

# Brazilian version of an assessment tool for the evaluation of work organizational aspects (AOT) by the NIOSH WMSD Research Consortium: Translation and application in industrial sectors

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**Abstract:** Work organization affects the production of a company as well as the health of employees. It is a challenge to create sustainable production systems with the least harm to the health. An observational assessment tool was developed by the NIOSH – WMSD Research Consortium and adapted by the SHARP study. The objectives were to translate this assessment tool into Brazilian Portuguese (as the Avaliação de Aspectos Organizacionais do Trabalho - AOT) and to evaluate its applicability in an industrial setting. The AOT final translated version was obtained after a consensus by the research team. Difficulties arose in applying the translated version due to technical terms with no direct equivalents in Portuguese, non-excluding or similar alternatives, and questions that gave room for various interpretations, besides the great complexity of the tasks performed in the sectors. Despite that, the results suggest that AOT was sensitive for discriminating differences between sectors. Nevertheless, for better application of this tool in complex industrial environments, it is necessary: training and consensus among evaluators, familiarity with organizational aspects of the occupational settings evaluated. Also for assuring the internal validity of the analysis, might be necessary, the creation of subdivisions in the sectors evaluated if the tasks vary significantly intra-sector. The present report can help to understand the difficulties inherent to the evaluation of organizational aspects on a collective level and also the possible implications related to the translation of this assessment into other languages.

Keywords: observational tool, collective organizational evaluation, health, ergonomics

## 1. Introduction

Work organization directly affects both the productivity of a company and the health and well-being of its employees. The term can be defined as the process by which work is conceived and carried out. Management, production methods, and human resource policies are all involved. External factors are also included in this concept, such as the legal, eco-

nomical and technological environments, which makes this a complex subject [1].

Most production systems have recently been submitted to restructuring and resizing in order to increase product quality. These new organizational practices usually imply mechanization, automation, and a reduction in the number of employees. As a consequence, workers perform, multitask and work longer hours. Thus, there is a current challenge to

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create sustainable production systems that cause the least possible harm to the mental and musculoskeletal health of workers [2].

There are few methods for evaluating work organization on an individual level and even fewer resources for evaluating work organizational aspects on a collective level in the literature [3]. This knowledge gap remains as one of the main obstacle for ergonomic intervention [1]. In order to help resolve this question, an observational assessment tool was developed by the NIOSH – WMSD Research Consortium and was adapted and used in the SHARP study [3].

Thus, the objectives of the present study were to translate this assessment tool into Portuguese (as the *Avaliação de Aspectos Organizacionais do Trabalho* or AOT) and to evaluate its applicability in complex activity sectors in an industrial setting.

## 2. Methodology

### 2.1. Place

The present study was carried out in a factory of office supplies in the state of São Paulo, Brazil.

The company employs approximately two thousand workers who are divided into several sectors. The work organization of each sector is defined according to the tasks performed, the type of machinery involved, the number of employees, and the administrative management. Because tasks vary substantially both between sectors and within the same sector, as well as the fact that the sectors are interconnected, the work organization assumes diversified and complex forms.

Very distinct sectors were chosen for applying the tool in order to achieve both the most representative evaluation possible of the factory's organization and a broader evaluation of the assessment tool. Three sectors were initially evaluated, one processing sector and two finishing sectors. In the finishing sectors, two different activities (painting and packing) were performed, which were classified as subsectors.

The two types of finishing required different hygienic measures, such as the need for special clothes, gloves, caps and air circulation control. This led to distinctions in the denomination and evaluation of these sectors, which were subsequently identified as Finishing 1 and Finishing 2 along with their respective subdivisions (Figure 1).

Processing sector employees were allocated into nine lines. Their tasks involved the upright position, the use of a relative amount of force, and job rotation among some of the workstations. Even though the machines varied to some extent, the workers had the same function and similar activities, which simplified task analysis.

