

Qualitative Analysis in Personal Authentication Systems for construction workers Cuenca Ecuador

Felipe López, Carlos Flores-Vázquez, Marco Avila Calle

Abstract— The management of employees in various professional fields has a great impact on the growth of an organization. This activity evolves with technology, and in the area of construction it is no exception. In the city of Cuenca, Ecuador, masonry attendance control faces a challenge, since it cannot adapt to its respective new trends. However, its difficulty seems to be not only technical, but also cultural, due to the discordance of the users' behavior regarding to sundry existing solutions. The dilemma in question gives origin to the current article where we present a project which focuses on personal authentication technologies used with construction workmen and their acceptance. In this document we present the project and some results. In order to determine the most appropriate technical tool for personnel registry and its relationship with the cultural context of the users, the project's methodology has two phases: The state of the art of access control systems for construction employees, and the determination of the local labor reality regarding the use of such technologies. For the first phase, a classification of the indexed academic contributions and the marketplace offer elaborated along with a basic meta-analysis of the regional scientific documentation. Secondly, local data collection through questionnaires will be carried out, jointly with the review of related undergraduate and graduate projects. As a conclusion, based on the results of both methodological stages, we intend to demonstrate the dependence between the social circumstances of the workers for the inclusion of an adequate attendance control tool.

Index Terms— Access control, Attendance control, Biometric Identity Management System, Construction workers, Personal Authentication, Technology management, Workers management.

1 INTRODUCTION

The evolution of informatics in conjunction with the demands of the professional sector has generated innovative solutions with positive effects at the productive level for countless organizations. These new trends not only include the production chains, information flow and marketing; they are also fundamental at an administrative level [1].

It is precisely in this aspect that, within the numerous logistic tasks and management in a company, whether it is a SME (Small and Medium Enterprise) or a large multinational, the registration and control of workers is an established need that motivates the development of technological proposals [2]. This requirement of staff attendance control in an organization aimed at: the supervision of the hours worked by employees, the fulfillment of their functions and a disciplinary follow-up regarding their entry and exit authentication [3]. However, there are several production sectors, such as construction, that have not prioritized investing in management tools for their employees [4].

The construction industry is an activity of high economic production that will make an important financial contribution at a national and local level in most countries, including Ecuador [5]. Due to its relevance, several innovative proposals can be found

to optimize the processes in construction projects. But, despite the technological development, there are obstacles in the implementation and adaptation of them, involving the control of workers' attendance [4].

The situation above explained motivates this article, which emphasizes in this industry and specifically aims to support the academia and the professional sector through an analysis of the response to personal authentication systems in a representative scenario. It will study the systems used by construction companies in the city of Cuenca and the dependence between social circumstances and the reaction to their implementation. Likewise, the respective recommendations to implement new attendance controls according to the needs of both, the companies and the employees involved, will be determined.

In the words of the former president of the Chamber of the Construction Industry (CAMICON), Silverio Durán the construction industry is one of the productive sectors that brings more wealth to society, internationally is considered the largest employer in the world. In Ecuador, this activity plays a role as a permanent contributor to the country's capital, it is the second largest production industry and the fourth largest economic sector that generates employment. It is also necessary to add to its added value, the tax collection it represents; therefore, it is qualified as a strategic sector and an efficient means for the economic reactivation of the nation in the face of various existing financial and social challenges [5], [6].

Since 2007, the Ecuadorian construction sector has contributed greatly to the national economy due to the investment in infrastructure by the government [5]. However, since 2015, the Gross

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Domestic Product (GDP) of the market in question began its decline to the point that in 2019 there was a reduction of 5.2%, adding the general crisis of 2020 due to the health emergency of the COVID-19 pandemic. Notwithstanding all the above-mentioned drawbacks, Ecuadorian construction represented 11% of the country's economy in 2019 [6].

The construction industry in the city of Cuenca characterized by being one of the most important sources of local employment. Human resources within this type of projects considered one of the most important elements to ensure success, and their management directly affects their optimal execution [7]. The approach to labor management emphasized in different academic documents that promote strategic planning and the inclusion of information technologies to guarantee the correct development of a project and to face common difficulties in this professional sector.

One of the biggest challenges in construction is absenteeism. On several situations, workers disappear resulting in staff shortages and considerable delays in the development of a given work. This is why it is important to train personnel for different tasks including the handling of personal authentication technologies as a control method against absenteeism. However, when a worker's salary depends on the work actually performed, training considered a waste of time within the working day [8], [7].

