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INFORMATION TECHNOLOGY AND TRANSIT: AN ANALYSIS ON THE MANAGEMENT IN A MUNICIPAL INSTITUTION

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ABSTRACT

It is evident that information-related technologies strongly influence the performance of any type of activity. In organizations, including public institutions, these technologies, when properly used, provide agility, flexibility, speed, and reliability in management and operation activities. In this context, this study addressed the following question: How does a municipal transit management institution use information technology tools to manage transit activities? Thus, this research aims to analyze how information technology (IT) tools are used for the management and operation of transit in a municipal agency. Specifically, this work sought to identify the information technology tools used, the main activities developed with the use of IT, as well as the main benefits and difficulties associated with the use of IT for transit management. The method used was a single case study, with a qualitative approach, which sought to present evidence of the facilities, difficulties, advantages, and deficiencies related to the use of computer resources. The results found show that among the various benefits that IT can attribute to traffic management activities, data processing speed, "community equity", control and planning activities for road signaling, and increased productivity are the most expressive results.

Keywords: Transit; Transit management; Information technology.

1. INTRODUCTION

Transit terminology is widely used by modern society. In fact, due to the economic and social development that different nations have achieved around the world, including favoring the acquisition of vehicles and other mobility mechanisms (TRAUB-MERZ, 2017; MOTA; REZENDE, 2019), transit has become a systemic issue that requires debate and attention from public managers (MANOUT; BONNEL; BOUZOUINA, 2018), especially for the indication that, in Brazil, every 15 minutes a person dies from accidents (OBSERVATÓRIO NACIONAL DE TRÂNSITO, 2020).

Additionally, Nobre (2018) explains that most transit accidents happen in municipalities, where there are many motorcycles, little signage and often lack a specific manager. Complementing this perception, Zamin et al., (2018) comment that the reality in which Brazil finds itself when it comes to the issue of transit is almost chaotic and of great disorganization, and management policies and practices are necessary to reverse this situation and optimize results in mobility (CARVALHO, 2016), especially in municipalities, responsible for their coordination in the context of cities (DENATRAN, 2016).

Regarding management practices, Rizzardo (2006) reinforces that transit management encompasses a set of administrative, managerial, and planning activities, focusing on offering the best conditions in vehicle transit, education, and engineering.

In the meantime, it is appropriate to explain that although similar, transit management and urban mobility, while they are complementary themes, they have different concepts, because transit management is directed to aspects of transit, education, and engineering (RIZZARDO, 2006), with an execution role, while urban mobility is a broader process that involves transport and circulation policies that attempt to offer broad and democratic access to urban space, through the primacy of public and non-motorized modes of transport in an effective, socially inclusive and ecologically sustainable way (PIRES; PIRES, 2016).

On this subject, the Victorian Auditor-General's Report (2014) adds that the functionality of information technology (IT) tools should also be considered in transit management activities since these resources promote an intelligent connection between users of transport systems, drivers, vehicles, and transit infrastructures a whole.

In addition, Munhoz et al., (2020) add that when applied to transit management and urban mobility, information technology allows better urban planning and improves environmental sustainability. In this sense, Tafids et al., (2017) complement that these information technologies (IT) have been widely applied in the monitoring, operation, and

management of transport services, providing gains in efficiency in the use of urban transport, infrastructure, and reduction of negative impacts on the environment.

This diversity of factors and elements that connect information technology and transit management are also predominant in discussions within the municipalities, which have implemented policies and draft laws to establish legal guidelines for transit management and urban mobility in the context of cities (BOHLER-BAEDEKER et al., 2014). Moreover, in Brazil, the Brazilian Transit Code/CTB (BRASIL, 1997) establishes that municipalities must create, in their administrative structure, a municipal executive agency of transit.

On this subject, it is pertinent to consider transit management in a northeastern capital, which has sought to professionalize, even more, its transit management and which has faced problems related to the increase in the fleet of automobiles, reflected in the slowness in the streets and avenues of this capital and the dissatisfaction of local citizens (BARBOSA, 2020).

Based on the arguments presented, this study identified the following problematic situation: How does a municipal transit management institution use information technology tools to manage transit activities? Based on this problem, the objective was: to analyze the use of information technology tools for transit management in a municipal management institution.

