernández et al., 2014), this design allows for observing and analyzing the relationships of influence and dependency in an objective and static way. The MACTOR analysis is used within this design as a structured framework to map and assess these dynamics at a given time, without modifying the conditions of the educational environment.

Procedure

The diagram in Figure 1 below shows the step-by-step procedure followed to develop this research. As can be seen, it consists of five steps or stages: A) Identification of key actors, B) Definition of objectives and motivations of the actors, C) Data collection, D) Application of the MACTOR analysis, and E) Analysis and reporting of results.

Figure 1. Proposed methodological scheme
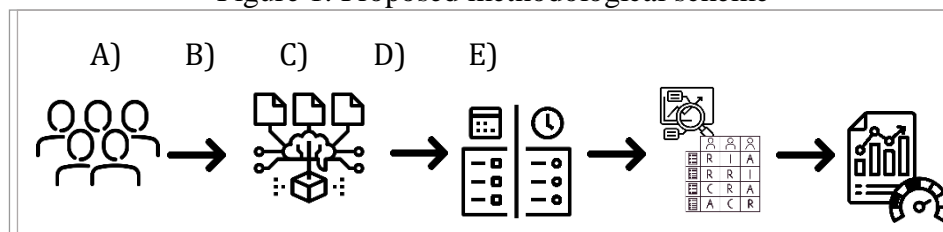
Source: Authors

A) Identification of key actors: It begins with the identification of the main actors that influence student absenteeism on the educational platform.

B) Definition of objectives and motivations of the actors: At this stage, the objectives and motivations of each actor are defined. This stage is essential to understand how each one can influence absenteeism and how their objectives can align or conflict.

C) Data collection: This stage was developed through a mixed approach. On the one hand, quantitative data were obtained from historical records of the SmartSchool platform, which is part of a project of the University of Cartagena (Universidad de Cartagena) in conjunction with the Administrative Department of Science, Technology, and Innovation (Colciencias). These data include aspects such as attendance, academic performance, and interaction on the platform. On the other hand, qualitative data were collected through

surveys and structured interviews with key actors, to obtain a deep understanding of their perceptions and objectives.

D) Application of the MACTOR analysis: With the actors and objectives defined, the MACTOR technique was applied to analyze the power and influence relationships, through the Matrix of Direct Influence (assesses the direct influence of each actor on the others, quantifying power and dependency); the Matrix of Objectives (measures the convergence or divergence between objectives, identifying possible alliances and conflicts); Strategic Scenarios (Strategies that the actors could adopt are determined, based on the influence and dependency matrices).

E) Analysis and reporting of results: In this stage the results of the MACTOR analysis are described.

Results

The different actors involved in school absenteeism were identified, as well as their objectives within the context, through data analysis from the SmartSchool platform and consultation with experts. The actors were identified as follows, in Table 1, three columns are observed that represent the code or short name of the actor, the name of the actor, and the role that they play within the system studied.

Table 1. List of identified actors involved in school absenteeism

Code	Actor	Role
A1	Students	Attending classes and meeting academic requirements, they have an active role in managing their own learning.
A2	Teachers	Learning facilitators, monitor attendance, act as a bridge between students and other actors, such as parents and administrators, to coordinate efforts and address the causes of absenteeism.
A3	Administrators	Educational policy managers, resource coordinators and support programs for both students and teachers in reducing absenteeism and supervising regulatory compliance.
A4	Parents	Support and motivate their children to attend school regularly, identify and address personal, emotional or health problems that may lead to absenteeism.
A5	Student Well-being	Provides physical, emotional, social, and economic support to students to ensure their overall well-being, which is crucial to reducing absenteeism, as well as developing and implementing strategies to identify and support students at risk of absenteeism.

Source: Authors

Likewise, the objectives of Table 2 were identified, where two columns are observed that refer to the code or short name of the objective, and the objective.

