

Application of the Quick Tool Exchange (QTE) System in Building Maintenance

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Abstract— *Quick Tool Exchange (QTE) acts to reduce losses and failures during the production process and throughput time, contributing to rapid response to market changes. The object of the work is a private school of the Municipality of Porto Velho, capital of Rondônia. The general objective is to study the building maintenance of a private school in the Municipality of Porto Velho / RO, focusing on QTE technology. Therefore, the specific objectives were to characterize the building maintenance in the study (1); compare the operational processes applied in the face of QTE concepts (2); and propose innovation for the operational improvement of building maintenance in operation (3). The building maintenance has a clear importance, since its compliance contributes to the preservation of life and health of users of any construction. Both the preventive and the corrective have been receiving the importance due to it, especially the preventive one, since this is always cheaper in comparison to the corrective one, since besides the damages caused to the physical structure of the building, there can exist to the users present in the occurrence of the fact. The methodological procedures consisted in carrying out a bibliographic survey followed by a case study. The results demonstrated measures approved and not approved by the QTE, suggesting simple innovations, but with significant consequences to the improvement of*

service rendering, minimizing costs in the area of building maintenance. This study is of interest to businessmen in general, especially the public or private educational sector, and those involved with the area of Production Administration.

Keywords— *Quick Tool Exchange. Educational Sector. Building Maintenance. Production Management.*

I. INTRODUCTION

This study deals with the application of the quick tool exchange before the building maintenance of a company of the educational sector located in the municipality of Porto Velho, capital of the State of Rondonia. The research can be observed the lack of studies related to building maintenance in companies of the educational sector and the convergence of thought of several authors on the subject.

The quick tool exchange, despite appearing in the nineteenth century, is important for the contemporary moment, both as an instrument for companies that seek to maximize their profits, in addition to becoming more competitive and managing to expand in front of the market, in that they can meet the needs of their customers, even in frequent changes.

This work began with an indication of the objectives of the research, followed by an explanation of the theoretical

and conceptual references that served as a basis for the interpretation of the case study, definition of methodological procedures, results achieved with research, conclusion and references. Therefore, the present aims to respond to the following research problem: How can the application of QTE contribute to the improvement of existing building maintenance in the company studied?

In order to answer, it is a general objective to study the property maintenance of a private school in the Municipality of Porto Velho, capital of the State of Rondônia, with a focus on QTE technology and for the results, it has as specific objectives to characterize the property maintenance of the establishment in study (1); compare the operational processes applied in the face of QTE concepts (2); and propose innovation for the operational improvement of building maintenance in operation (3).

II. THEORETICAL-CONCEPTUAL REVIEW

This task is based on the Theory of Scientific Administration in conjunction with Contingency Theory. Since the classic Frederick Taylor, studies on the factory floor were already deepening, demonstrating how the organization should work, what production means, the costs and time needed, which manpower would meet the need of the organization, noting that the increase of the effectiveness and qualification of the organizations promoted the expansion of the factories, which in turn struggled to change the disorganization by commercially optimized models, improving the working conditions and its products, maintaining a good relationship with its employees, according to Taylor (2015) .

It introduces the Contingency Theory that deals with organizations in general and the interferences of the external environment that provoke structural changes, demonstrating that there is nothing absolute in the organizational environment, as Moreno et al. (2016). It states that there are several ways to run an organization to achieve success, considering that the environments in which it is inserted are not equal, and its organizational structure must be confronted with the characteristics of its environment. Emphasizes the need for systems of managerial controls to visualize the adaptations that promote alignment with the internal and external environments, and the manager must promote the changes so that the performance of the organization does not suffer negative variation, being able to offer competitive products and / or services , both in quality and in selling price.

Survey in Fagundes et al. (2008) indicates that some factors that contribute to the decision-making process regarding the systemic evaluation of the situation in which the organization is facing the market are: division

of labor, centralization and decision-making process, work specialization, standardization of activities and organizational environment.

The aforementioned factors are contingent variables related to the organizational structure, which according to the highlighted theory, cooperate to define an optimized structure and the management systems most appropriate to the organization.

2.1 Concepts of building maintenance

According to Ribeiro (2015), building maintenance treats the infrastructure of a building in all its systems, whether electrical, fire and security, communication, air conditioning, among others. He also says that building maintenance must take place in a planned way, because it involves resources of the organization, and the better to apply them in the first maintenance, the less it will be spent in the second.

