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DRIVING TOWARDS A SECURE FUTURE: STRATEGIES FOR COMPREHENSIVE BIOLOGICAL RISK CONTROL AT COLECTIVOS CIUDAD DE IPIALES COMPANY, COLOMBIA

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Abstract:

This research identifies factors that represent biological risk to the health of users and workers of the public transportation company Colectivos Ciudad de Ipiales. Through the application of the matrix of change to experts and the tools of strategic foresight, it is possible to identify key variables, relevant actors and scenarios that are pertinent for the consolidation of the considerable reduction of risk and safety in the organization in the year 2030. Finally, using the IGO matrix, strategies are developed as a roadmap for the anticipation of the betting scenario, with emphasis on the system's protagonists.

Keywords. Biohazard; public transportation; foresight; scenarios; strategies.

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CONDUCIENDO AL FUTURO SEGURO: ESTRATEGIAS PARA EL CONTROL INTEGRAL DE RIESGOS BIOLÓGICOS EN LA EMPRESA COLECTIVOS CIUDAD DE IPIALES, COLOMBIA

Resumen:

La presente investigación identifica factores que representan riesgo biológico para la salud de los usuarios y trabajadores de la empresa de transporte público Colectivos Ciudad de Ipiales. Mediante la aplicación de la matriz de cambio a expertos y las herramientas de la prospectiva estratégica, se logra reconocer variables clave, actores relevantes y escenarios que son pertinentes para el afianzamiento de la disminución considerable del riesgo y seguridad en la organización en el año 2030. Por último, mediante la matriz IGO, se elaboran estrategias como hoja de ruta para la anticipación del escenario apuesta con énfasis en los protagonistas del sistema.

Palabras Claves. Riesgo Biológico; transporte público; prospectiva; escenarios; estrategias.

CONDUZINDO PARA UM FUTURO SEGURO: ESTRATÉGIAS PARA O CONTROLE INTEGRAL DE RISCOS BIOLÓGICOS NA EMPRESA COLECTIVOS CIUDAD DE IPIALES, COLÔMBIA

Resumo:

Esta pesquisa identifica fatores que representam um risco biológico para a saúde dos usuários e trabalhadores da empresa de transporte público Colectivos Ciudad de Ipiales. Através da aplicação da matriz de mudança a especialistas e das ferramentas de prospectiva estratégica, é possível identificar variáveis-chave, atores relevantes e cenários pertinentes para a consolidação da considerável redução de risco e segurança na organização no ano de 2030. Finalmente, utilizando a matriz IGO, são elaboradas estratégias como roteiro para antecipar o cenário, com ênfase nos atores do sistema.

Palavras chave. Riscos biológicos; transporte público; visão de futuro; cenários; estratégias.

1. INTRODUCTION:

The urban growth and development of Ipiales, Colombia, in recent years has raised various concerns, mainly related to biological risks due to its status as a border area frequented by the local community, migrants, and tourists (Cámara de Comercio de Ipiales, 2022). In response to this issue, a plan aimed at mitigating biological risk factors is proposed for the passenger transport company Colectivos Ciudad de Ipiales. This plan is based on the identification and evaluation of health risks for workers (Gobernación de Nariño, 2020 Through the application of prospective strategic methodologies, structural and stakeholder analyses, as well as cross-impact matrix analysis and scenario creation, the most relevant risk factors are identified. These findings serve as the basis for the development of proposals and scenarios aimed at significantly reducing biological risk by the year 2030 (Ministerio del Interior de Colombia, 2021; Ministerio de Salud y Protección Social, 2017). The ultimate goal is to improve risk management, ensuring safer working environments and services, benefiting both workers and the community and environment (Quintero, 2019). This research work aims primarily to provide the company and society with a higher level of security in this area, addressing the challenges posed towards a safer and more sustainable future.

In this context, it is crucial to recognize the presence of various potential risks, which can be classified into categories such as physical, chemical, biological, locative, electrical, mechanical, ergonomic, and critical, among others. Despite their identification, these risks often do not receive the necessary attention, becoming critical risk point (Arias et al., 2016).