Table 2. Objectives of the identified actors involved in school absenteeism

Code	Objectives
O1	To increase the relevance and applicability of learning
O2	To encourage self-management of learning
O3	To maximize grade-earning efficiency
O4	To increase attendance and class participation
O5	To improve student motivation and commitment
O6	To detect and address the causes of absenteeism
O7	To implement policies to reduce absenteeism
O8	To monitor and analyze attendance data
O9	To develop support programs for students at risk of absenteeism
O10	To identify and resolve problems that affect attendance
O11	To create a family environment that values education
O12	To support their children in overcoming academic difficulties
O13	To develop absenteeism intervention and prevention programs
O14	To coordinate with teachers and parents to address absenteeism
O15	To raise awareness about the importance of school attendance

Source: Authors

Once the actors and objectives were identified, this information was introduced into the MACTOR software, developed by LIPSOR (Laboratoire d'Investigation en Prospective, Stratégie et Organisation), to subsequently fill out the influence and dependency matrices and the valued positions matrix. As a result of this process, which is part of phase D of the proposed scheme, the following results were obtained:

Influence and dependency of the identified actors

First, Figure 2 shows the location of each actor according to their influence and dependency, thus determining the positions that each one will occupy and the role they will have in the system. The map is composed of four quadrants: the quadrant of dominant actors (top left), the quadrant of link actors (top right), the quadrant of autonomous actors (bottom left), and the quadrant of dominated actors (bottom right).

As can be seen in Figure 2, A3 (Administrators) are in the position of dominant actors, since they have a strong capacity to influence other actors but they depend very little on them. This position indicates that they have control over the policies, resources, and programs that directly impact the management of absenteeism; on the other hand, both A2 (Teachers) and A5 (StudentWell-being) are in a position of interdependence, these actors have a strong capacity to influence the educational system and student absenteeism but they also depend a lot on other actors (particularly Administrators); while A1 (Students) and A4 (Parents) are actors with low influence and high dependency, that is, they are in a position in which they depend greatly on other actors to be able to fulfill their roles and objectives within the system.

The absence of actors in the autonomous category indicates that all actors are embedded in a network of influence and dependency relationships. There are no low-influence and low-dependency actors operating independently. This is common in educational contexts where

all actors, directly or indirectly, affect or are affected by the system. This analysis suggests that any strategy to reduce student absenteeism should focus primarily on strengthening collaboration between influential and dependent actors, and especially on the role of A3 as a key change agent for the entire system.

Figure 2. Plane of direct influences and dependencies between actors involved in school absenteeism
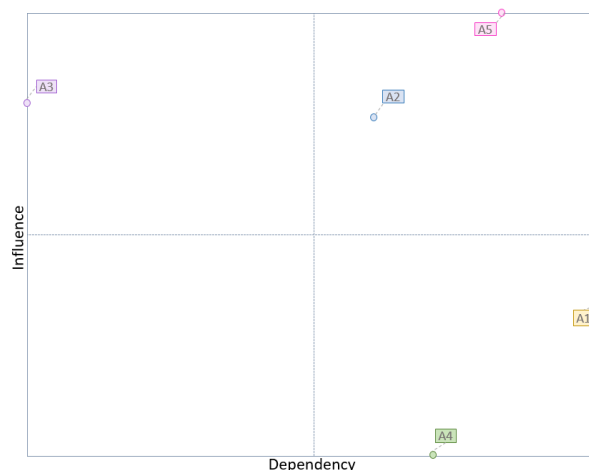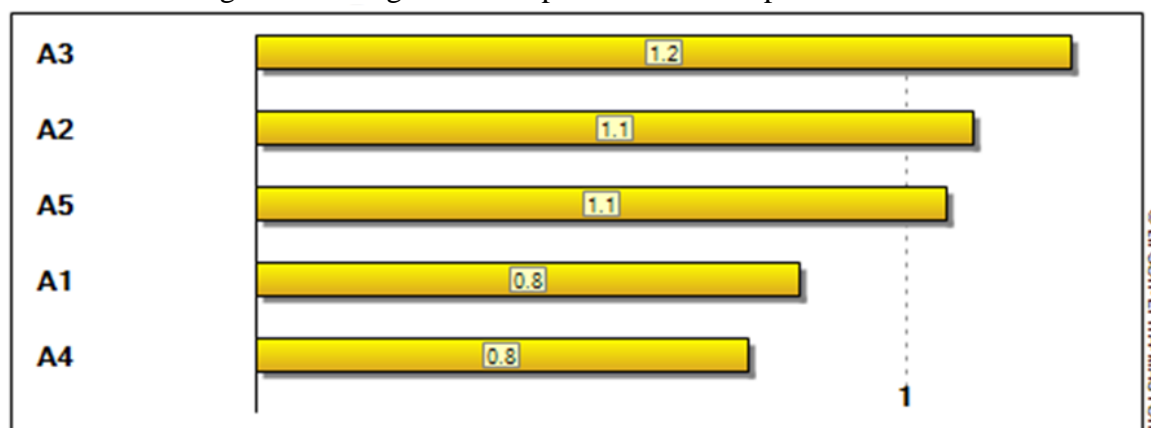

Source: Authors

Secondly, the Matrix of direct and indirect influences (MDII) was generated, from which the analysis of the power relations of each of the actors could be carried out, as evidenced by the MDII power relationships histogram in Figure 3. This analysis allows for understanding the power structure in the system studied and allows for identifying the strategic actors.

