ASPECTS OF PERFORMANCE INFORMATION INTEGRATION IN THE INDUSTRIAL MAINTENANCE

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Abstract. *The challenges imposed to big companies in the world-wide scenario is making them to improve their global efficiency supported by information technology. Performance measurement and management systems search the integration of different information generated in specific areas to aid the decision making processes and improvement of actions linked to this strategic effort in several instances. On this track, many companies are searching for better ways to integrate performance indicators, as well as the investigation of choerence and consistency in the data processing. An important issue is to apply the evaluation criteria defined for each performance indicator matched with its meanings and correct measurement. Another is concerned with the characteristics that the data collection, storage and disposal of these data should have to reduce the difficulties of implantation and information sharing. The objective of this work is to discuss aspects of the implantation of a part of such system in the industrial maintenance area (of a rubber devices manufacturing company) analyzing the integration of a indicator of unavailability for a specific equipment, and its corespondent generated in the manufacturing area. The discussion envolves the evaluation of both indicators, accomplished with the mediation of the enrolled interests. A comparison, through parallel observation, is made for the difficulties found in the application of both indicators as well as due to the differences among the evaluation criteria adopted, which are reflected in the numeric values measured in both areas.*

Keywords: *Availability, Industrial Maintenance, Information Systems, Integration, Performance Indicators*

1. Introduction

The development of the globalization process, in the sphere of some transnational groups, is demanding that their companies look for prominence position in the dispute for the competitiveness. This position refers to the "concept" that each organization unit that belongs to a group shall to favor through performance management and in large scale the whole group highlights in the local and world-wide scenery, by the development of appropriate strategies. In this context, the implantation local systems of information linked for performance measurement linked to the corporative level became common in the great business groups. However, these systems suffer variations activity to activity in the companies, in function of the results that each one wants to obtain and of the understanding reached by the users in the different instances. This makes that the integration of the computerized means and the involved evaluation criteria become a complex task of accomplishing. As point the studies of Andersen and Henriksen (2004), Eccle (2000), Hayes and Wheelright (1995), among other, the simple fact of the implantation of performance management systems doesn't give warranty to obtaining the wanted results, as many think. Andersen and Henriksen (2004) esteem, with base in their studies and in other authors, that "about 70% of the implantation initiatives fail", and this unsuccessful rate can be attributed fundamentally to problems of systemic integration of indicators and of misinterpretation of the results and meanings of the performance for the users, in different instances.

This work focuses some aspects of the local module of the performance measurement and management system, of a great manufacturing company of rubber products, being implanted in the area of industrial maintenance, for about two years, and makes a parallel of the operation of this module with the operation of another module of the system, already consolidated, that has been used by the manufacture area for several years.

The Section 2 makes the methodological remarks of the research. The Section 3 presents a vision of the corporate objectives deployment through the whole organization, delimiting the impacts in the maintenance areas and manufacture areas. The Sections 4 and 5 contextualize the main characteristics of the performance indicators in the two

areas respectively. The Section 6 performs the jointed analysis of the two types of unavailability indicators obtained in the areas, presenting a graph with behavior of both and focusing the difficulties found in the process of integration of the maintenance and manufacture modules. It shows some consequences of the construction of the unavailability indicators by the adoption of differentiated criteria of evaluation. In the Section 7, the evaluation is extended to some systemic integration characteristics of the local information toward the corporate level. The Section 8 presents the final considerations.

2. Methodological remarks

This paper is part of an empiric research that it is being carried out as part of the development of a master's degree dissertation linked to mechanical engineering. The main methodological principles applied in this work were developed: (i) in Peixoto (2004) and Peixoto, Dias and Xavier (2003) for interaction of evaluation criteria and meanings of performance in applied researches of organizational objects. In the present case, with the organizational object being focused on the interaction between the different users' of the performance information system, and (ii) in Andersen and Henriksen (2004), for evaluation of systemic integration issues of the data processing toward to the corporate level.