In the realm of risk assessment related to travel and transportation, especially concerning provisional guidelines for public health authorities, a social challenge is posed. Consequently, it is imperative to implement a variety of preventive systems to safeguard the integrity of users and customers. It is essential to recognize that managing the risk of infection during people's travels can be enhanced by adopting basic prevention and control measures (OMS, 2020).

The purpose of this research is to utilize prospective tools to develop strategies and establish an ideal scenario that strengthens the prevention of biological risks and the implementation of protective measures for the personnel of the urban passenger transportation company, Colectivos Ciudad de Ipiales, aiming towards the year 2030. The relevance of this study lies in the necessity for the company to adopt and implement the identified strategies, thereby ensuring the achievement of the set objectives.

2. LITERATURE REVIEW:

Biological Risk and Transportation

Biological risk refers to the possibility of exposure to microorganisms, viruses, bacteria, fungi, and other infectious agents that can cause diseases in humans and other living organisms. Exposure can occur through direct contact with blood, saliva, semen, urine, feces, and other bodily fluids, or by inhaling infectious particles suspended in the air (Quintero, 2019).

The Pan American Health Organization defines biological risk as "the probability of exposure to agents that can cause harmful effects on human or animal health" (Villaveces y Silveria, 2010). Workers exposed to biological risks include those working in medical laboratories, public transportation, hospitals, pharmaceutical industries, agri-food industries, among others.

To prevent and control biological risk, it is important to implement prevention measures, including worker training on hazards and risks associated with contaminating agents, the implementation of engineering control measures, the use of appropriate personal protective equipment, proper storage and disposal of infectious waste, and monitoring and surveillance of workers' health. Therefore, continuous tracking of important factors such as air quality is necessary to reduce the negative effects caused by pathogens, most of which are resistant to available

antibiotics (Uj Jaman et al., 2021).

Norms and regulations also play a significant role in preventing biological risk. For instance, the World Health Organization (WHO) has established a series of guidelines to ensure safety in handling biological materials (OMS, 2016). Additionally, there are national and international regulations governing worker protection and safety in handling biological agents across various sectors, such as the WHO's International Health Regulations (OMS, 2005) and the ISO 15189:2012 standard for clinical laboratories (ISO, 2012).

Therefore, biological risk is a significant concern in many fields and sectors, and appropriate prevention and control measures must be implemented to minimize exposure and ensure the safety of workers and the community at large. Additionally, public transportation refers to the transportation system used to move a large number of people within a city or metropolitan area. In the context of biological risk, public transportation can be a high-conflict area for the spread of infectious diseases due to the high density of passengers and the physical proximity among them.

According to Gołofit et al. (2019), in public transportation, there are instruments that create suitable conditions for the development of microbiological agents, serving as an active source of emission of harmful elements. Among them, three classes of pathogens have been identified: (1) Opportunistic pathogens, which often cause infectious diseases; (2) Opportunistic pathogens that rarely cause infectious diseases, and (3) non-pathogenic microorganisms (Gelashvili et al., 2020). In this regard, the Pan American Health Organization (PAHO) has emphasized the importance of preventing and controlling the spread of infectious diseases in public transportation, which require preventive and control measures such as adequate ventilation, regular cleaning and disinfection of vehicles, the use of masks by passengers and drivers, and the implementation of social distancing measures (Villaveces y Silveria, 2010).

Furthermore, the WHO has also emphasized the importance of educating and raising awareness among passengers about maintaining good personal hygiene measures, such as frequent hand washing and the consistent practice of protective habits, along with the use of masks. (OMS, 2020).

In the context of the COVID-19 pandemic, many states implemented specific measures to prevent and control the spread of the virus in public transportation. For example, some countries reduced the number of passengers allowed in vehicles, implemented regular disinfection of vehicles, and required passengers and drivers to wear masks (OMS, 2020). According to Wang et al. (2022), n public transportation, the enclosed space provides suitable conditions for the spread of diseases, especially if they are related to virus-laden droplets that spread within the existing environment such as ventilation, use of expired personal protective equipment, air temperature, and relative humidity.