The most widely used technology for time and attendance is biometrics, specifically the one that analyzes the fingerprint. Its popularity based on its unique morphological characteristic for which there is no correlation between individuals. However, when it is processed it presents some difficulties due to the user's conditions; essentially in construction workers who present calluses on their fingers making it difficult to capture the ridges of the fingerprints [9].

This document structured as follows: section 1, besides of the main introduction, also describes the scenario regarding the construction industry in Ecuador and in the city of Cuenca. Section 2 outlines the methodology implemented for literature review and local data collection. Section 3 presents the acquired results. Finally, in section 4, the conclusions discussed.

2 METHODOLOGY

2.1 State of Art

Personal authentication has become more stringent over the years. Initial proposals that included only passwords, manual records and others have been described as inadequate methods due to human error and information vulnerability [10]. Among the great variety of proposals, the analysis of biometric information is one of the most diverse, focusing largely on the validation of fingerprints as is the case of Adeniji, Scott, and Phumzile [11] who carry out this type of proposal aimed at tracking school attendance.

In addition to features like the one mentioned above, there are several academic developments that use the shape of the hand

and the characteristics of the palm [12], [13], [14]. Other relatively common aspects are the recognition of iris and retina as Kumar and Passi [15] and Mariño, Penedo, Penas, Carreira, and Gonzalez [16] demonstrate respectively in their work.

However, the great impact of authentication has led to a great breakthrough with respect to classic biometrics, for example the capture of fingerprints produced by knuckles [17]. In his article, Takeda [18] proposes to analyze the pressure on the foot produced by the distribution of a person's weight; and Tao [19] uses a person's walk to verify their identity. There is even the study of vein patterns [20], [10] or the characterization of the ear canal [21].

The evolution of these technologies makes much emphasis on security to the point that a single technique is not enough giving rise to robust projects where, additional functionalities such as RFID [22] added in combination with biometrics. Similarly, since biometric data are easy to obtain and duplicate [23], another trend arises corresponding to the analysis of two biological elements such as the iris and face at the same time, and it is exactly this approach that is developed by [24].

In order to proceed in obtaining results in different scientific platforms, the use of boolean expressions in advanced search options was implemented. Due to the extension of the logical equations used, the consultation in specific databases such as Scopus, Springer, IEEE Xplore, results in minimal documentation, reason why it decided to deploy an enhanced query through the Google Academic search engine that includes besides than the previous mentioned, also repositories, publishers among others, excluding patents and citations.

The selected documents correspond to academic contributions developed in the last 20 years in relation to the topic. For the respective extraction of the scientific articles, an analysis of metadata corresponding to the title, abstract and keywords carried out through two search strings: a logical equation in English and another in Spanish to explore the contributions at a regional scope.

The first query structured as follows: ("construction workers" OR "construction manpower") AND ("attendance control" OR "attendance management"), which selected 43 articles. The second string used: "trabajadores de la construcción" OR "obreros de construcción") AND ("control de asistencia" OR "control de ingreso") resulted in a total of 55 academic results.

Despite the usual procedure for a logical search, certain documents were filtered that did not describe the control method used or, in other cases, the type of scenario corresponded to factories and other institutions separately. Due to this first outcome, it was necessary to determine inclusion criteria to evaluate whether each documentary piece in the resulting universe actually met the necessary requirements: control items for construction workers where the type of technology or tool used was specified; resulting in a reduction from an initial universe of 98 to 17 units to be analyzed.

2.2 Development

The methodology employed for this project based entirely on qualitative research, since the aim is to obtain non-numerical data to understand a context and its implications by defining a grounded theory. The collection of information mainly based

on surveys as the main method, since their results are juxtaposed with theoretical data derived from a literature review. In order to analyse the situation subject to the study in this article, it was essential to acquire data present within the academy framework as well as from the working reality. The conditions and problems will be derived from the social and economic culture variant to the population and location of the target scenario of enquiry. Therefore, the methodology in this research has been classified into two major phases: a literary review of scientific contributions, and a collection of data from the main agents in the field of construction.

By applying Cochran's sample calculation formula, a 95 % confidence level and a ± 10 % accuracy is assumed, resulting in a sample of 73 subjects. Their questionnaire designed to perceive the reality regarding the implementation of personal authentication control technologies and the limitations they have encountered.