Specifically, this work sought to identify the IT tools used, the main activities developed with the use of information technology, as well as the main benefits and difficulties associated with the use of information technology for transit management. To achieve the proposed objectives, a qualitative research was conducted, whose research strategy was the study of a single case, with the application of interviews.

From the theoretical point of view, this work enhances the findings about transit, a subject so commented on and pertinent in the last years, bringing new theoretical evidence due to the association with the use of information technology, topics little discussed, in an integrated way, in the national context. On this subject, it is observed according to a survey conducted in the SPELL platform that transit management has not been explicitly (title) treated in national studies, and that from the perspective of urban mobility, discussions have involved legal aspects (MEYER; GUNTHER, 2019), socio-technical actors (PEREIRA; SILVA, 2020) and sustainability (LOCATELLI; BERNARDINIS; MORAES, 2020).¹

Furthermore, from a practical point of view, this research identifies how information technology has helped transit managers and what is the potential of these tools, allowing insights that may be useful to institutions similar to the one researched.

¹ Base date: 27/07/2021

2. TRANSIT MANAGEMENT

It is recognized in all environments, whether academic and/or professional, that the term transit is a frequent and widely repeated expression. On this subject, Marques and Machado (2010) explain that the word transit comes from the Latin *transitu*, which means to change position, move.

Brazilian legislation through Law 9.503/1997 shows that transit is the movement and immobilization of vehicles, people, and animals on land roads (BRASIL, 1997). This same legislation defines it as the use of roads by persons, vehicles, and animals, isolated or in groups, whether, for movement, stop, parking, and loading or unloading operation.

Additionally, Hoffmann (2005) understands that transit is formed by three components: the physical environment, the vehicle and the driver, the physical environment is the space where it happens the movement of vehicles, the vehicle is the means of transport that allows movement in physical space, while the driver is the human and rational agent that controls and directs the vehicles. About these elements, Boas e Silva (2015) explain that the driver is the most prominent and complex member since his behavior can organize and/or disorganize the entire system.

Fraz and Seberino (2012) understand that transit is formed by three elements: man, vehicle, and road. For these authors, only the proper balance between these elements can provide security and harmony to transit. In addition, these authors state that transit consists of three major areas: engineering, legal effort, and education.

According to Al-Talabani (2017), transit engineering is the area that deals with transit planning, operation, and control. In more detail, Goldner (2013) explains that transit engineering is responsible for the development of projects and basic infrastructure for transit, such as the construction of bridges, viaducts, and road devices. Going beyond, the area of transit engineering has among its attributions: definition of road hierarchy, road circulation direction, parking lots, circulation priority at intersections, transit lights, implementation of vertical and horizontal signaling.

Concerning the legal effort, the Transit Institute (ITE, 2013) explains that the area of legal effort has the focus of supervising and policing people's behavior and respect for transit laws and rules, guiding and applying the penalties provided for by law. Finally, Moraes et al., (2013) argue that education is one of the main areas of transit and, under this area, efforts are concentrated to prepare and develop people to drive vehicles and/or walk more safely respecting laws, rules, and regulations.

In addition, Bavoso (2014) understands that transit encompasses three social spheres: technical, social, political and legal. The author explains then that the legal issue refers to the needs of regulation, legislation, ordering, and use of public and private spaces, while the social issue comprises the characteristics and demands of different social groups in the use of space, finally, the political and legal issue includes prioritizing actions and public works.

The definitions previously presented conceptualized the term transit from a more technical and objective point of view, but some definitions about this term encompass sociological and political issues, as presented by Vasconcelos (1998) and Araujo et al., (2011) which argues that transit is a competition for the use of physical space and urban equipment.

Under this understanding, Simioni (2007) reflects that transit is a constant process of negotiation between individuals in society and that this negotiation does not happen between equal people but constitutes an ideological and political dispute that reflects how people see themselves in society.

The interpretation of the information already presented, it is inferring that the practice of locomotion, movement, and transit is a complex activity that involves the management of personal and governmental conflicts at different levels, making necessary actions directed to its management. In that regard, Rizzardo (2006) argues that the concept of transit is not limited to transit and movement itself, but also includes administrative activities, responsible for planning and implementing safe and legal conditions for the movement of vehicles. This author adds that the concept of transit includes a set of actions and rules that regulate and manage the movement of vehicles and pedestrians on the roads, that is, the concept of transit is tied to the idea of transit management.