Strategic foresight

Strategic foresight is a discipline aimed at analyzing an organization's future and designing strategies and action plans to address the challenges that may arise (Godet & Durance, 2009 This discipline focuses on environmental analysis and the construction of future scenarios to identify trends, opportunities, and risks that may affect the organization (Aceituno, 2017). Some key characteristics of strategic foresight include: (1) Environmental analysis: Strategic foresight focuses on analyzing the environment in which the organization operates, identifying trends and significant changes that may affect it (Noguera, 2009), This analysis includes economic, social, technological, political, and cultural aspects. (2) Scenario construction: This technique involves developing different models of the future, considering variables and situations, to define the best strategies to follow (Villacorta et al., 2020). (3) Flexibility: Strategic foresight focuses on defining flexible strategies that allow the organization to adapt to different situations and changes in the environment (Medina Vásguez, 2011) y (4) Informed decision-

making: It seeks to make decisions based on data and evidence, rather than decisions based on intuition or empiricism (Hernández, 2016).

Currently, strategic foresight is an essential tool for making business decisions in uncertain and changing environments. Organizations that apply this method can anticipate changes in the situation, seize opportunities, and minimize risks. Additionally, it can be used in different fields, such as urban planning, public management, and decision-making in the financial sector (Medina & Cruz, 2022).

Similarly, it utilizes different techniques and tools that allow its application in changing environments. These methodologies are: (1) Structural Analysis: This method focuses on analyzing the structures and systems that make up the most influential and dependent trends (variables) that may affect their evolution in the future (Cruz & Medina, 2015; Mendoza et al., 2011). (2 Stakeholder Analysis: It is a technique used to identify and understand the different perspectives, interests, positions regarding a process, and mission objectives of institutions, individuals, or experts relevant in a particular context (Godet & Durance, 2009). (3) Cross-Impact Analysis: It is a tool that allows evaluating the feasibility of a strategy or policy concerning the social, economic, political, and cultural factors that may influence its implementation, and designing mitigation measures, action plans, and scenarios to achieve the proposed objectives (Quinteros & Hamann, 2017). (4) Scenario Building: It involves creating different possible scenarios for the future, based on the identification of different trends and factors that may influence it. Scenarios allow analyzing different possibilities and evaluating the implications of each of them (Medina & Cruz, 2022), and (5) Importance and Governance Matrix (IGO): A tool that allows assessing the relevance and feasibility of different strategic options in a given context, based on their level of importance and governance. This helps identify the most viable and relevant options based on the proposed objectives and design action plans for their implementation (Mojica, 2008).

3. METHODOLOGY:

The approach of the present research is mixed. It starts with the study of the biological risk variable and seeks to understand to what extent it develops. Using the Matrix of Change method (Godet, 2007), data collection was conducted to discover discursively conceptual categories and strategic variables of the past, present, and future. Additionally, it was necessary to process the information to assess the current situation and project future scenarios based on different variables, actors, and risk factors. For this purpose, a group of 39 experts was convened, who contributed their knowledge and experience in the fields of transportation, epidemiology, occupational health, and risk management, all related to public transportation, as well as administrative personnel from the company and drivers. Subsequently, the structural analysis technique is used applying the Micmac software to identify and analyze the factors that influence biological risk in the company. This technique allowed determining 32 variables or factors with the greatest influence on biological risk, as well as the relationships between them and their impact on the company, of which 16 variables with the greatest influence and dependence were identified.

On the other hand, through the Mactor software, the different relevant actors within and outside the company are identified, as well as their interests, objectives, and opinions regarding biological risk. This would allow for a clear vision of the objectives to include them in the research process. The experts indicated that there are 3 main actors that influence the system.For scenario creation, the Cross-Impact Matrix tool Smic is used, which evaluates the likelihood of each identified hypothesis. This technique, through the use of software, allows recognizing the hypotheses with the greatest impact and probability, facilitating the definition of areas of focus and the most critical risks in the company. Additionally, it generates scenarios that must be evaluated by the experts.

Finally, the Importance and Governance Impact Matrix (IGO) is used to create strategies that enable the

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achievement of the desired scenario in the medium and long term.