For Antonini (2011), building maintenance consists of a cluster of services and activities that allow reliable and safe conditions for the conservation of buildings, within technical norms and standards. We emphasize preventive maintenance that seeks to avoid simple problems to the most complex and harmful to the health and safety of users. Lack of planning to do this type of maintenance can affect the organization's finances, because, according to the authors, corrective maintenance, which happens after the problem arises, is more expensive and can have more serious consequences.

2.2 Concepts about operational processes and Quick Tool Exchange (QTE)

Process consists of the joining of functions and activities organized in a logical sequence, performed by machines or people, seeking to transform resources into goods and services, through a processing methodology, as prescribed by Martins (2012). All departments of the organization are considered a process, which, for good management, must be analyzed, studied and structured, because the intention with the management of processes is always to achieve the best possible results.

Fogliatto and Fagundes (2003) further argue that QTE aims to reduce or eliminate losses during the production process, resulting in an increasingly simplified and effective model in terms of cost minimization and the duration of the production process, as it provides a chain reaction as it is implanted in the organization, causing direct changes in several factors, among them: production model, unit costs, raw materials and secondary materials, labor quantitative in each phase of production, profit organization.

According to Moura and Banzato (1996), the focus should not be on the productive process, but rather on the time lost between machine stops, since the main objective is to meet the demands and demands of the customers.

2.3 Innovation concepts

According to the OCDE Handbook of Oslo (2005), innovation is defined as the improvement of a good or service, making it new or substantially improved, process, organization of the workplace or external relations.

The innovation is correlated to the increase in organizational performance, as well as to several administrative theories, mainly Contingency, since innovation tends to be a response to changes imposed by external and internal environments, as discussed by Amorim et al. (2013).

This author cites Sundbo and Gallouj (1998) to remind us that service innovation comprises an incremental phenomenon, easier for imitation by competitors and with less development time when compared to the innovation of materials; because these variants lead to constant changes in the performance of services, highlighting them in the consumer market.

According to Martins (2012), in the area of productive operations it is necessary to manage processes with the implementation of management controls, given the various advantages that the organization provides, among them: focus on the main business, determining the necessary resources and costs involved, but also the elucidation of customers and suppliers; delineating processes in the form of drawings allows the identification of problems or improvements; among others

III. METHODOLOGICAL PROCEDURES

This section presents the steps that were taken to develop the research. For Prodanov and Freitas (2013), scientific research is a planned study that aims to solve problems with the application of the scientific method, from hypotheses that will be confirmed or disregarded by the research.

According to the aforementioned authors, the research means the search for knowledge, using procedures capable of giving reliability to the results. This statement represents this study, which sought to establish how maintenance is performed, to confront operational processes with theory and, finally, to propose innovations for the improvement of the executed service, not only to present the results, but with them, the possible solutions of the problems encountered.

The work was developed under the aegis of the bibliographical review, because it sought to build a solid basis for the contribution of the continuity of the study, since the next step was the survey of the practical part of the object in question, leaving for another crop, the of the case study.

The case study is related to the instruction of one or a few objects and consists in the collection and analysis of information about a particular individual, studying their varied aspects, according to the subject of the research, according to the vision of Prodanov and Freitas (2013).

Table.1: Detail of the methodological procedures adopted

Aspects	Classification	Description
Nature	Applied	✚ It aims to generate knowledge for practical application in solving specific problems.
Purpose of the Study	Exploratory	✚ It is worth of bibliographical survey and realization of interview with people who have practical experiences.
Procedures	Bibliographic Survey	✚ Elaborated from published material, with the aim of familiarizing the researcher with the topic addressed.
	Case study	✚ Research, which aims to study a unit in depth.
Problem approach	Qualitative	✚ Research has the environment as a direct source of data. The researcher maintains direct contact with the environment and the object of study in question, necessitating a more intensive field work. In this case, the questions are studied in the environment in which they arise without any intentional manipulation of the researcher.

Source: The authors. Adapted from Prodanov and Freitas (2013).

The research instrument was the conduction of an interview guided by a semi-structured questionnaire, following the prescription of Prodanov and Freitas (2013), applying intensive direct observation. The interview with the manager of the establishment under study was applied in order to obtain information about the research problem.