In this context, Bavoso (2014) explains that the goal of transit management is to provide everyone with the opportunity to meet the needs of locomotion in a satisfactory, fast, safe, economical, and efficient way. In the context of the municipalities, focus of discussion in this work, and according to the CTB (BRASIL, 1997) is the responsibility of the municipalities, according to the wording of Law No. 13,154, of 2015 (BRASIL, 2015) the management of activities related to the stop, circulation, and parking in the municipal environment.

On this subject, Perotto (2010) explains that all municipalities are charged with fulfilling the obligations described in Law 9,503 (BRASIL, 1997), regardless of the size or characteristics they have among themselves since the responsibility of the municipality is objective, that is, the municipal executive power can be directly penalized in case of damages or losses resulting from non-compliance with the premises of the Brazilian Transit Code.

Thus, given the clarifications presented, this work adopted the concept of transit management proposed by Bavoso (2014), according to which this management includes the activities of planning, execution, operation, control, regulation, education, and transit inspection through a set of government actions that aims to promote mobility, safety, fluidity, quality of life and satisfaction of the interests of society as a whole.

In this way, transit management activities, whether for legal reasons or not, carry a series of responsibilities and objectives that can be aided and better executed with the help of information technology (IT) tools. Given the possibilities and debates on the use of these tools in transit management activities, this topic will be addressed below.

2.1 INFORMATION TECHNOLOGY AND TRANSIT MANAGEMENT

Rocha (2014) explains that there are several definitions for the term information technology (IT), but due to its area of coverage in different segments, no definition would be sufficient to describe it fully. In this discussion, Dutta, Geiger, and Lavin (2015) explain that information technology can be perceived on any device that can systematically treat data and/or information.

Expanding these perceptions, Garcia et al., (2013) argue that the tools and functionalities of information technology (IT) are diverse and can be grouped into two large groups, hardware or equipment, and software or programs. It is explained that all computer equipment can be called hardware (VETTER, 2019), while software, in turn, is computer programs (LAPORTE; APRIL, 2017) with algorithmic solutions and coded in the programming language (GODOI, 2016).

Based on these clarifications, it is understood that information technology is the set of hardware and software that performs processing tasks (AL-MAMARY; SHAMSUDDIN; AZIATI, 2014) for analysis and dissemination of information in the shortest time (TECHNOLOGY AND INNOVATION REPORT, 2018).

From the concepts presented, this work adopted the definition of information technology proposed by Rocha (2014) that informs that IT represents the processes of interaction and interrelation of computational, human, and organizational resources that aim to effectively and efficiently manage the information of organizations and the environment in which they are inserted, aiming at improving production processes, creating a system to support management decisions and assign competitive differentials to organizations, whether public and/or private.

Specifically, to transit management, the use of information technology tools can reduce

chronic congestion, improve the quality of public transport (ELKOSANTINI; DARMOUL, 2013), optimize mobility and accessibility, as well as reduce environmental degradation and high accident rates (VENTER; MAHENDRA; HIDALGO, 2019).

In addition, Fiore, Florea, and Lechuga (2019) point out that information technology has tools capable of monitoring and controlling online the flow of vehicles on land roads, allowing a better quality of management and prevention of transit accidents, in addition to generating gains in scale with the maintenance and management of transit infrastructure.

For transit management, Carvalho (2016) shows that information technology tools can be categorized into:

1. **Advanced Public Transportation Systems - APTS:** Use of advanced technologies to improve the safety, efficiency, and effectiveness of public transport systems. The intention is that the implementation of APTS technologies will allow users and drivers to be informed of existing routes/lines, itineraries, stop points and estimated time of arrival. Benefits for users include minimizing wait times, security, and ease of payment of the fare, as well as accurate and up-to-date information about itineraries and schedules (ADELEKE; JIMOH; AKINPELU, 2013).

2. **Advanced Transit Management Systems – ATMS:** Actions for general transit coordination. These systems use technologies to minimize congestion on urban roads and ensure greater safety for users. Key technologies used include the use of automated signaling systems (smart transit lights), transit security systems, and congestion and route management systems (SHAHGHOLIAN; GHARAVIAN, 2018). ATMS obtains information, within a given geographic area, through technologies such as inductive loop, non-invasive detection devices, closed-circuit TV cameras, vehicle monitoring, police reports, among others.