4. RESULTS:

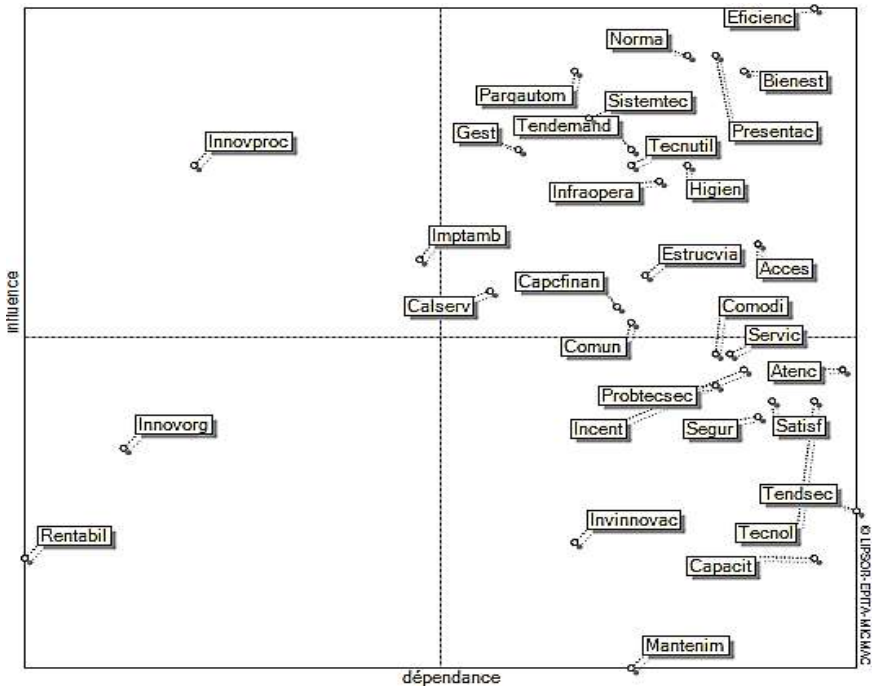
Structural Analysis

The influence and dependence direct plane consists of four quadrants. In the upper left part of the plane are the variables that have high influence and low dependence. In the upper right side, there are influential variables that are highly dependent. In the lower left part are variables with low influence and low dependence, and in the lower right quadrant are factors that are highly dependent and have little influence.According to Illustration 1, it can be highlighted that within the 16 key variables, efficiency in processes and procedures is the one with the greatest strategic importance, as it has both great influence and great dependence. It is followed by well-being, communication, regulations, and presentation. The maintenance of a safe environment in motor vehicles (fumigation) and training for all employees are the most affected variables. Profitability and organizational innovation are variables that, although important, are indifferent, meaning they are not operating well within the system.

For the analysis, the plane is interpreted considering that influence is given on the vertical axis and dependence on the horizontal. The upper left quadrant is called power, the upper right is the key strategic quadrant, the lower right represents the effect, and the lower left is the indifference quadrant.

Efficiency in safety and compliance with societal norms are key strategic variables since reliability is sought, as they have both high influence and high dependence. On the other hand, maintenance and training are the most affected variables. Profitability in Personal Protective Equipment (PPE) and organizational innovation - biological risk regulatory compliance are indifferent variables, meaning they are not operating within the system as they are normally established.

Illustration 1:
Direct Influence and Dependence Plane



Source: Own elaboration

Below, in Table 1, the description of the 16 key variables rated by the experts, along with the topics they belong to, is provided.

Table 1:
Description of Key Variables

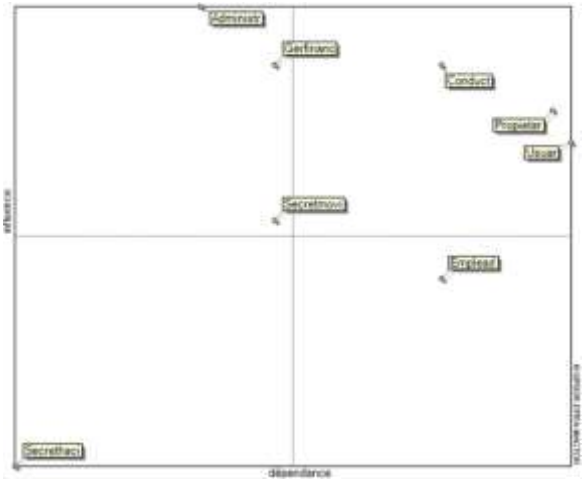
No	*Long Title*	*Short Title*	*Theme*
1	Well-being	Bienest	Quality of life
2	Communication	Comun	Administrative
3	Accessibility	Acces	Mission-oriented
4	Hygiene	Higien	Service
5	Efficiency	Eficienc	Misional-oriented
6	Presentation	Presentac	Quality
7	Service quality	Calserv	Administrative
8	Administrative management	Gest	Strategic
9	Operating infrastructure	Infraopera	Social
10	Road infrastructure	Estrucvia	Road
11	Regulations	Norma	Road
12	Fleet	Parqautom	Legal
13	Demand trends	Tendemand	Road
14	Used technology	Tecnutil	Innovatión
15	Technological system	Sistemtec	Innovatión
16	Financial capacity	Capcfinan	Financial