Due to the informality of the hiring processes of the workmen, it is difficult to address a specific guild, hence work was done with the employees of a locally active civil construction site, in which 57 people contributed by answering a series of questions where information was obtained on the attendance control systems and their experience in this regard.

3 RESULTS

As you can observe in figure 1, with the implementation of a literature review through a metadata analysis it was possible to obtain a reference regarding the technologies used for the time and attendance control of construction workers. The sample of acquired items indicates that more than half of the items, 58.8%, make use of RFID technologies for the use of cards, as well as bar codes and tag readers.

From the other half of the documentation, it can be seen that the monitoring done, either by a construction resident or another staff member, is of greater preference than the use of biometric sensors. Finally, with a minimum percentage of 5.9%, the use of entry sheets and other uncommon techniques is considered.

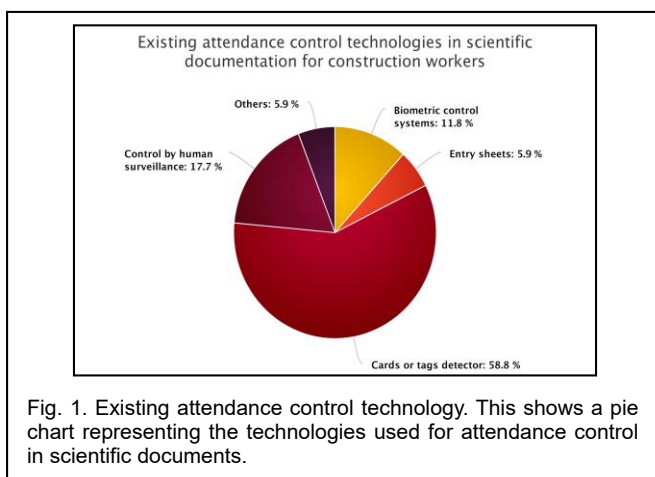


Fig. 1. Existing attendance control technology. This shows a pie chart representing the technologies used for attendance control in scientific documents.

As In the surveys directed to the construction workers, a series of questions were asked in order to establish which is the most comfortable system for them, which they are actually required

to use and how they receive them.

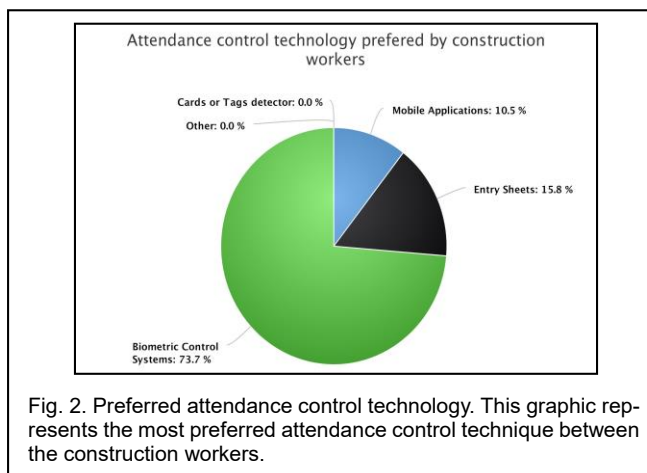


Fig. 2. Preferred attendance control technology. This graphic represents the most preferred attendance control technique between the construction workers.

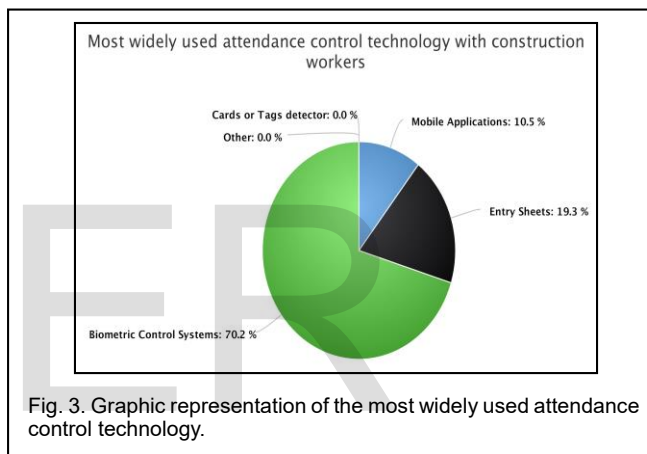


Fig. 3. Graphic representation of the most widely used attendance control technology.