3. **Advanced Traveller Information Systems – ATIS:** Set of technological tools that inform drivers and travelers about the route, environmental conditions, and transit. These technological tools include the use of navigation and information systems to ensure driver safety and minimize congestion (LIAO; CHEN, 2014).

4. **Vehicle Operations – CVO:** Include the management and operation of commercial vehicles and technologies to improve cargo transport management and service and minimize interference on routes and lost time.

5. **Advanced Vehicle Control Systems - AVCS:** Ensure improvement in road safety, since vehicles are equipped with technologies that monitor driving conditions and prevent transit accidents (ZHAO; LYON, 2009).

6. Electronic Toll Collection – ETC: Use of advanced technologies to provide the most appropriate and efficient toll collection methods, minimizing lost time and, consequently, reducing congestion (ROY; NAG; GOSWAMI, 2016).

Given the tools presented, Santos, Silva, and Nascimento (2015) also explain that the use of information technologies favors the monitoring of vehicles to monitor operations and routes, as well as provide information for better management of decision-making processes in urban mobility.

Liu, Xuegang, and Elrahman (2016) share a similar understanding and state that the use of information technology certifies a more incisive and effective control of locomotion in urban public transport, allowing effective monitoring of operations carried out with accurate and real-time information.

Additionally, Elkosantini and Darmoul (2013) reinforce that the use of intelligent systems that use information processing and communication technologies, sensing technology, navigation, and control, can implement a series of improvements in transit management, such as management and operation of transport systems; better efficiency in road use; improve road safety; increased mobility; reduction of social costs (waiting time and environmental impacts).

According to the discussion presented, multiple possibilities and benefits are arising from the use of information technology tools in transit management activities, since technological functionalities can optimize the quality of services provided, reduce congestion, and optimize travel processes.

3. METHODOLOGICAL PROCEDURES

According to Fontelles et al., (2009) there are several ways to classify research, and the authors are not unanimous about the standardization of this classification. As a result, these authors defined that the research can be classified mainly according to the approach, objectives, and technical procedures.

Regarding the approach, this study can be classified as qualitative research. The qualitative method is considered appropriate to acquire an in-depth understanding of the phenomenon of interest (CORBIN; STRAUSS, 2008). In the case of this research, we seek to understand, based on the interpretation of the participants and the real context of the phenomenon (GODOY, 1995), how information technology tools are used for transit management activities.

Regarding the objectives, this study is characterized as descriptive, because it seeks to describe and understand how the phenomenon studied occurs and who are the participating actors (NEUMAN, 1997). The descriptive aspect of this research is based on the description of the use of information technology tools and their benefits and difficulties in a municipal institution for transit management.

As for technical procedures, bibliographic research and field research were used, with single case study (YIN, 2005) in a municipal executive agency of transit. It is added that this institution was selected because it is the only municipal institution with legal attributions to plan and implement activities related to transit management. In addition, the aforementioned institution has undertaken discussions and directed efforts to review its urban mobility plan, in which transit management and the search for technological optimization, implementation of intelligent transit light, and acquisition of management software have been considered as strategies to optimize transit in the city.

For data collection, a semi-structured interview script was constructed based on literature review and divided into two categories of analysis: use of information technology tools and benefits and difficulties associated with IT use. It is added that the questions used in the interview script were open to making the collection of evidence more conversational, allowing the interviewees to address the themes and discussions they considered relevant (YIN, 2016) about the use of information technology for transit management.

Table 1 presents the categories and elements of analysis and the questions that guide each of them.

Table 1: Categories, elements, and north-key issues

Analysis category	Analysis elements	Northing issues
Use of ITs	<ul style="list-style-type: none"> • Technological tools • IT-using processes 	<ul style="list-style-type: none"> • Comment on the IT tools you use in your daily work. • How are information technology tools essential to do your work? • How do you use IT? (Report at least one activity/process.)
Benefits and difficulties	<ul style="list-style-type: none"> • Technology advantages • Difficulties and failures in the use of information technology • Gains in transit management 	<ul style="list-style-type: none"> • How do you identify the main deficiencies and difficulties associated with the use of these tools? • How do you evaluate the main gains in transit management and operation, from the use of IT tools?