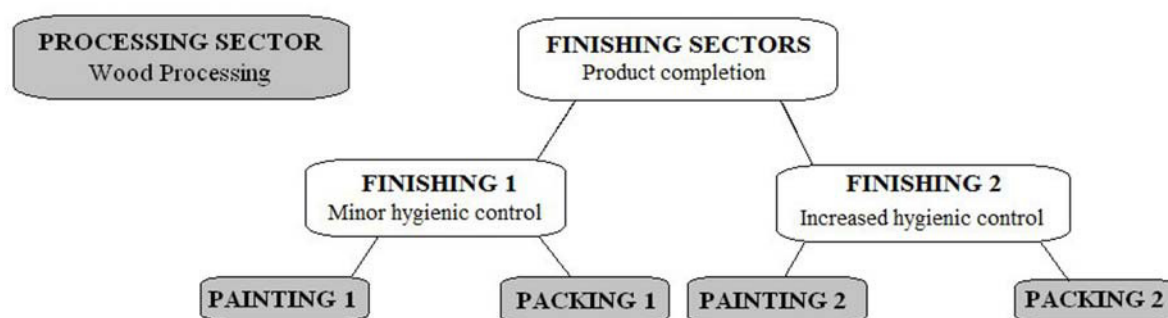


Figure 1 – Description of sectors and subsectors

The finishing sector included the painting and packing subsectors. In the painting subsector, products were painted, stamped, selected and stocked until packing. These processes were carried out in 18 cells, each controlled by an average of five employees. Packing activities were performed manually, either seated or standing depending on either worker preference or on the product to be packed. On average, eight employees were standing in a line at the tables to pack products of various kinds, sizes and shapes. The diversity of products and processes made work organization more complex in finishing sectors than in the processing sector.

### 2.2. Subjects

The subjects who worked in these sectors were heterogeneous in all aspects: gender, number, age, experience, and educational background. Employees were divided into three eight-hour (on average) shifts and worked from five to six days per week, depending on company demand.

The physical and mental requirements, although present in all studied production sectors, varied widely among them and depended on the task

### 2.3. Evaluators

Three undergraduate ergonomics students and two experienced post-graduate level researchers acted as evaluators in this study.

### 2.4 Evaluation Assessment Tool

In order to evaluate work organization in the designated sectors, the AOT was used. This tool was originally developed by the American agency NIOSH (National Institute for Occupational Safety and Health), specifically by the NIOSH WMSD Research Consortium (MSCD). Later it was adapted for the needs of the SHARP study, which is described by Howard et al. [3]. This instrument analyses work organizational aspects through observation. The aspects considered are described in Table 1.

Table 1  
Aspects considered in the AOT assessment tool [7].

| ASPECTS                                 | QUESTIONS   |
|---|---|
| DEMOGRAPHIS                             | 1 - Overall job gender mix<br>2 - Sub-task gender segregation<br>3 - Other demographic segregation  |
| AMBIENT ENVIRONMENT                     | 4 - Illumination<br>5 - Noise<br>6 - Housekeeping   |
| TASK-LEVEL WORK ORGANIZATION            | 7 - Labor type<br>8 - Skill level<br>9 - Position type<br>10 - Work structure<br>11 - Muscle activity level<br>12 - Social interaction<br>13 - Task/activity level<br>14 - Work pacing type<br>15 - Work pacing control<br>16 - Job rotation<br>17 - Type of preparation for action |
| WORK GROUP                              | 18 - Flexibility in work hours<br>19 - Flexibility in work arrangements<br>20 - Formal break schedule<br>21 - Informal break possibilities<br>22 - Extended work hours<br>23 - Shift work   |
| ATTENTIVENESS DEMANDS                   | 24 - Demand for attention   |
| RESPONSIBILITY FOR THE SAFETY OF OTHERS | 25 - Responsibility for the Safety of Others  |
| STRUCTURAL JOB CONSTRAINTS              | 26 - Restrictions in Work Structure   |

### 3. Procedures

#### 3.1. Translation

In the present study, those who translated the assessment tool into Portuguese were familiar with concepts in the area, experienced in the use of questionnaires with workers, and familiar with technical English. The procedures adopted here were in accordance with the ones proposed by Beaton et al. [4], in which a translation carried out independently by at least two translators allows the identification of mistakes and different possible interpretations for ambiguous terms present in the original text.

The three undergraduate researchers carried out the initial translation process, resulting in three independent versions. At the end of this stage, a consensus was reached by the full team of five evaluators. Nevertheless, doubts about the interpretation of some of the items still persisted, which resulted in direct contact with the authors of the adapted NIOSH assessment tool [3]. A second version of the translation was produced after conferring with the authors and was used in the final application of the assessment tool (Appendix I).