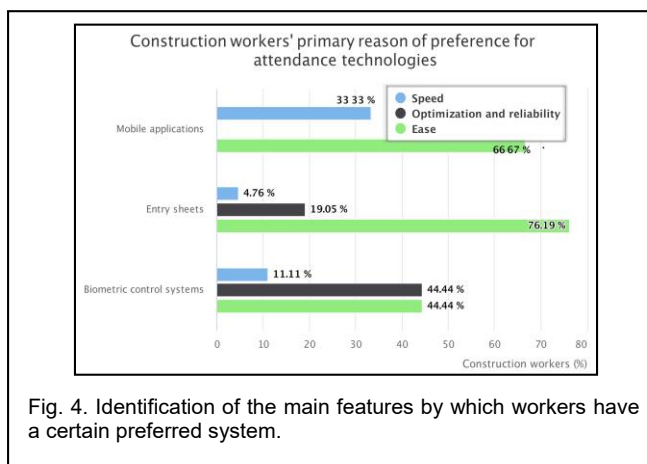


Fig. 4. Identification of the main features by which workers have a certain preferred system.

To begin with, in figure 2, it was sought to determine the technique of preference for them, proving biometric control to be the first option for the great majority with 73.7%. As a second choice but with a considerable difference, entry sheets were selected by 15.8% of the respondents. Finally, there was a 10.5% who preferred the idea of mobile applications. It is important to

note that the alternatives for cards and labels were not considered by any of the builders.

In the following graph, figure 3, it is possible to notice that the technology most used corresponds to the biometric sensors in a 70%. The use of entry sheets belongs to an old technique, but it still remains at 19.3%. Finally, it can be evidenced that the use of mobile applications is reflected in 10.5%.

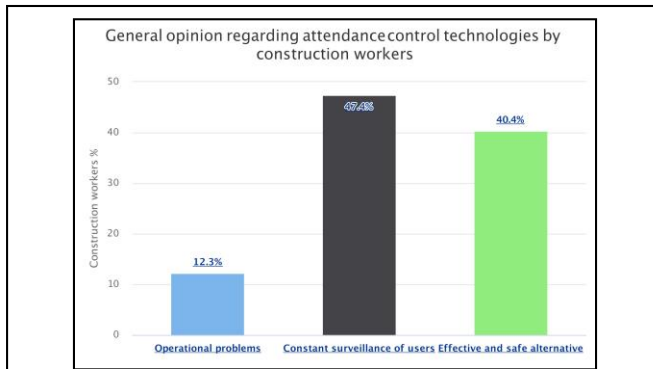


Fig. 5. General opinion regarding de technology as a whole for attendance control.

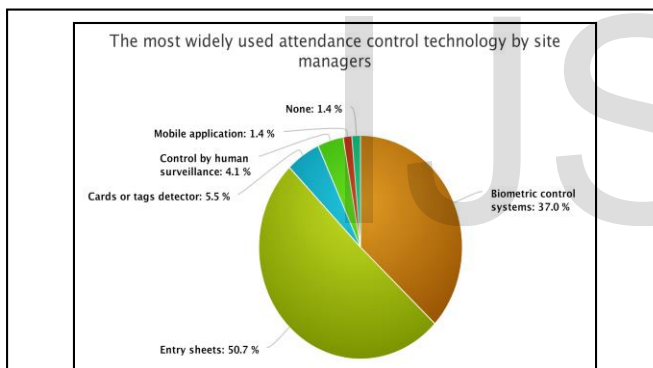


Fig. 6. Graphic representation of the most widely used attendance control technology by construction site managers.

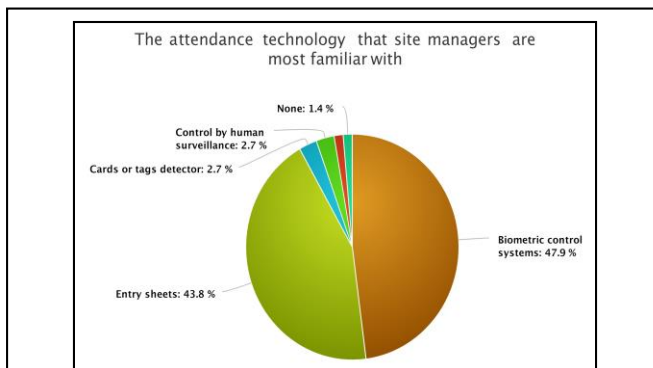


Fig. 7. Best known attendance control technology. This shows a pie chart for the recognition of the most popular attendance control technique between site managers.