As can be seen in the figure, A3 has the greatest influence force in the system, with a value greater than 1. This confirms their dominant role since they are the actor with the greatest capacity to affect others and modify the educational system in relation to absenteeism; on the other hand, A2 and A5 present a moderately high influence value, just below A3, which confirms that both have a significant influence, but also a certain dependency on other actors; finally, with a value less than 1, actors A1 and A4 are the least influential in the system, which reaffirms their dependent role.

Figure 3. Histogram of the power relationships of the actors

Source: Authors

In relation to the positioning of the actors in relation to the objectives, the data illustrated in Figures 4 and 5 provide a detailed analysis of the degree of commitment and the capacity for action of the actors around the objectives established in the context of school absenteeism. These findings are essential to understand not only which objectives are priorities for the actors, but also which can be achieved, taking into account the proactivity and available resources of each one.

The histogram in Figure 4 reveals that actors are highly committed to achieving objectives O6, O5, O10, O13, and O15. These objectives highlight the fundamental actions that must be addressed to reduce school absenteeism. A medium commitment from actors can also be observed to carry out objectives O9, O14, O7, and O4, which suggests that these objectives are relevant, although they may not be completely aligned with the core functions of all actors, or that their achievement requires a greater amount of resources and a higher level of coordination. Finally, objectives with a low commitment O12, O1, O8, O2, O11, and O3 may be perceived as less relevant or urgent for certain actors in school absenteeism.

Figure 4. Histogram of actors' involvement on 2MAO objectives
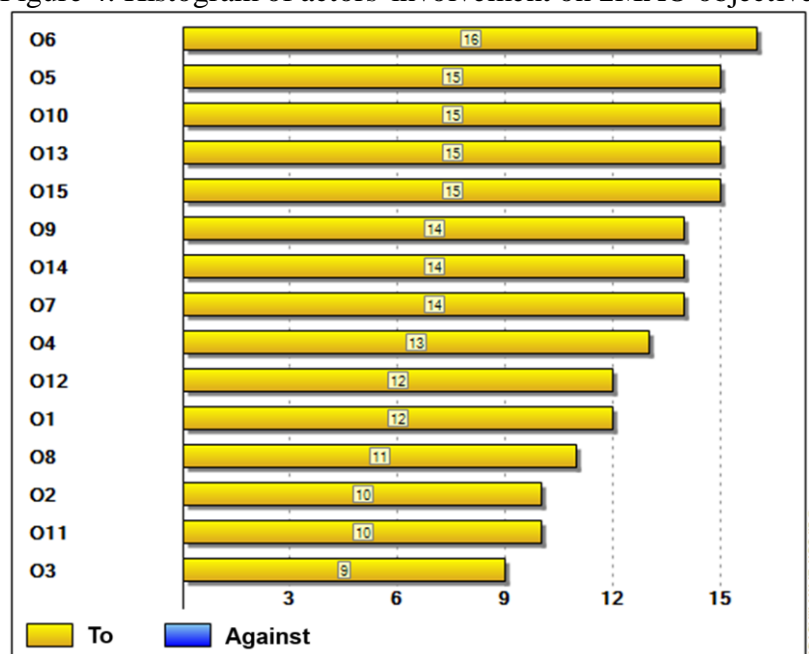
Source: Authors

The histogram in Figure 5 shows the actors' capacity to act with respect to the objectives. It can be observed how the same objectives that have a high degree of commitment (O6, O13, and O10) on the part of the actors also have a high capacity to act; the high commitment and capacity reflect an aligned approach between the actors and the resources available for these objectives, suggesting that they are a priority in the strategy to reduce absenteeism. A medium capacity to reach objectives O15, O7, O5, O14, and O9 is also observed; which suggests that, although there is commitment on the part of the actors, the implementation of these objectives depends on external factors such as inter-institutional coordination or additional resources. Finally, the objectives that have a low capacity to act are O4, O1, O8, O12, O2, O11, and O3, which indicates significant limitations in terms of resources,

influence, or commitment, so it would be necessary to strengthen collaboration between actors, allocate additional resources and design specific strategies that address these areas.