In agreement with Peixoto (2004) and Peixoto, Dias and Xavier (2003), the performance should not only be approached only with the focus in the production of planned results, but as a multifaceted construct that expresses cultural and conceptual differences implicit in the evaluation criteria and meanings produced in each context of evaluation. It shall be observed with a enlarged model of reflexivity suitable to the objectives of the research, in order to manifesting the possibility of being observed as only opportunity for reception of new meanings for articulation of adjustment and innovation actions.

Andersen and Henriksen (2004) distinguish three axes of evaluation for systemic integration of performance information, which are worked partially in this article. Those axes concern the analysis: (i) of the requirements of selection of performance data, (ii) of the requirements of the performance measurement and management system and (iii) of the presentation of information of performance outcomes. The application of the same axes facilitates to identify key aspects in the management of performance data linking to the different instances of the measurement and evaluation actions.

The comparison of the maintenance and manufacture points of view allows to verifying the coherence and consistence of the performance indicators inside of the delimited methodological context - applied to the operations of the two modules of the performance measurement and management system - that can spread through other levels of use toward the level of the corporation management. The comparison of the data generated in the modules uses the parameter of unavailability of a single equipment as the indicator of performance, standing out the differences between both and generating an entire "base" of arguments, with elements of comparison and of reading of meanings, brought by the inherent differences of vision inside each activity. The data collection of the research was made with one of the authors acting as participant observer.

3. General vision of the of the performance objectives deployment

At the end of each year, the researched company - as it is habitual in most of the companies linked to international groups - draws objectives for the following year that represent the positions in which it wants to reach. Usually those objectives are associated the quantitative goals accompanied by aligned justifications with the strategy local, regional and global of the institution, representing the way to be followed. The deployed goals linked to the global ones are distributed by the several sections of the organizational units, fitting to each one what to do in order to reach the objectives in the different instances of that deployment.

Soon afterwards, taking as base the available equipments in the productive park and its maximum capacity of production, it is settled down which the percentage of the available total time, that each one of the equipments should effectively produce, so that the objectives are reached. To accompany these numbers just answers if the objectives were reached or no, of the quantitative point of view, but the reason of the reach or not of the goals many times continues being unknown. So, in the case of failure in the reach of the goals, someone lost information to determine the reasons and, in the positive case, also lost information to increase knowledge to reach innovation or learning about the use of good operational practices.

As example, in the treatment of the unavailability indicator of the equipments of the researched company, it can look for more qualification of these parameters associated to the calculations, or more knowledge in general about the behavior of the contexts associated to the use of the same. Dealing with the percentage of acceptable stop can be better negotiated between the manufacture and the maintenance, inside of the actions associated to the efforts of improvement of the quality and productivity.

Inside of this focus, the company developed a program to register all of the occurrences that disable that the equipments can produce. The occurrences that more concern to the performance of the function maintenance become separated basically in: stops for corrective maintenance, emergencies or programmed, and stops for preventive maintenance. This attendance is accomplished for all of the equipments of the industrial park. For its turn, the

manufacture area only accompanies the equipments responsible for the production of the final product. Other equipments that prepare products in phases previous to the final processing, are not usually accompanied, once they usually work in advanced schedule (i.e. premature production), so that stops of short duration do not interfere in the final production. On the part of the manufacture area, these equipments are only observed when happens a long stop that results in other in the main equipment group, but, for the maintenance area they are seen in another way, because this has a very larger concern with the of medium and long period planning.

4. The indicators of the manufacture

The data collection, accomplished by the manufacture, is done manually by the production operators, and the data are introduced in the local database for processing. The local module of the system allows the access, through the net of the factory, for the whole authorized personnel. Through this access, is possible, at any moment, to verify the registered data, as well as to emit reports standardized by the system, in function of what was defined as of interest for the manufacture personnel. The analysis of those data happens periodically, at the end of every month, according to the definition adopted during the fixation of objectives. The structuring of the parameter of unavailability of the manufacture area is represented by the percentage of yield of the main equipments, and its complement composes the percentages of stop of those equipments distributed by the several reasons of occurrence. That supports the interests of the function manufacture, in the sense of knowing how much was produced, as well as the as how long and "who" turned the unavailable equipment for the manufacture. Those data are used inside the group for comparison among same equipments of other organizational units, identifying factories that are considered as "benchmarking" front to the others. Inside of those comparisons, it should be considered that, due to the flexibility of the equipments in manufacturing different products, not always those comparisons are fair of the point of view of the efficiency of the productive processes. Inside of the manufactured products, some are easier and other more difficult to produce; that is, more or less problematic. There are factories that just have an equipment that should produce products of several types and other that have several of the same equipments, dedicating some to the production of specific products with greater or smaller complexity.