Source: Own elaboration

Stakeholder Analysis

The Influence and Dependency Mactor plane graphically represents the positions of the actors in relation to their relationships and interests with each other. This information is useful when constructing scenarios because it allows identifying the actor with whom to work.

Illustration 2:
Influence and Dependency Plane among Actors



Source: Own elaboration

From Illustration 2, the following conclusions were derived:

The dominant actors are: Administration, Financial Management, and Mobility Secretary.

The most influential and dependent linkage actors are: Drivers, Owners, and Users.

The autonomous, less influential, and dependent actors are: Treasury Secretary, which is located away from the central zone of the regulatory plane of the system, acts as a secondary lever, and constitutes a complementary agent, although of significant importance.

Finally, internal actors, employees, are considered submissive actors in this methodology due to their analysis resulting in high dependence and low influence.

Long-term Convergences

To analyze the alliances and conflicts among actors regarding the proposed objectives, the results shown in the convergence illustration of order 3 are studied. Additionally, actors with greater influence on the objectives and their positioning on them are observed.

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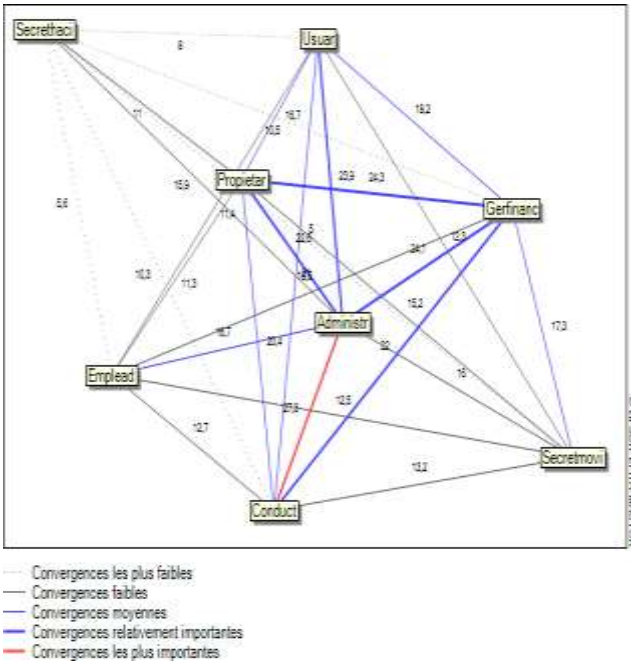
The aim is to identify actors favorable or unfavorable to the objectives.

Illustration 3:
Long-term Convergences of Order 3



Source: Own elaboration

Illustration 3 allows us to observe that the most relevant convergence occurs between administrators and drivers. Additionally, to a relatively significant extent, administrators, owners, and users converge. On the other hand, financial managers, drivers, and owners converge.

Matriz de impacto cruzado de hipótesis o conjeturas de futuro SMIC

According to the above, the following hypotheses were developed for the present and the year 2030, and the results were obtained by using the SMIC Prob-expert software.