Figure 5. Histogram of actors' involvement on 3MAO objectives
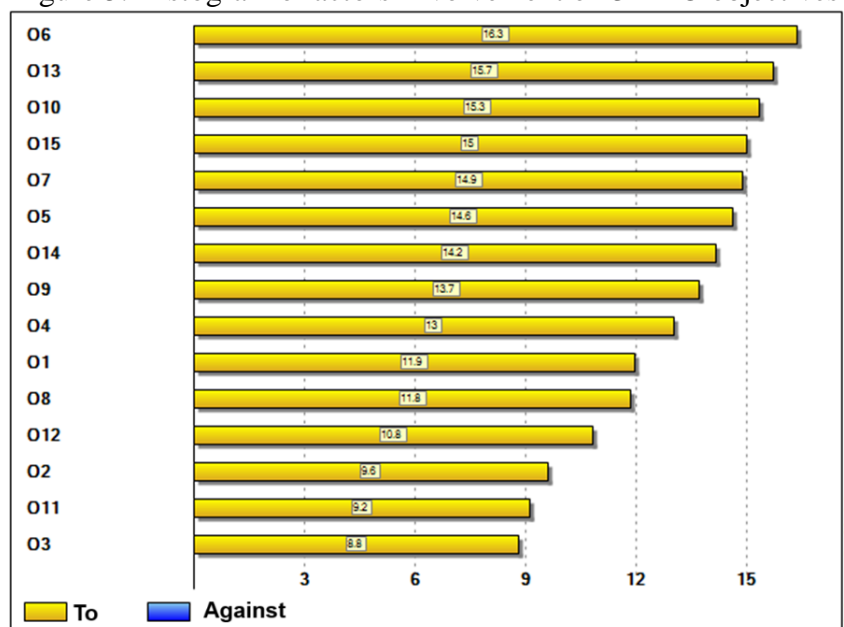
Source: Authors

Analysis of convergences and divergences between actors

In this section of the study, convergences and divergences between actors are analyzed, using the second-order convergence matrix (2CAA) and the third-order convergence graph.

Second order convergences

Figure 6 presents the Matrix of convergence 2CAA (where N.C means number of convergences and G is the convergence grade) which reveals that the actor with the highest overall convergence is A5, with a score of 165. This high level of cumulative convergence indicates that this actor has interests well aligned with the other actors, which could place it as a regulating or mediating actor in the system. In contrast, the actor with the lowest overall convergence in the system is A3, with a score of 150. This lower convergence suggests a more limited alignment of its interests with respect to the rest of the actors, which could reflect a degree of autonomy or a more independent position within the system.

Figure 6. Matrix of convergence between actors of order 2 (2CAA)

A/A	A1	A2	A3	A4	A5
A1	0	39	37	38	42
A2	39	0	37	38	42
A3	37	37	0	36	40
A4	38	38	36	0	41
A5	42	42	40	41	0
N. C	156	156	150	153	165
G (%)	100				

Source: Authors

The graph of convergences between order 3 actors in Figure 7 reveals that the most important convergences occur between actors A2-A5 and A5-A3. This is due to the synergy of roles and the alignment in priority objectives. Both teachers and Student well-being share a direct approach toward students and their needs, while Administrators support these actions by providing policies and resources. These relationships reinforce the collective commitment to the strategic objectives of reducing absenteeism and improving student well-being.

Figure 7. Graph of convergence between actors of order 3
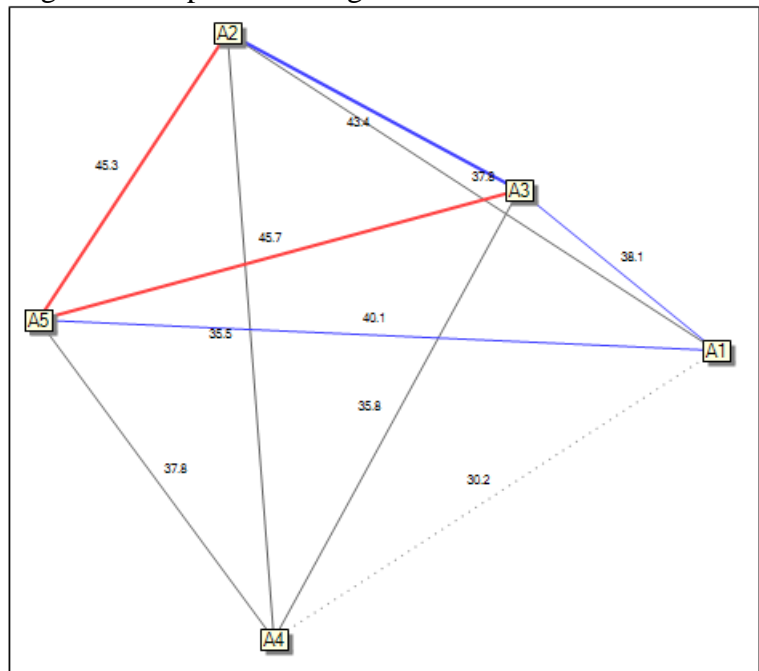
Source: Authors