5. The performance indicators in the maintenance

To accompany the indicators of the manufacture gives a good idea of how the presence or absence of maintenance area, "disturbs" the production activity in a certain period, through the service performed in order to attending faults that happened in the equipments. However, this is limited information among a great universe of performance dimensions of the maintenance. Today, it can be said that the larger orientation, inside of a modern vision of the maintenance function, is summarized in the concern of reliability. This concept, not only focused exclusively on the equipments that produce the final product, but in all of the equipments of the park that can impede the productive activity, at any moment, without notice. There is a concern, quite accentuated, in developing scientific studies involving risks of several types, where that one of fault in accomplishing production schedule is just one of the categories of interest. According to Monchy (1989), the mission of the maintenance is the "optimized" management of the park of equipments, also called the *production device*. Still, according to Monchy (1989), “the mission of the maintenance is triple: permanent or periodic supervision, retreats of states of breakdowns and repairs, and preventive actions" and to do that it will be necessary “collection of the data, storage in memories and treatment of the operational information processed”.

In order to manage the maintenance activities and complement the information obtained from the manufacture, the maintenance area uses specialized software to control their activities. It is a trade package that registers all of the maintenance activities and allows interface with other used by the factory, including that used by the area of manufacture. The data are collected manually and introduced in the database by authorized people. The subsystem allows the emission of graphs and reports, at any moment, for the period that the user wants, as well as the export of data for special treatment by other software of general use. Differently of the manufacture, the maintenance needs information of the whole park of machines, being machines that produce the final product or not. So that it also of interest the interventions that don't stop the machine and other extraordinary actions accomplished with the guarantee of the manufacture. In short, the maintenance area has interest in the control of every work that has as consequence the unavailability of equipments in the park of machines. This is different of the vision of the manufacture that only worries about the stops that interfere in the production of the final product. There are, with the unavailability indicators, other derived of the theory of the reliability that are common in the "benchmarking" of "indexes of world class" (Tavares, 1999 and Monchy, 1989), that generate similar subjects, but they are not treated in this article due to the delimitation adopted for the theme.

6. Analysis of performance indicators

In order to understand the difficulties of this implantation process better, as well as the conceptual differences among the visions of the manufacture and of the maintenance, we will take as base the first 23 months of the

implantation of this system of data acquisition of the maintenance in the referred company. The system of data collection of the manufacture is a stable system, used for several years. This study limits to the indicator of unavailability of an equipment denominated as Equipment "A", by the maintenance area.

Fig.1 displays the data for comparison among the percentages of deviation of the unavailability objective due to the maintenance work, according to the vision of the manufacture area and of the maintenance area. In brown, the results considered by manufacture and, in blue, the results according to the vision of the maintenance.