The tools used for interview transcription were the Windows Media Player audio player, along with the Microsoft Office Word text editing program.

IV. APPLICATION OF THE QTE SYSTEM IN BUILDING MAINTENANCE

The company under study has been in the educational sector for more than three decades and is located in the eastern part of the municipality of Porto Velho, capital of Rondônia State; provides services to over two hundred children in primary and secondary education. The institution operates under the modality of partnership by limited liability share to two partners. In its table it is estimated present forty employees, comprising professors and personnel of administrative support. In the area of the municipality where it operates, this is the only private educational institution, which is a positive point in terms of competitiveness.

4.1 Characterization of the building maintenance in the study

Initially it is incumbent to compare theories of the Scientific Administration and Contingency with the practice in the school researched. On-site observation of

the certificates was carried out in connection with the cleaning of water tank and artesian well, detention, air central maintenance, operating license, fire brigade and sanitary surveillance demonstrating concern with the structure physical, because Ribeiro (2015) points out that, when acting in a planned way, building maintenance manages to ensure the zeal for the existing infrastructure. So much so that Taylor (2015) deepened studies on the Theory of Scientific Administration, pointing out how the organization should work, which manpower would meet its needs, among others; and Moreno et al. (2016), when discussing Contingency Theory, states that nothing is absolute in the organizational environment and that external factors cause interference in the company, which in the present case corresponds to the search for vacancies above the capacity served, provoking the need for space expansion in order to offer more vacancies. Figure 1 and Table 2 below demonstrate the steps for making decisions in response to the new demands that arise.

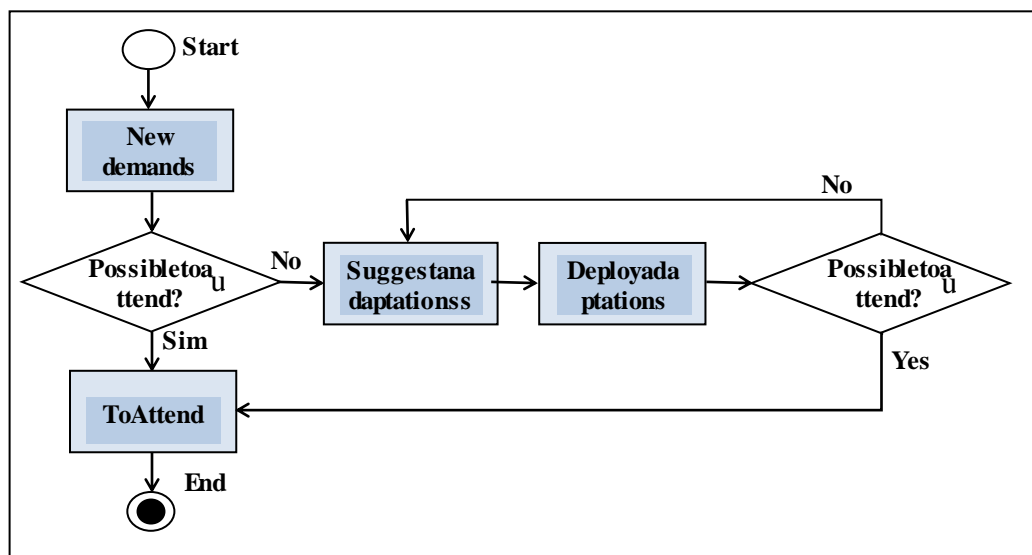


Fig.1: Reconfiguration of decision making in the face of new demands, in view of QTE.

Source: The authors.

Table.2: Specification of the steps of the process for decision making.

Process steps	Description
Start	It represents the phase in which the productive process of building maintenance has its start.
New demands	The emergence of new demands related to building maintenance may require market consultation.
Decision	At this stage, the decision on the systemic analysis to meet the new demands of the building maintenance, encompassing the financial, personnel, logistics, among others, will undergo changes to the faithful attendance of the demands to be implemented.