Source: Prepared by the authors (2021)

The interviews were conducted with managers from two technical areas: data processing coordinator (Interviewee A) and signaling coordinator (Interviewee B). The participants were selected by preliminary analysis by the researchers, in which it was found that these managers had a more incisive role in the policies and discussions about the use of information technology tools in the institution surveyed.

Data analysis was performed according to the stages of selection, codification, tabulation, analysis, and interpretation, proposed by Birochi (2017) and summarized in Table 2.

Table 2: Data analysis procedures

Stage	Procedure
Selection	The evidence obtained was initially verified to detect description flaws in the interviewees' reports.
Encoding	Sentences, excerpts, and paragraphs were highlighted and associated with the themes under study, specifically application of IT tools for transit management.
Tabulation	The data were ordered in tables to facilitate visualization and comparison by the researchers.
Analysis	The data were analyzed according to the literature consulted on information technology in transit management. Thus, the results detected in the analysis of evidence were compared to consolidated theoretical constructs to analyze convergent and divergent points between this research and the literature (ZANELLI, 2002).
Interpretation	The data were interpreted with inferences and perceptions of the researchers.

Source: Prepared by the authors from Birochi (2017)

4. PRESENTATION AND ANALYSIS OF CASES

The case analyzed is that of an institution for transit management domiciled in a capital of the Northeast. For better visualization of the data obtained, the results are presented according to the previously identified analysis categories.

4.1 USE OF INFORMATION TECHNOLOGY TOOLS FOR TRANSIT MANAGEMENT

Initially, the coordinator of the data processing area was asked about the IT tools used for transit management, on this subject he said:

For transit management, we have systems developed by ourselves. It is a own system transit management, integrated into the JARI² system. This same system is integrated into the banking area, digital collection area and digital AR³ control as well. In general, these are the solutions for transit management that we have today (INTERVIEWEE A, 2019).

² The administrative board of appeals for infractions.

³ Abbreviation for the Receiving Notice service offered by the Post Office that by filling out a specific form, allows you to confirm, together with the sender, the delivery of the object or letter posted by it.

In addition to the tools already mentioned, the interviewee added that:

For the transit management itself, we use *ciatran* which is a system that looks like a compass, it shows exactly where we will make interventions in what relates to the part of transit signalization [...] this system considers the statistics and places of accidents and proposes interventions, in terms of signs, for these places. Of course, there is a signaling sector that makes a final analysis of these interventions, but this system functions as north of what can be done. We even use the data provided by *ciatran* to justify the deployment of radars at certain points (INTERVIEWEE A, 2019).

Asked about the origin and maintenance of this system, the interviewee informed that:

"This system was developed by ourselves" (INTERVIEWEE A, 2019).

And he adds:

In addition, we have many systems here that are not used, such as service charts, where we can see the flow of people in each service station, the graph of the evolution of fines, graph of typical fines, graphics, and information systems on the types of car drivers we have, a graph of the most committed infractions, etc., etc., etc. (INTERVIEWEE A, 2019).

The indication of not using all technological functionalities of information systems is corroborated by Freitas and Medeiros (2015) who state that in public organizations technological tools are not explored in-depth, being used only to meet basic and routine activities.

Specifically, to the use of IT tools in internal processes, interviewee A reported a specific process, he said:

We work with a third-party company that provides the electronic form so that the transit agent fills out the infraction notice and our system is integrated and synced to this form for verification of incompatible situations, such as vehicle data, infraction location, and photo conference. And only from there do we make the first issue and posting of the infraction notice (INTERVIEWEE A, 2019).

In addition to this interviewee, the technical advisor of the superintendent⁴ was heard, responsible for the signaling coordination. In the performance of her daily activities, with the support of IT tools, this interviewee reported that: "In terms of software are used autocad, coreodraw, office package, flexi Sign⁵ and eventually photoshop. In terms of equipment, the computer, and the printer plotter" (INTERVIEWEE B, 2019).

Asked about the use of specific management software for signaling activities, the interviewee explained that:

⁴ General manager of the institution.