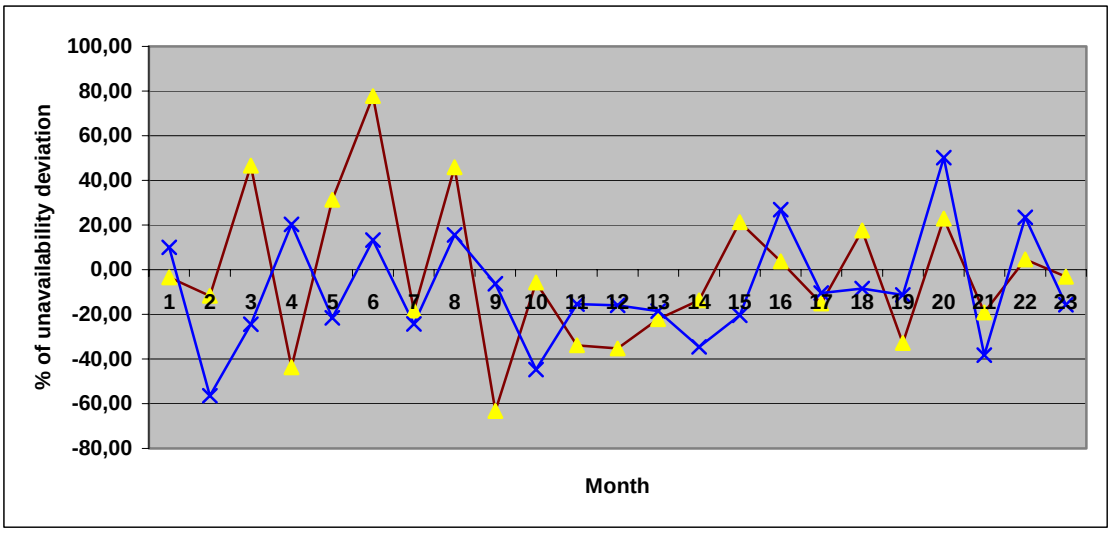

Figure 1. Unavailability results in the visions of the manufacture (brown) and maintenance (blue).

First of all, there will be made considerations in relation to the differences of criteria adopted by the manufacture and maintenance areas in the data collection and data processing, from which the indicator arises. Those considerations are displayed in Tab. 1, seeking a better understanding of the differences between the approaches.

Table 1. Differences of the measurement criteria applied to the evaluation of performance in the manufacture and maintenance areas.

Criteria	Manufacture	Maintenance
1- Maximum possible time of operation in the month.	It considers the total of scheduled hours in the month, less the time of equipment overload.	It considers the total scheduled hours in the month.
2- Measure of the stops due to absence of products in the Equipment "A", due to a problem in another equipment that is its supplier.	It considers as a flaw in the Equipment "A".	It considers as fault in the supplier equipment, because it happened in this equipment that the maintenance acted.
3- Observation of problems in subassembly that is not decisive for a total stop of the Equipment "A".	It considers only the time that the Equipment stopped the production of "A".	It considers the total time of stop of the subassembly where the intervention was accomplished.
4- Measure of the time spent in preventive maintenance.	It considers only scheduled stops, exclusively for such. It doesn't consider interventions of the maintenance during other stops of the equipment (breakdowns, cleaning, etc.)	It considers every preventive or corrective scheduled intervention, independent of the time of execution.

Evaluating the consequences of each one of these differences, we will have:

a) For a given intervention of the maintenance, the unavailability percentage in the vision of the manufacture will be smaller than in the vision of the first one, in case it has happened "overcapacity" in the referred month;

b) Case the Equipment has stopped many times in function of problems in accessory equipments, the unavailability percentage inside of the vision of the manufacture it will be larger than in the vision of the maintenance, because those interventions of the maintenance will appear in other equipments and not in the equipment "A";
c) In case it happens a lot of interventions in sub-assemble not essential for the operation of the Equipment "A", the unavailability percentage inside of the vision of the manufacture it will be smaller than in the vision of the maintenance. This happens due to the maintenance to compute the total time of the interventions, and the manufacture, to compute the partial time, or even to compute anything;
d) In the case of the occurrence of "overcapacity" taken to advance preventive maintenance, the unavailability percentage inside of the vision of the manufacture won't contemplate those interventions, and the time not computed. For the maintenance these interventions are seen.

A first analysis of the Fig. 1, shows a great difference among the indicators in the first months of the implantation of the maintenance software. It is a difficult phase for the professionals that are not still totally familiarized with the new tool. Starting from the second year of use, the indicators begin to be more coherent, presenting larger drifts in the months 15 and 18, being these in sides opposed in relation to the objective. This fact can be justified for the criteria *a* or *b* presented in the Tab. 1, or even due to wrong data entry or missed data. Actually, what is still observed at the maintenance workshop is the professionals' difficulty in working with computer tools, mainly the more experts, as well as they have not created the habit of considering the data entry as part integral, and important, of the intervention. They leave this part in second plan and a lot of times forget it. Following the pattern of the results, it is observed that there is not a constancy of the unavailability out of the drawn objective. This means that the stipulated objectives are feasible and that the maintenance is accomplishing, in satisfactory way, its mission. Those results should be observed related to the characteristics of the equipment, mainly in what they refer to the size and complexity.