No divergences were identified between the actors, which allowed progress in the analysis of possible alliances using the net distance plane, represented in Figure 8. This plane analyses the net influence (capacity to influence minus dependency) of the actors in a system. In this case, the graph illustrates how each actor is positioned according to its relative capacity to influence and its degree of dependency in relation to the others. In this sense, A4 as a dominant actor reveals that it is a key figure with a low level of dependency. Its influence on absenteeism may be related to motivation and family environment. For its part, A3 as a strategic actor, although influential, depends on coordination with actors such as A5 and A2 to execute its plans. A5 as a support actor has an auxiliary role that depends on the organizational framework established by A3, while A1 and A2, due to their limited influence, may be recipients of policies and decisions coming from the most influential actors.

Figure 8. Plane of net distances between actors
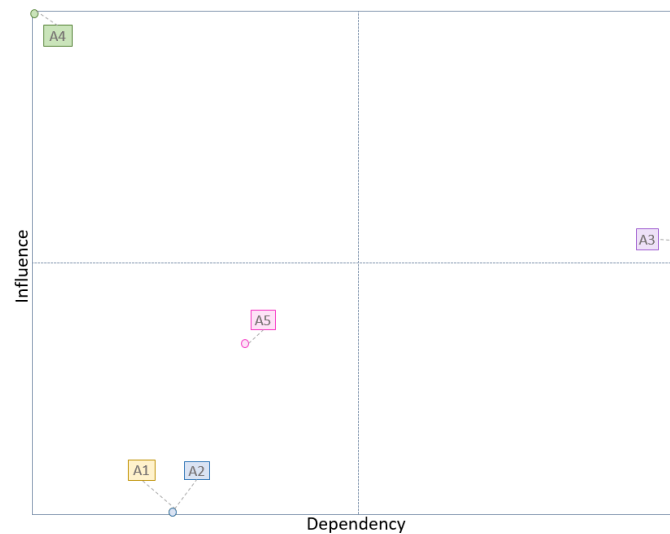
Source: Authors

The map reveals a clear hierarchy in influence and dependency capacity. The most influential actors A4 and A3 lead the system, while actors A1 and A2 play important, but more restricted, roles. A5's dependency reinforces its role as a support in the system. These dynamics must be taken into account to design effective strategies against absenteeism.

Discussions

In the analysis carried out, the dynamics of influence and dependence between key actors that impact student absenteeism within an educational platform assisted by Machine Learning were identified. The results allow for reflecting on the role of each actor in the educational system and its relationship with the objectives set to mitigate absenteeism.

The analysis placed actors A2 (Teachers) and A5 (Student Well-being) as key strategic actors. They showed high influence but with a marked dependency on other actors, such as administrators. Teachers act as learning facilitators and primary detectors of problems, but their impact depends on alignment with parents and administrators. According to Childs & Grooms (2018) A2 are influential because they interact directly with students, monitor attendance, and collaborate with other actors, such as parents and administrators, to improve student participation. On the other hand, their dependency suggests that they need the support of policies, resources, and coordination with Administrators and Student Well-being to be effective.

In contrast, A5, despite playing a critical support role, needs clear resources and policies to implement absenteeism prevention and intervention programs. According to Maier et al. (2020), this department has a central role in providing comprehensive support to students (physical, emotional, social, and economic) and collaborates with teachers and administrators in the implementation of assistance programs.

The analysis placed A3 (Administrators) as dominant actors due to their high influence in the system. Administrators act as strategic coordinators, responsible for designing and implementing policies that directly impact student attendance. According to Mayger and Hochbein (2021), Administrators act as key decision-makers, as they implement strategies that affect all other actors (students, teachers, student well-being, and parents) without

needing to rely heavily on them to achieve their objectives. However, the analysis by Al-Hail et al. (2021) emphasizes that the implementation of effective educational policies carried out by administrators depends largely on working collaboratively with secondary actors, such as teachers and families.