⁵ Specific software used in the plotter for clipping signaling boards.

I feel the need for us to have a specific program to do control and planning of signage and to manage the ombudsman and requests we receive. It is necessary to develop a specific program for our needs, that manages the information that arrives to the sector and the processing of this information (INTERVIEWEE B, 2018).

Regarding the acquisition of specific software for signaling activities, the interviewee explained that:

[Some time ago] I tried to get this software, but instead of doing something specific to our need, [they] tried to build a global system for the entire institution that ended up not meeting our demand. I believe that we have the potential to develop this system right here in the institution, but for this, it is necessary for the institution to set priorities (INTERVIEWEE B, 2019).

Interview B's statements are supported by other studies, such as the Public Sector Performance Improvement Survey (WORD BANK GROUP, 2018), which found that increasing the efficiency of municipal institutions is directly influenced by the definition of priorities by public managers.

The interviewee also added that:

In addition, we need control software for transit light programming so that we can control and schedule times at transit lights, as well as software for managing intersections. These softwares are already planned, including resources reserved to deploy the software together with a central and the entire transit light modernization (INTERVIEWEE B, 2019).

Specifically, carrying out activities with the use of IT tools, the interview reported its use of autocad software. She said:

I use autocad to carry out road signage projects. To use autocad I can take as a basis the city map and start the project from scratch, starting the drawings from scratch and then i leave by inserting the necessary plates and markings (INTERVIEWEE B, 2019).

After the identification and main uses of information technology tools, it was also investigated about the benefits and difficulties in the use of IT, as discussed below.

4.2 BENEFITS AND DIFFICULTIES ASSOCIATED WITH THE USE OF INFORMATION TECHNOLOGY

Regarding the benefits, interviewee A believes that the speed and safety of the process are the main perceived benefits. As reported:

In our case the great benefit is speed of processing and justice with the community because we were able to identify the real offenders of our municipality since these people commit many transit violations (INTERVIEWEE A, 2019).

When considering the speed of data processing, the interviewee approaches the understanding of Oliveira and Malinowski (2017) who explain that using information technology tools, the storage of information is simultaneous, reliable, and instantaneous with a considerable speed for information processing.

Reinforcing justice for the community, the interviewee pointed out another characteristic of the system used. He said:

Our transit ticket management system issues reports with history and flows of the most frequent transit violators, for example, there are car drivers who commit on more than 300 infractions in a year (INTERVIEWEE A, 2019).

Regarding the difficulties, the interviewee was categorical in stating that:

Infrastructure! We do not have the necessary equipment to handle the systems, we do not have a reliable electrical network, and especially the cabling part of the institution that is very scrapped. Sometimes all the institution's activities are paralyzed due to a lack of basic connectivity. The problem is not associated with the systems themselves, but with the lack of infrastructure for these systems (INTERVIEWEE A, 2019).

In dealing with the difficulties inherent in the institution's infrastructure, the interviewee addresses the ideas of Luftman, Lyytinen, and Zvi (2015) who argue that investments in IT infrastructure are a critical factor that affects business development and that a good relationship between business and IT is essential to improve organizational performance and avoid resource wasting in non-strategic causes. On this subject, Melo et al., (2020) add that the use of integrated systems and adequate connectivity is a basic requirement for the operation of technological tools. These same authors also reinforce, as perceived in the researched institution, that infrastructure is still a great challenge to the appropriation of technologies in organizations.

And the interviewee added that:

For the future, I desire the development and evolution of the systems we already use here. This should be done with manuals, lists of procedures. Because here everything is done "point blank", without planning. We need to invest in systems development and efficiency for the institution (INTERVIEWEE A, 2019).

By highlighting the lack of planning as an obstacle to the better performance of technological tools, the interviewee corroborates the perception of Karim (2011) who stated that the management of information technology without proper planning affects the performance and productivity of organizations.

On the benefits related to the information technology systems used, interviewee B explained that:

It is possible to control the implemented signaling schedule and the signaling to be implemented. Likewise, I can control the number of plates used, the footage of paintings made, the number of pedestrian tracks that have been implanted. Without the software, this job would have to be done manually, which would be unfeasible. In general, I have gained in the overall productivity of the sector and my activities (INTERVIEWEE B, 2019).