To attend	<ul style="list-style-type: none"> ✚ Phase in which the organization acts to meet the existing demands related to property maintenance and those recently implemented until the appearance of new ones.
Suggest an adaptation	<ul style="list-style-type: none"> ✚ After concluding in the systemic analysis that at the moment there is no possibility to meet the new demands, the organization will propose measures to be implemented in the production process, so that these new demands are met.
Deploy adaptations	<ul style="list-style-type: none"> ✚ At this stage, after the measures are listed, they will be inserted into the existing production process for further verification if they are sufficient to meet the demands that have arisen.
Decision	<ul style="list-style-type: none"> ✚ Another phase of systemic analysis, only this time in order to verify if the measures proposed to the production process are sufficient to meet the new demands related to land building maintenance. ✚ If yes, go to event 4 - Attend. ✚ If they are judged insufficient, return to event 5 - Suggest adaptations.

Source: The authors.

Still on the expansion, the organization acted in a positive way for the conservation of its patrimony, in complying with the mandatory norms to carry out the work, as on the CREA in Rondônia State, with architectural, electrical, sanitary and hydraulic projects, all of which are approved by the respective supervisory bodies. In view of this focus, it is verified that the researched establishment follows the prescription of Antonini (2011), when it conceptualizes the preventive maintenance, exposing on the guarantee of the safety conditions and reliability related to the conservation of the buildings, in the norms and technical standards required.

It was also studied the issues related to the maintenance of air conditioning equipment, such as air central, wiring, cabling distribution; it is still included in this study the maintenance of the communication system, namely the telephone and internet connections. With the expansion of the establishment, there was a need for interconnection in the network and cabling system, in order to meet the new internal demand of the organization. Another situation refers to corrective and preventive maintenance, including here the interconnection of the communication system between the two physical structures that starts to be operated after the renovation and building expansion. As far as this increase in the physical structure of the building is concerned, six more classrooms were constructed, and in the existing structure there are ten classrooms, four in the upper part and six in the lower part. The stairway leading to the upper floor is narrow to the size of the students, making them deliberate by deactivating the upper classrooms, reducing the number of classrooms in operation; instead of making sixteen rooms available, only twelve are being used.

The logical network undergoes maintenance as problems appear on the computers and cameras installed, increasing the frequency with the passage of time, possibly due to

the life of the materials and equipment. The cameras installed serve for the security of the organization, as well as for monitoring the children, and parents are allowed remote monitoring via a worldwide computer network. Maintenance in the hydraulic, electrical, architectural, sanitary, air-conditioning and communication systems is carried out by outsourced companies, due to the expense of financial resources to maintain a proper maintenance team to cover so many important areas, since the maintenance of buildings guarantees conditions reliable and safe for the conservation of the building. In this way, it reaffirms Antonini (2011) understanding that the lack of planning for preventive maintenance can affect the finances of the organization, which is not the case under study, since the organization is acting in a planned way.

4.2 Comparison of the operational processes applied to the concepts of QTE

In this subtopic will be confronted the concepts gathered from QTE in the face of the survey elaborated in this task. Significant is to consider the theoretical prescriptions with the practices observed, in order to interpret the coherence or not of the precepts of QTE. The study allowed to verify the degree of conformity in the operational processes carried out in the organization, which made possible the introduction of the innovation ahead.

Comparing theory with practice, it is possible to verify that in the physical expansion of the studied project, the legal norms necessary to avoid future disturbances or even imputation of fines due to their noncompliance were observed, besides reducing or even avoiding structural problems that have serious consequences, explaining in practice the concept of process, in order to carry out activities organized in a logical sequence, reaffirming the understanding of Martins (2012).

Another fact that deserves to be highlighted is the maintenance of buildings in the area of air conditioning, since in the view of Antonini (2011), corrective maintenance has higher values than preventive maintenance, which interferes with the expected profit margin, despite the fact that with the prevailing climate in the Amazon Region, it is necessary to monitor this issue, since lack of it will cause difficulties for its clients.

For the expansion of the physical space of the school, it was not conjectured the physical appropriateness of the existing staircase in the old part, which made that the management decided to deactivate the classrooms that worked in the upper part of the school. At this point, the organization acted contrary to the theory applied by the QTE, because according to Fogliatto and Fagundes (2003) and considering the number of vacancies that could be

offered, this decision resulted in financial losses, besides that this theory, when defending as beneficial the reduction of the time of duration and losses in the productive process, seeks the simplification of this and not make it idle. In this same sense is the understanding of Moura and Banzato (1996), stating that the organization's main goal should be to meet the demands and demands of customers, so if there is a demand, it should be sought. In order to corroborate that the application or not of QTE on land maintenance interferes in other areas of the organization, Table 1 below presents a comparison between the current scenario and the one considered as ideal in the view of the QTE, with hypothetical values and quantitative, but within of the local reality, expressing at the end the amount of the financial loss as a result of the decision taken.