Table 2:
Present Hypotheses

H	DESCRIPTION
H1	The technological issues in the sector significantly influence the processes in the field of biotechnology. Workers often exhibit high levels of awareness regarding biological risks in the workplace, but these training sessions are repetitive because the topic to be implemented is new and many do not assume the risk.
H2	Investment is a crucial point as it is a scenario where the risk falls and efforts are made to ensure biological risk factors.
H3	The objectives of the users are essential for both the drivers and owners as well as for the company. That's why these objectives are tied to a managerial administrative commitment, where reliability and social responsibility are sought.
H4	Compliance with the trust and security objectives of the users has a positive impact on the profitability of the company. Therefore, it is necessary to comply with all regulations, achieving quality and service standards with biosafety.
H5	Safety in the biosafety factor for both insiders and outsiders has a positive impact on the quality of service, everyone's health, and achieving acceptability.

Source: Own elaboration

Table 3:
Hypotheses of Possible Future

2030

The biotechnological solution integrated into urban bus services will have a significant impact on the safety and health of passengers, administrative staff, and operational personnel. Investment in Personal Protective Equipment (PPE) and compliance with regulations will greatly enhance safety, regulatory compliance, and comprehensive service within the organization. If all regulations and biosafety protocols are adhered to, it would lead to meeting user objectives, thereby benefiting drivers, owners, the company, and users alike. Quality attention to biological risk positively affects the company's profitability. Continuous training on biological factors for drivers will positively impact service quality, achieving health and well-being for all.

Source: Own elaboration

Source: Own elaboration

Table 4:
Scenario Analysis

Scenario	Maxi Probability	Description
01. Everything is possible	57,8%	In the year 2030, the transportation system will be characterized by technological solutions, investment in Personal Protective Equipment (PPE), meeting the biosafety needs of users, quality service, and driver training, providing well-being and health.
32. Another reality is coming	22%	In the year 2030, the transportation system will be characterized by the absence of technological solutions and investment in Personal Protective Equipment (EPP). However, it will still meet the biosafety needs of users, provide quality service and driver training, thus promoting well-being and health.
05. DISILLUSIONED USERS	9,3%	In the year 2030, there will be technological solutions applied to biosafety factors, investment in Personal Protective Equipment (EPP), but the biosafety needs of users will not be met. However, there will still be quality service and driver training, promoting well-being and health.
06. Disillusioned Users and Unskilled Drivers	3,4%	In the year 2030, there will be technological solutions in biosafety, investment in Personal Protective Equipment (EPP), but the biosafety needs of users will not be met. However, there will be quality service, but driver training will not be provided.

Strategies for the "Bet" Scenario

To achieve anticipation of the "Bet" scenario, the created strategies are related to the mission of the most relevant and influential actors in the system (drivers, owners, and users). For their identification and actions, the IGO Matrix (Mojica, 2008). was used. Table 5 shows the "Bet" scenario and the placement of strategies in consensus according to their importance and governance. For this, the following scoring items were assigned: 4 (very important), 3 (important), 2 (slightly important), 1 (not important). Regarding the governance of the action, that is, the degree of commitment to fulfilling the mission of the actors, a rating of Strong (5), Moderate (3), Weak (1), and Null (0) was proposed (Chalapud, 2022).

Table 5:
IGO Matrix

Bet Scenario: Anything is Possible

In the year 2030, the transportation system will be characterized by technological solutions, investment in Personal Protective Equipment (PPE), meeting the biosafety needs of users, quality service, and driver training, providing well-being and health.

No	Actions/Strategies	Imp	S	Gob M	W	N
1	Mitigate the risk with accurate information and communication that contributes to improving service and the user experience.	4	X			
2	Establish organizational technological development as a source of safety in	3	X			

	vehicles, through the acquisition of fumigation machinery and biological risk detectors.			
3	Establish a biological hygiene protocol for the vehicle fleet and conduct daily checks.	**4**	**X**	
4	Create an organizational culture of efficiency to project positively with biosafety protocols.	**2**	**X**	
5	Acquire and provide drivers with Personal Protective Equipment (PPE), train them in its handling, maintenance, and support.	**4**	**X**	
6	Train the administrative unit in management models and processes, their implementation, and execution.	**3**		**X**
7	Implement a Quality Management System to accompany policies and process improvements in administrative tasks for service provision.	**2**		**X**
8	Investment in improving the physical infrastructure of the company.	**4**	**X**	
9	Provide suggestions, support, and participation in the municipal mobility plan.	**4**	**X**	
10	Ensure strict supervision to guarantee the biological safety of the vehicle fleet.	**3**	**X**	
11	Implement PQRS (complaints, claims, suggestions, and congratulations) forms for external clients and passengers regarding service satisfaction, fumigation, and disinfection. These forms will be made available through web platforms, email, applications, or physical formats.	**2**		**X**
12	Implement a financial sufficiency plan to create a special fund for the management and purchase of instruments to counteract biological risk.	**3**	**x**	