Regarding A1 (Students) and A4 (Parents), they emerge as actors with low net influence, this means that they are more recipients of policies and actions to a greater extent than true actors of change in the system. For Cayubi (2022), students are the most dependent actors, they work with the efforts and resources provided by teachers, student well-being, and administrators to be able to motivate themselves, attend, and participate in class. On the other hand, the importance of the parental role appears in studies such as Bradley's (2021), where the relevance of family support is defended when it comes to meeting attendance and academic performance. McDonald et al. (2023) also state that the role of parents is mainly supportive, and they need communication and guidance from teachers and student well-being to help their children overcome problems that can lead to absenteeism.

Conclusions

The analysis carried out allows for revealing patterns and relationships that will be useful in creating action plans to face the problem related to absenteeism. Based on the results, the following conclusions were reached:

Administrators and parents are formalized as actors with a high potential to make proposals that impact student behavior. They have a primary role in developing, coordinating, and maintaining the educational policies necessary to reduce absenteeism. For their part, teachers and student well-being show an important influence, although only in terms of the work carried out by other actors, especially administrators. Their ability to carry out intervention programs is subject to the coincidence of efforts and the availability of sufficient resources. On the other hand, the student, despite being the focus of attention of policies, shows a low capacity for influence, which shows their much more passive nature within the system. This shows the need to develop proposals that promote self-management of students and their active involvement in solving the problem.

The objectives related to the detection and direct intervention of absenteeism O6, O13, and O10 show a high level of involvement and capacity to act. These should be the central axes of the interventions in the short term, while objectives O2 and O11, being decisive, are limited by the low capacity to act. This underlines the need to involve strategic actors more in order to achieve changes that are sustainable over time.

The relationships of convergence with stronger powers are found between A2-A5 and A5-A3, which shows the need for a joint relationship between these actors to maximize the impact of the actions carried out. On the other hand, since some key objectives have a high capacity for action, a considerable number of them (O4, O1, O8, O12, among others) showed medium or low capacities. This would explain why it is important to make a continuous assessment of the resources and approaches used in the institution.

The research corroborates that student absenteeism is a problem that can't be solved from a fragmented perspective such as one in which the strategic resources proposed by the research are ignored. It is necessary to apply a systemic approach, where each actor assumes a complementary role in building a climate that favors attendance at the institution and learning.

Recommendations

Based on the conclusions drawn from the data that have been analyzed, the following strategic recommendations are proposed to effectively address school absenteeism:

1. *Strengthen early detection and monitoring (O6, O10)*

- Design of key performance indicators (KPI) that allow for tracking attendance in real time and that are linked to automatic alerts aimed at teaching and student well-being.

- Development of specific monitoring protocols for students with repeated absenteeism.

2. *Promote active collaboration between strategic actors (A2, A3, A5)*

- Organization of periodic working groups between administrators, teaching staff, and student well-being to coordinate common actions and avoid duplicate efforts.

- Create direct communication networks between actors through digital platforms for the exchange of information in real-time.

3. *Empowering students (A1) and their families (A4)*

- Design social-emotional education programs focused on developing self-management skills and intrinsic motivation in students.

- Encourage active participation activities, such as student tutoring, to increase personal commitment to attendance.

- Offer regular workshops for parents, providing tools to manage academic and emotional support at home.

4. *Prioritize objectives with medium or low capacities (O2, O11, O14)*

- Increase the allocation of resources towards secondary objectives that currently show low capacity for action, but are essential for long-term structural change, such as promoting a supportive family environment (O11) and student self-management (O2).

- Design incentives that motivate active participation in these areas, both by key actors and students.

5. *Develop specific interventions for dependent actors (A1 and A4)*

- Create personalized academic support programs and tutoring for students, focusing on the specific factors that influence absenteeism (lack of motivation, transportation problems, etc.).

- Involve parents in school decisions through activities such as collaborative meetings, needs surveys, and informational talks.

6. *Design evidence-based intervention strategies*

- Conduct additional studies that identify the underlying causes of absenteeism in different social and academic contexts.

- Implement a pilot testing process to assess the effectiveness of each strategy before its wide-scale deployment.

7. *Maximize available technological and human resources*

- Digitize school management systems, incorporating predictive analysis tools, attendance control, and automated surveys.

- Train teachers and administrators in the use of these technological tools.

8. *Strengthen institutional policies*

- Establish clear guidelines on mandatory attendance and the consequences of absenteeism, aligned with a preventative and non-punitive approach.

- Promote a culture of support through programs that promote student retention, from enrollment to graduation.

Acknowledgments

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