Table.1: Confrontation between the current and ideal scenarios (in the view of the QTE).

Current scenario		Scenarioideal	
1. Students per room	20	1. Students per room	20
2. Monthly payment – Value in USD	200	2. Monthly payment- Value in USD	200
3. Total per room (item 1 x 2)- Value in USD	4.000	3. Total per room (item 1 x 2)- Value in USD	4.000
4. Used rooms	12	4. Used rooms	16
5. Total with 12 rooms (item 3 * item 4)- Value in USD	48.000	5. Total with 12 rooms (item 3 * item 4)- Value in USD	64.000
6. Possible shifts (morning and afternoon)	2	6. Possible shifts (morning and afternoon)	2
7a. Monthly Revenue (item 5 * item 6)- Value in USD	96.000	7b. Monthly Revenue (item 5 * item 6)- Value in USD	128.000

8. Monthly Difference (item7b–item 7a) - Value in USD	32.000
9. AnnualDifference (item 8*12) - Value in USD	384.000

Source: The authors.

The last item analyzed was by whom the building maintenance is carried out, either preventive or corrective, detecting that as a result of the disbursement to maintain a proper team for this purpose, it was decided to outsource the various necessary maintenance. This measure is adequate in the view of Martins (2012), stating that this allows the reduction of costs with property maintenance, evidencing its focus on the enterprise, mainly regarding the involvement of financial resources, which contributes to its maintenance in the competitive market.

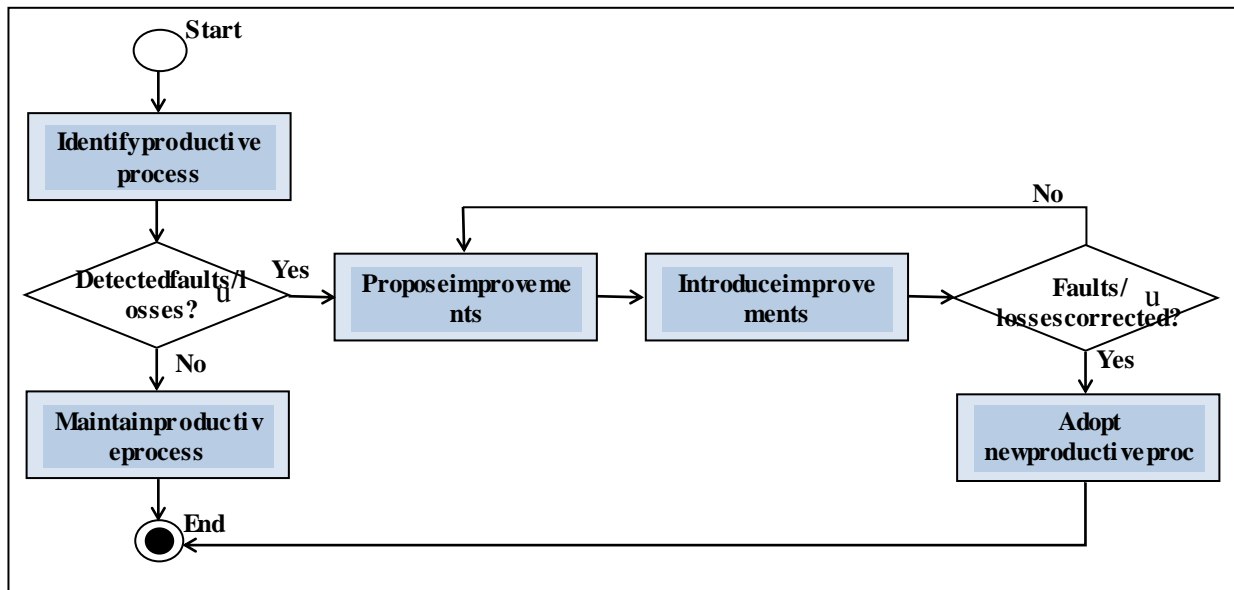
4.3 Innovation for operational improvement of building maintenance nowadays

In view of the findings verified during this research, some changes in the building maintenance are presented, thus promoting, according to the theoretical-conceptual revision explained in item 2.3, innovation to them.