#### 3.2. Pilot Study

The pilot study was carried out by the three undergraduate evaluators, who applied the first version to the processing sector and finishing sectors 1 and 2, without including the above-mentioned subdivisions. Difficulties in application motivated the division into subsectors with different activity and complexity levels. After this subdivision but during the pilot test stage, the first version of the assessment tool was reapplied.

Questions that arose during this period were resolved in five meetings to arrive at an agreed interpretation. After achieving consensus, the second version of the AOT was prepared and applied in the Final Application stage.

#### 3.3. Final Application

Based on the second version of the assessment tool, the final application was carried out independently in the processing, painting 1, packing 1, painting 2 and

packing 2 sectors. Throughout the process all steps and questions were recorded and reported here.

### 4. Results and discussion

#### 4.1 Translation

The main difficulties identified in the translation referred to certain technical terms that had no direct equivalents in Portuguese. This became particularly apparent for the term Work pacing type (Question 15 Table 1).

The researchers sought clarification from the authors of the original text in order to find the closest corresponding terms in Portuguese.

#### 4.2 Pilot Study

After the first translation of the assessment tool, each evaluator applied the pilot test to the three sectors. The application was independent and lasted approximately 15 minutes per sector. Evaluators were free to interview employees, supervisors and managers if necessary to fill in the assessment tool.

After the division of the finishing sector, a new application was carried out in the subdivided sectors, which lasted approximately 12 minutes per sector. The results were compared for interobserver agreement. Table 2 illustrates the agreement percentages obtained, as well as the items showing disagreement. The agreement rate between evaluators was low, and did not reach the 80% suggested in the literature [5] in any sector. Only in seven of the 26 questions were the answers agreed upon by the three evaluators in all sectors.

#### 4.3. Final Application

After solving the uncertainties from the previous phase, a second version of the assessment tool was produced and applied. The application time was similar between evaluators, with a mean of 10 minutes. The agreement rates varied between sectors. The highest rate was for the processing sector (97%), and the lowest for the Painting 2 sector (81%). In all cases agreement was above 80% (Table 3).

Table 2  
Interobserver agreement in the pilot study

| Question    | Painting 1 | Packing 1 | Processing sector | Painting 2 | Packing 2 |
|-------------|------------|-----------|-------------------|------------|-----------|
| 1           | N          | Y         | Y                 | Y          | Y         |
| 2           | Y          | Y         | Y                 | Y          | Y         |
| 3           | Y          | Y         | Y                 | Y          | Y         |
| 4           | Y          | Y         | N                 | Y          | Y         |
| 5           | Y          | Y         | Y                 | N          | N         |
| 6           | Y          | Y         | Y                 | N          | Y         |
| 7           | Y          | Y         | Y                 | Y          | Y         |
| 8           | Y          | Y         | N                 | Y          | Y         |
| 9           | N          | N         | N                 | N          | N         |
| 10          | Y          | N         | N                 | Y          | N         |
| 11          | Y          | Y         | Y                 | Y          | N         |
| 12          | Y          | N         | Y                 | Y          | Y         |
| 13          | Y          | Y         | Y                 | Y          | Y         |
| 14          | N          | N         | Y                 | N          | Y         |
| 15          | Y          | N         | N                 | N          | N         |
| 16          | N          | N         | Y                 | Y          | N         |
| 17          | Y          | Y         | N                 | N          | N         |
| 18          | Y          | Y         | Y                 | Y          | Y         |
| 19          | Y          | N         | Y                 | N          | Y         |
| 20          | Y          | Y         | Y                 | N          | Y         |
| 21          | N          | N         | N                 | N          | N         |
| 22          | Y          | Y         | Y                 | Y          | Y         |
| 23          | N          | N         | N                 | Y          | N         |
| 24          | N          | Y         | N                 | Y          | Y         |
| 25          | Y          | Y         | N                 | Y          | Y         |
| 26          | Y          | N         | N                 | N          | N         |
| % Agreement | 70%        | 61,50%    | 57,69%            | 61,50%     | 61,50%    |

Legend: N = no agreement among evaluators; Y = agreement between all three evaluators

There were still some remaining doubts, even though the related questions had been previously discussed. This could have been due to the existence of similar non-excluding alternatives, the possibility of different interpretations to some questions, or the diversity identified within the sectors. These aspects are discussed below.