It is noticed that the control of activities and materials is an important benefit reported by the interviewee and this finding can be confirmed in the studies by Cascio and Montealegre (2016) that reinforce that the planning and control of data, materials, inventories, and activities represent important operational and strategic results resulting from the use of information technology tools.

As for the difficulties in using informed IT systems, the interviewee gave a similar opinion to interviewee A, she said:

I have no difficulties with the systems. The problem is my computer and the institution's infrastructure. My performance is affected by the problems I have with my machine. The time I take to access basic information about my work ends up affecting my performance because I waste a lot of time just opening an Excel spreadsheet (INTERVIEWEE B, 2019).

Regarding the deficiencies in infrastructure, notified by the two interviewees, it is evident that the appropriate support for the information technology infrastructure should consider from the simplest issues of the day-to-day of the user to the guarantee of the operation of servers and the entire set of computer resources since an adequate infrastructure is the guarantee of the operation of servers and increased overall productivity in organizations of public and/or private nature (TOSSY, 2016).

To better synthesize the results obtained, a summary of the main evidence identified in this study is presented in Table 3.

Table 3 - Summary of the results obtained

Interviewee	IT tools		Benefits	Difficulties
	Tools	Functionality		
Data processing coordinator	<ul style="list-style-type: none"> Sistema integrado de gestão de trânsito - CIATRAN 	<ul style="list-style-type: none"> Citizen service graphics The flow of care at each service station; Graph of the most 	<ul style="list-style-type: none"> Processing speed; Justice for the community. 	<ul style="list-style-type: none"> Inefficient infrastructure

		committed offenses; Graphs and information systems of the types of conductors; Graph of the typicality of fines.		
Signage Coordinator	<ul style="list-style-type: none"> • AutoCAD; • Corel • Draw; • Office Suite; • Flexisign. 	<ul style="list-style-type: none"> • Projection and sketches of road signs 	<ul style="list-style-type: none"> • Productivity improvement of the sector; • Control of planned and implemented signaling schedule. 	

Source: Prepared by the authors (2021)

Thus, although there are limitations in the infrastructure for the use of information technology tools, the interviewees recognize its benefits and potential, which, although little explored, provided gains in transit management activities.

5 FINAL CONSIDERATIONS

Based on the results presented in this research, it was corroborated that the use of information technology facilitates and streamlines the operations developed by transit management institutions, because it unites the advantage of speed and reduction of time in the execution of routine activities and, simultaneously, provides information about activities and implementation needs regarding transit issues, including road signs, supervision, and process management.

As evidenced in the speeches presented, even working at the same institution, the interviewees indicated the use of different information technology solutions and applications for transit management. Consequently, it was observed that there is no global management system that meets the needs of all sectors. Perceiving itself then that the tools used, as indicated by respondents are included in the Advanced Transit Management Systems (ATMS) group.

From the perceived results, it is evident that the lack of uniqueness in information technology tools affects the overall performance of the researched institution, since one of the main features of information technology, which is internal communication, is negatively compromised, because each sector works in an isolated and non-integrated manner, as proposed from the use of computational resources.

Some limitations should be listed regarding the development of this work, the first of which is that having adopted the single-case strategy, the results obtained cannot be generalized, suggesting new research with a greater number of municipal transit management institutions, as well as the comparative analysis of the use of computer resources among these organizations at municipal levels, state and federal.

Another limitation pointed out is the low number of interviews conducted, on this subject new research is recommended with more interviewees. On this limitation, it is understood that the selection of managers directly associated with the use and definition of information technologies allowed to obtain the main information the use of IT for transit management in the analyzed institution.

The research suggestions resulting from the limitations identified do not end the possibilities of further studies on the subject, so longitudinal research is also suggested to identify the evolution in the use of information technology tools for transit management, as well as quantitative studies to measure the impact (in terms of benefits) of the use of IT tools.

Considering the understanding that the use of information technology is a preponderant element of transit management, this study achieved its objective, because it was able to identify the technological tools used, as well as the benefits and difficulties associated with its use in a municipal institution for transit management. In addition, the discussion of the association between information technology and transit management can help identify new or similar findings in other transit management institutions, allowing us to understand how IT can be used to optimize operational, control, and transit management processes, and is consequently to improve mobility in municipalities.

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