As for the lack of communication of the existing logical network in the old part and with the extension, it is suggested the interconnection of the same and the creation of the Data Processing Center (DPC), in which all the devices that need access to the network will be managed computer world, such as: computers, monitoring cameras; internet and telephone services. In agreement with the one approached by Amorim et al. (2013), when citing Sundbo and Gallouj (1998) on the increase of organizational performance, this study considers that the application of the QTE through this approach of these authors, will lead to improvement in the prevention of failures, as well as the rapid identification of these in what refers to the exchange of materials and equipment in non-conformity or with a lagged useful life.

Another possible innovation would be the implementation of control of preventive and corrective maintenance of the air central, which are the most frequent in the two options, updating it to each maintenance, describing the maintenance date, the services performed and the parts replaced with their and thus the system can be analyzed in terms of the cost that each air station generates to the school, making possible the most beneficial decision making to the organization, according to Martins (2012). Regarding the deactivation of the classrooms that functioned at the top of the existing physical structure

before the expansion, due to the access ladder, it is suggested the accomplishment of an architectural project that promotes the improvement of access to the upper floor, so that improve the safety of employees and students, since the decision made interfered in the improvement of the physical structure of the building, property maintenance and income of the educational institution. Finally, we suggest the reconfiguration of the quick tool exchange, as shown in Figure 2 and Table 4 below.



Source: The authors. Adapted from Fogliatto and Fagundes (2003).

Fig.2: Reconfiguration of QTE.

Table.4: Specification of process steps for QTE reconfiguration.

Process steps	Description
Identify productive process	Phase in which the detailing of the productive process in execution related to the building maintenance occurs.
Decision	From the definition of the production process, its analysis must be performed in a systemic way, in order to verify the existence of failures / losses during the process.
Maintain productive process	In concluding that there are no failures / losses, the production process identified initially is preserved.
Propose improvements	If failures are detected, the necessary improvements should be listed in an organized and planned manner.
Introduce improvements	The improvements will be inserted in the pertinent phases of the productive process, seeking the correction of the failures / losses.
Decision	Promote observation of the productive process under test, aiming at a posterior analysis to ensure the absence of failures / losses. In the detection of failures / losses, return to event 4 - Propose improvements.
Adopt new productive process	Once there is no failure, the new production process is approved. The process should be run from then until further faults / losses occur.

Source: The authors.

These proposals are characterized as innovations, because according to ODCE (2005), the improvement of the existing service is being opportune, modifying the operational process, organization of the workplace, also contributing to the improvement of external relations, when a new offer customers.

V. CONCLUSIONS

The present work aimed to discuss the application of the quick tool exchange in the property maintenance of a company of the educational branch. In this sense, the research problem was to respond in what way the QTE can contribute to the improvement of the existing building maintenance of the school under study.

The relevance of the QTE to the organizations is also due to the competitiveness that increases each day and globalization of the economy, causing companies to seek the means to remain active in the market, acting in a rational way for decision making, mainly to property maintenance, as this reflects in the possibility of responding to the expectations of its customers, which is to be met with more speed, quality and reduced prices, as has been discussed in Rodrigues and Billar (2015).

Regarding the objectives proposed by the research, the first one was to characterize the property maintenance of the establishment under study and with the research process it was noticed that despite some failures, the same seeks, within its limitations, to meet the legal norms and techniques in the field of building maintenance, characterizing a rational use of resources, especially financial resources.

The second objective reached by the research was the comparison of the operational processes applied in the face of the concepts of quick tool exchange, being possible the visualization of measures approved and disapproved by this one. Nevertheless, the disapprovals consist of simple nonconformities, but their regularization will contribute to the improvement of the procedures and the consequent reduction of failures and losses in the productive process referred to the property maintenance, main objective of the QTE.

The last objective was to propose innovation for operational improvement of the building maintenance in operation, it was verified that it is necessary to interconnect the logical network of the two present physical structures (old and enlarged), converging to a data processing center; the implementation of control of maintenance of the central air would contribute to deliberations about the economic viability or not of other maintenance, either preventive or corrective; and finally, the physical suitability of the staircase present in the first

structure of the school so that the four classrooms that are idle can be reactivated.

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