#### 4.3.1. Similar or non-excluding alternatives and the possibility of different interpretations

In the block “Work Group” (questions 18 to 21), the following answer choices were allowed: “yes”, “no”, and “some”. However, some evaluators considered that the alternative “yes” included the option “some”, resulting in answer overlap among evaluators.

The low agreement rates in questions concerning noise (question 5) and work pacing type (question 14) could have been caused by non-excluding answers. It was observed that several alternatives were possible in these questions, which led to confusion about the possibility of choosing more than one response.

Furthermore, some questions either allowed different interpretations or did not express exact answer values. Several meetings were necessary to arrive at a consensus. Nevertheless, the final version does not preclude the possibility of different interpretations from those adopted in this study by other research groups in other situations. Thus, caution is necessary when comparing results between different groups.

#### 4.3.2. Agreement Rate between Pilot Study and Final Application

As could be expected, the agreement rate increased considerably after consensus was reached between evaluators; the mean agreement was 62.4% (Table 2) in the pilot study and 87.4% (Table 3) in the final application. The use of clearer and more concise terms as well as uniform interpretations seems to account for these results. Repeatability studies have shown that different observers can report reasonably similar results if they adopt the same concepts and abilities through adequate training [6].

Table 3  
Interobserver agreement in the Final Application.

| Question    | Painting 1 | Packing 1 | Processing sector | Painting 2 | Packing 2 |
|-------------|------------|-----------|-------------------|------------|-----------|
| 1           | N          | Y         | Y                 | Y          | Y         |
| 2           | Y          | Y         | Y                 | Y          | Y         |
| 3           | Y          | Y         | Y                 | Y          | Y         |
| 4           | Y          | Y         | N                 | Y          | Y         |
| 5           | Y          | Y         | Y                 | N          | N         |
| 6           | Y          | Y         | Y                 | N          | Y         |
| 7           | Y          | Y         | Y                 | Y          | Y         |
| 8           | Y          | Y         | Y                 | Y          | Y         |
| 9           | Y          | Y         | Y                 | Y          | Y         |
| 10          | Y          | Y         | Y                 | Y          | Y         |
| 11          | Y          | Y         | Y                 | Y          | Y         |
| 12          | N          | Y         | Y                 | Y          | Y         |
| 13          | Y          | Y         | Y                 | Y          | Y         |
| 14          | N          | N         | Y                 | N          | Y         |
| 13          | Y          | Y         | Y                 | Y          | Y         |
| 15          | Y          | N         | Y                 | N          | N         |
| 16          | Y          | Y         | Y                 | Y          | Y         |
| 17          | Y          | Y         | Y                 | Y          | Y         |
| 18          | Y          | Y         | Y                 | Y          | Y         |
| 19          | Y          | N         | Y                 | Y          | Y         |
| 20          | Y          | Y         | Y                 | Y          | Y         |
| 21          | N          | N         | Y                 | N          | N         |
| 22          | Y          | Y         | Y                 | Y          | Y         |
| 23          | Y          | Y         | Y                 | Y          | Y         |
| 24          | Y          | Y         | Y                 | Y          | Y         |
| 25          | Y          | Y         | Y                 | Y          | Y         |
| 26          | Y          | Y         | Y                 | Y          | Y         |
| % Agreement | 85%        | 85%       | 97%               | 81%        | 89%       |

Legend: N = no agreement among all three evaluators; Y = agreement between all three evaluators

#### 4.3.3. Sector Diversity

Different types of work organization can differently influence exposure levels to physical and biomechanical risk factors in the occupational environment. Thus, the greater the complexity of factors involved in the organization of the occupational environment, the harder it is to evaluate the sectors involved. As previously mentioned in the Methods, the evaluated sectors were quite diversified regarding both activity type and organization complexity.

Diversity clearly influenced the agreement rate between evaluators when applying the AOT, i.e., the greater the heterogeneity of the tasks carried out in the same sector, the greater the difficulty in applying the tool. In the processing sector, where tasks were more homogeneous, the agreement rate was the highest (97%), whereas the lowest rate was obtained (81%) in the painting sector, which besides incorporating many different tasks also involved rigid hygienic measures.