Source: Own elaboration

Classification of Strategies to Achieve the Target Scenario

Table 6:
Classification of Strategies

No.	Immediate Strategies: Very Important and Governed Actions
1	Mitigating the risk with thorough information and communication that contribute to the improvement of the service and user experience.
2	Establishing organizational technological development as a source of vehicle security, through the acquisition of fumigation machinery and biological risk detectors.
3	Establishing a biological hygiene protocol for the vehicle fleet and conducting control procedures once a day.
4	Acquiring and providing drivers with Personal Protective Equipment (PPE), training them in its handling, maintenance, and support.
5	Investment in the improvement of the company's physical infrastructure.
6	Make suggestions, provide support, and participate in the municipal mobility plan.
7	Implement a financial sufficiency plan to create a special fund for the management and purchase of instruments to counteract biological risk.
8	Ensure biological safety of the vehicle fleet through strict supervision.
	Challenges strategies: Very important and poorly governed actions
1	Foster an organizational culture of efficiency to project positively with biosecurity protocols.
2	Train the administrative unit in management models and processes, their implementation, and execution.
3	Implement the Quality Management System to support policies and improve administrative processes for service delivery.
4	Implement PQRS (Petitions, Complaints, Claims, and Suggestions) forms for external customers and passengers to provide feedback on service satisfaction, fumigation, and disinfection. Their completion will be available through web platforms, emails, applications, or physical forms.

Source: Own elaboration

Table 6 shows the classification of strategies summarized as immediate and challenge, which, according to their characteristics, determine their degree of opportunity in anticipating the desired scenario. Immediate strategies can be executed in the short term with continuous monitoring to establish a roadmap for achieving the objective. On the other hand, challenge strategies should be implemented over time, as they are not conditional and contribute to the enrichment of the system.

5. DISCUSSION AND CONCLUSIONS

The identification of risk factors for passengers of public transportation services entails, on one hand, diagnosing the safety conditions of vehicles (Arias et al., 2016); and on the other hand, it becomes necessary to conduct periodic inspections of workstations to verify cleanliness and order conditions, leading to the application of disinfectants, training in the use of personal protective equipment such as gloves and face masks, as well as cleaning work areas, personal hygiene training, and providing hygiene items in specific areas (Adams et al., 2016).

The passenger bus transportation service has not proven to be as competitive in overcoming the threats related to biological factors posing risks to the health of workers and personal protection management. The company "Colectivos Ciudad de Ipiales" needs to visualize innovation in biosecure service, based on the qualities presented by ISO-9001 quality certification. However, it also needs to take into account the low indicators presented in the workers' perception regarding associated risk factors such as driver training, provision of materials, risk assessment, training, among others.

To achieve the scenario by the year 2030, it is necessary for the transportation system to be characterized by having a technological solution and

investment in Personal Protective Equipment (PPE) to meet the biosecurity needs of users, ensuring quality in service delivery and training for drivers, providing well-being and health. Influential factors such as communication and updating of regulations need to be determined; both external and internal users should have accessibility to biosecurity measures; the Quality Management System should be integrated into administrative processes; physical infrastructure, fumigation, and continuous disinfection need improvement; and technological innovation should be involved in service delivery.

A proposal based on service differentiation in the urban passenger transportation sector of the city of Ipiales should focus on technological innovation for biosecure service. This can be achieved through increased communication and information dissemination. Internally, companies need to prioritize risk prevention and enhance personal protection measures. Ultimately, customer satisfaction and biosecurity for Colectiva Ciudad de Ipiales can be achieved by providing and inspecting personal protective equipment for drivers, continuously training them, improving waiting stations, establishing an accessibility program for all individuals, adopting control systems and software to ensure comprehensive customer safety, while simultaneously increasing the profitability of the companies.

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