7. Characteristics of systemic integration

In the analysis of the key-aspects of the systemic integration of performance information linking the different instances of the measurement and evaluation, in agreement with the three axes of evaluation of Andersen and Henriksen (2004), stands out:

(i) of the requirements of selection of performance data.

That the model of selection and collection of data basis to the building of the indicators is a powerful tool that enables the daily consultation of interventions in the equipments. The professionals can make the collection of data in real time and storing then in the computerized basis, whose fidelity is directly linked to the registrations for identification of them. That is important to guarantee fast decision making, because the direct contact with the professionals that worked with the equipments not always is possible, in function of the several schedules of work. In a global vision, a growing familiarization of the professionals can be observed with the system, being reflected in information more and more reliable.

(ii) of the requirements of the system of measurement of the performance.

The outstanding characteristic of the module of performance measurement in the maintenance area is that the system elaborates reports and calculates programmed indicators automatically, taking advantage of the established pattern for the data entry from professionals. The database suffers periodic backup, and the access in network can be restricted with the adoption of password profiles.

(iii) of the presentation of the information of resulting performance.

The manufacture module makes available several types of graphic and standardized reports, however its great advantage is to make available the database for the creation of specific software that access the storage data. The same data can be exported and used in tools of windows basis.

As more critical aspects for the management of the system, stand out: the misalignment among the interests of short period of the manufacture and of medium and long period of the maintenance as a consequence of the natures of the two functions, and the dissonance among the visions of final results, in the local level and in other levels of decision of the corporation, that it can punish the work of the maintenance indirectly, more focused in accompanying intrinsic aspects of the processes applying the theory of the reliability, that are not noticed in other instances. In consequence, emerges a dispute that, in an employee's words, it should not have been loser nor winner, whose ideal is that an eye looks at the results they have to reach and the other stay worried about producing them". With technological infrastructures

compatible and management more and more improved, looking forward through a developed vision of the types of knowledge shared in the flows of processes and evaluations of performance used.

Everyday there happens a meeting in the maintenance area with the objective of evaluates the occurrences of the maintenance system, and also weekly meetings (sometimes more than one) for explanations close to the manufacture. These meetings include the technical body, supervisors and maintenance leaders. Manufacturing people try to explain logged problems for the manufacturing people with the base of data of the maintenance and vice verse. Some types of implanted actions and of data of tendencies need to wait the end of an observation period to begin to make sense. Even so, the established indicators can be updated daily, while the database goes being fed.

8. Final comments

The analysis of aspects of the implantation of the module of the performance measurement and management system in the maintenance area and the comparison of unavailability indicators generated by this module and for its contestant of the manufacture allows to reach a general idea of as those areas of the company are making their work and contributing to the global objectives. The largest lesson of the research is that an indicator should not be seen as a cold number nor about a simple point in a graph other without meanings, besides its relative position to the evaluation criteria and decision established in advance. As this work show, it should be known with clarity the contexts in which the indicators and criteria are adopted in order to obtaining of a more appropriate explanation that, in general, don't emerge from the most immediate understanding of what they suggest. There is a need to adopt more developed models of reflexivity that allows reaching enhanced explanations of the reality.

The implantation of new analysis procedures in the maintenance brought, initially, a great concern for the management of the manufacture, because the monthly collection of the data makes possible to evaluate and to validate actions of medium and long period out of its immediate control. On the other hand there is a fear that this facility reduces the specialists' daily presence in the factory ground; of the absence of their eyes in the "thermometer of the workshop", taking the immediate maintenance action, when necessary. Those subjects are only resolved through the dialogue in situations of interaction among the parts. For this type of action, the systematized indicators just aid, but which it become more important is a larger knowledge of the nature of the performance in itself.

Finally, it is necessary to stand out that it is not enough to have a performance measurement and management system capable to integrate much of defined indicators. The man who is the interface among the system and the reality that someone wants to represent through those indicators is the main factor of this whole process. It is important that the professionals, in the different areas, develop visions of local and global performance more and more representative of the reality for better use of the operational databases.

9. References

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