#### 4.3.4. Tool choice aspects

According to Takala et al. [6], the selection of an observational method should be based on several aspects, including application objectives, characteristics of the work to be evaluated, the individuals who will use the method and the resources available for data collection and analysis. Even though the scale we translated here has been recognized as useful for evaluating work organization [7], the complexity of the workplace analyzed and the diversity of tasks within the same sector required extra caution in its application.

## 5. Final considerations and conclusions

The evaluation of work organization is a complex task since it should reflect the complete range and

diversity present in the evaluated occupational situations. The difficulties identified in both translating the AOT and in applying it in several industrial sectors demonstrate this complexity.

We recognize that after adjustments, the assessment tool was sensitive to differences between evaluated sectors. However, the use of this tool in industrial environments presenting intricate organization levels will involve certain prerequisites for satisfactory use, including the training of evaluators and control of their agreement, as well as familiarity with organizational aspects of the production system evaluated. It may also be necessary to create subdivisions of evaluated sectors and to apply the assessment tool as many times as necessary to each activity or task for reaching more precise evaluation of the organizational demand.

Other important aspects to be considered are clear definitions of the objectives for which the assessment tool is being applied and the need for prior consensus, to be evaluated, between evaluators about the interpretation of items. The need for consensus increases the chances of greater agreement between evaluators when analyzing a given situation but, on the other hand, can hamper the direct comparison of results between different groups of evaluators, which reduces the external validity of the assessment tool. Situations that could benefit from the use of this tool is, for example, pre- and post-ergonomic intervention comparisons carried out for the same sector and performed by the same group of evaluators. In such cases, the results could be very useful for evaluating organizational aspects.

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## Appendix I

Setor: \_\_\_\_\_ Avaliador: \_\_\_\_\_

### ASPECTOS DEMOGRÁFICOS

|                                      |                                    |                                   |                                |
|--------------------------------------|------------------------------------|-----------------------------------|--------------------------------|
| 1 - Predominância de Gênero no setor | <input type="checkbox"/> Masculino | <input type="checkbox"/> Feminino | <input type="checkbox"/> Misto |
| 2 - Subtarefas segregadas por gênero | <input type="checkbox"/> Sim       |                                   | <input type="checkbox"/> Não   |
| 3 - Outra segregação demográfica     | <input type="checkbox"/> Sim       |                                   | <input type="checkbox"/> Não   |

### CONDIÇÕES AMBIENTAIS

|                                    |  |  |  |
|------------------------------------|--|--|--|
| 4 - Iluminação                     | <input type="checkbox"/> Adequada        | <input type="checkbox"/> Muito baixa para a tarefa | <input type="checkbox"/> Muito clara                                 |
| 5 - Barulho                        | <input type="checkbox"/> Conversa normal | <input type="checkbox"/> Necessidade de gritar     | <input type="checkbox"/> Proteção auricular                          |
| 6 - Limpeza / Organização do Local | <input type="checkbox"/> Muito boa       | <input type="checkbox"/> Boa                       | <input type="checkbox"/> Ruim<br><input type="checkbox"/> Muito Ruim |