Having defined the types of systems most used thanks to the previous questions, the reason why they chose their preferred

method was determined. The main virtues of the systems are their ease of use and their efficiency in operation. In figure 4, the most used option, that is, biometric clocks, it is evident that the reason for their preference is due to the simplicity in their use and the confidence in correctly registering time.

In the case of entry sheets and applications, the greatest attribute is the simplicity of their use over any other feature.

Finally, what was attempted to define in the surveys for workers was their general reflection on the existing technologies. As it is shown in figure 5, 47.4% of them consider that the advice or presence of a third party is necessary to guide the correct use of the systems. 40.4% define them as effective and safe alternatives; however, for 12.3% of users they consider that there are operational problems in one way or another due to the production of agglomerations and electrical failures produced by conditions of the project site itself.

Site managers, who due to their hierarchy have greater authority in personnel management decisions, have a great influence on their perception of the appropriate tools because in most cases they are the ones who acquire them. It is for this reason that their contribution to this research considered equally valuable as that of academics.

In the following graphic representation figure 6 we can determine that the most used system by our target group corresponds to the entry sheets with 50.7%, followed by biometric sensors with 37%. The implementation of RFID technology, as well as the use of a human agent for verification, mentioned in smaller quantities of 5.5% and 4.1% respectively. The proposal of mobile applications is almost imperceptible.

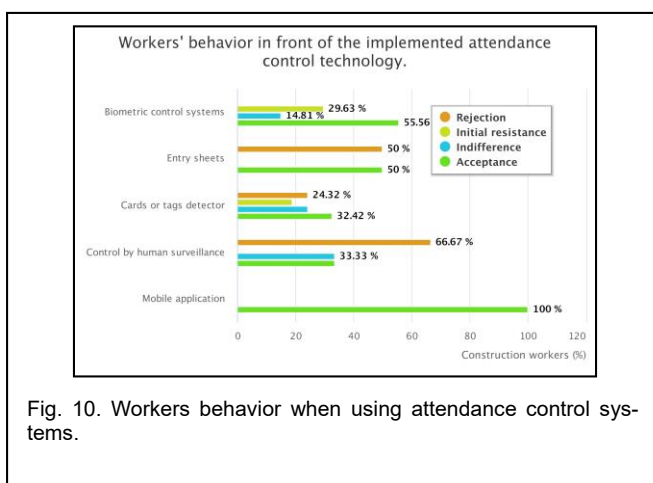
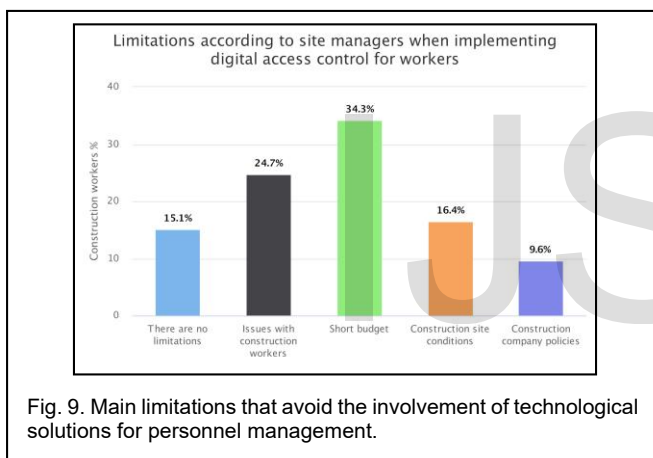
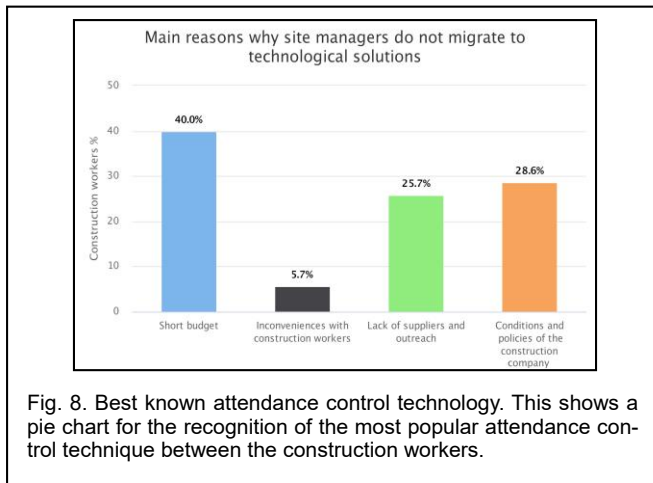
Between the most known options among the construction managers are the biometric systems (47.9%), as well as the response of the workers. However, there is more consideration (43.8%) for entry sheets by those evaluated in this subsection. The rest of the technologies represented with values lower than 2.7%. See figure 7.