### NÍVEL DAS TAREFAS

|                                   |  |  |
|-----------------------------------|--|--|
| 7 - Tipo de Trabalho              | <input type="checkbox"/> Produção Direta   | <input type="checkbox"/> Produção Indireta                                     |
| 8 - Nível de Habilidade           | <input type="checkbox"/> Sem habilidade  | <input type="checkbox"/> Treinados/Qualificados                                |
|                                   | <input type="checkbox"/> Semi-qualificados   | <input type="checkbox"/> Profissional  |
|                                   | <input type="checkbox"/> Habilidade Manual   |  |
| 9 - Tipo de Posições              | <input type="checkbox"/> Temporário  | <input type="checkbox"/> Assalariado – Período Integral                        |
|                                   | <input type="checkbox"/> Por hora – Período Integral                                 |  |
| 10 - Estrutura do Trabalho        | <input type="checkbox"/> Linha de Montagem   | <input type="checkbox"/> Trabalho de Escritório                                |
|                                   | <input type="checkbox"/> Células de Trabalho   |  |
| 11 - Nível de atividade Muscular  | <input type="checkbox"/> Dinâmico  | <input type="checkbox"/> Estático  |
|                                   | <input type="checkbox"/> Estático  | <input type="checkbox"/> Ambos   |
| 12 - Interação social             | <input type="checkbox"/> Individual  | <input type="checkbox"/> Time de trabalho, coordenação moderada                |
|                                   | <input type="checkbox"/> Time de trabalho, coordenação mínima                        | <input type="checkbox"/> Time de trabalho, alta coordenação                    |
| 13 - Nível de Tarefa/Atividade    | <input type="checkbox"/> Tarefa Simples, Atividade Simples                           | <input type="checkbox"/> Múltiplas Tarefas                                     |
|                                   | <input type="checkbox"/> Tarefa Simples, Atividades Múltiplas                        |  |
| 14 - Tipo de Ritmo                | <input type="checkbox"/> Auto-determinado  | <input type="checkbox"/> Peça produzida  |
|                                   | <input type="checkbox"/> Máquina   | <input type="checkbox"/> Quota   |
|                                   | <input type="checkbox"/> Linha   |  |
| 15 - Controle do Ritmo            | <input type="checkbox"/> Nenhum  | <input type="checkbox"/> “Gargalo”   |
|                                   | <input type="checkbox"/> Substituição manual   | <input type="checkbox"/> “Pulmão”  |
|                                   | <input type="checkbox"/> Disparado por eventos                                       | <input type="checkbox"/> Pausas regulares informais                            |
|                                   | <input type="checkbox"/> Produção “puxada”   |  |
| 16 - Tipo de preparação para ação | <input type="checkbox"/> Nenhum  | <input type="checkbox"/> Manuseio de peça                                      |
|                                   | <input type="checkbox"/> Manutenção da postura de trabalho entre eventos de trabalho | <input type="checkbox"/> Manutenção da ferramenta entre os eventos de trabalho |
| 17 - Rotatividade do trabalho     | <input type="checkbox"/> Sim   | <input type="checkbox"/> Não   |

### GRUPO DE TRABALHO

|   |                              |                              |                                  |
|---|------------------------------|------------------------------|----------------------------------|
| 18 - Flexibilidade nas horas de trabalho    | <input type="checkbox"/> Sim | <input type="checkbox"/> Não | <input type="checkbox"/> Alguma  |
| 19 - Flexibilidade nos arranjos de trabalho | <input type="checkbox"/> Sim | <input type="checkbox"/> Não | <input type="checkbox"/> Alguma  |
| 20 - Pausa formal padrão                    | <input type="checkbox"/> Sim | <input type="checkbox"/> Não | <input type="checkbox"/> Algumas |
| 21 - Possibilidades de pausa informal       | <input type="checkbox"/> Sim | <input type="checkbox"/> Não | <input type="checkbox"/> Alguma  |
| 22 - Horas corridas                         | <input type="checkbox"/> 8h  |                              | <input type="checkbox"/> 12h     |
|   | <input type="checkbox"/> 10h |                              | <input type="checkbox"/> Outros  |
| 23 - Trabalho em turnos                     | <input type="checkbox"/> Sim | <input type="checkbox"/> Não | <input type="checkbox"/> Pouco   |

### 24 - DEMANDA DE ATENÇÃO

|                                      |   |
|--------------------------------------|---|
| <input type="checkbox"/> Superficial | <input type="checkbox"/> Relativamente alta |
| <input type="checkbox"/> Média       | <input type="checkbox"/> Muito alta         |

### 25 - RESPONSABILIDADE PELA SEGURANÇA DOS OUTROS

|   |  |
|---|--|
| <input type="checkbox"/> Não se aplica  | <input type="checkbox"/> Média               |
| <input type="checkbox"/> Muito limitada | <input type="checkbox"/> Significante        |
| <input type="checkbox"/> Limitada       | <input type="checkbox"/> Muito significativa |

### 26 - RESTRIÇÃO NA ESTRUTURA DO TRABALHO

|  |   |
|--|---|
| <input type="checkbox"/> Restrições muito pequenas | <input type="checkbox"/> Restrições grandes       |
| <input type="checkbox"/> Restrições pequenas       | <input type="checkbox"/> Restrições muito grandes |
| <input type="checkbox"/> Restrições médias         |   |