Given the high preference for the use of entry sheets, the reasons why they did not migrate from this method were discussed, and according to the response it was possible to graphically show in figure 8 that the main factor is the costs by 40%. Subsequently, they indicated that due to company policies and construction conditions (infrastructure, security, scale) the implementation of technology is complicated.

A considerable 25.7% expressed ignorance of the existing options, they are not in contact with suppliers that promote products or technological solutions for this. Finally, with a value of 5.7%, the inconveniences with the workers mentioned, since the site managers report that there are problems of recognition with the fingerprints of the workers and the disorganization produced in the marking process.

As in the previous results, a similarity can be seen in figure 9 with respect to the major limitations of technology installation. The main one with 34.3% corresponds to the short budget that be expected in a construction site. However, complications with

workers already represented more strongly with 24.7%. In values, it identified that the conditions of the construction and the policies of the company also correspond to an impediment. Otherwise, for 15.1% there is no obstacle at all.



In the following graph figure 10, users grouped according to the most used technological option in order to evaluate their reaction. As can be seen, there is a percentage of rejection in almost

all categories, the most notable being the method where a third party is in charge of monitoring the other members with 66.67%. Similarly, the response of acceptance is considerably good to be able to implement and experiment in the future with the collaboration of the workers.

4 CONCLUSION

The present academic article aimed to demonstrate the problem of adapting technological tools for personal authentication for construction workers and the dependence on the social conditions of the users themselves in Cuenca, Ecuador.

An evident social discordance demonstrated through this paper where inconsistencies between academic studies and real life practices detected. The dependence on social circumstances for personal authentication systems show through workers and managers own opinions and how distant they are from current solutions. Although the intention was to propose a suitable technological authentication system, it was only possible to determine why none of the methods already widely used were entirely functional, since it is more a matter of the users than of the principle of operation of each system.

To develop our objective, an analysis of industrial construction importance carried out involving its role as a generator of employment and its effect on the national GDP. Once the fundamental part of this economic activity clarified, it was difficult to ignore to some extent the stagnation of this sector in order to optimize important administrative processes such as the personal authentication.

Through this research, three factors identified as hurdles for a normal evolution in this market segment: the social and physical conditions of the workers who would be the users of the system; the lack of interpretation of existing solutions in the local reality; and the reluctance of high-ranking officials to train their employees.

The first factor was determined by contrasting the scientific evidence with the methods implemented in our study scenario. To begin with, it demonstrated that the use of biometric sensors -strictly with a fingerprint reader- is not suitable for this profession due to the physical condition of the users caused by deformations in their hands, instigated by the very nature of the job. However, it is one of the most widely used technologies, although it presents disadvantages as verified by the results of the site managers' questionnaires.

Still mentioning the first indicator, as can be seen in Figure 5, workers consider that they need a guide to be able to use the authentication tools even though they are autonomous-low difficulty equipments. It is possible to verify that there is already a predisposition as not a viable solution on their part and on the part of the site managers, when the fact of having signature registers or a person to oversee them represent greater complexity and labor pressure.

Regarding the interpretation of existing solutions, it demonstrated in the qualitative research that one of the most used tools is the entry sheet, when there are card-reading devices

that are faster than a signature but are not even known by the workers.

Lastly, if representatives of construction projects expect to see the increased productivity that comes with attendance control of their workers, there must be proper guidance and investment in innovation. If there, is no interest in seeking commercial options, giving up manual methods and defining an adequate infrastructure to optimize personal management; then construction in Cuenca, Ecuador will continue to be affected by absenteeism and stagnation of its processes.

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