79 - ERGONOMIC ANALYSIS USING THE TOR-TOM METHOD ON A MEAT PROCESSING INDUSTRY

MANOELA GALAFASSI ARANTES[1];
MASSAYUKI MÁRIO HARA [2];
JUAN ALBERTO MONGELOS GIMENEZ [3];
RODRIGO EDUARDO CATAI[4]
1 - Work safety engineer - Curitiba - PR – Brasil
3 - Master's Degree student – UTFPR/Curitiba - PR – Brasil
2, 4 - Professor of Civil Engineering Masters Program/UTFPR - Curitiba - PR - Brasil
manoarantes@hotmail.com

doi:10.16887/86.a1.79

1.INTRODUCTION

According to data from the Ministry of Social Welfare, in 2012, there were 18,346 accidents in this sector, which represented 2.60% of all accidents (BRAZIL, 2014). The main cause of accidents and occupational diseases is the high ergonomic risk inherent to this industry, the work standing out at low temperatures, the manual transport of loads and the large amount of repetitive movements required in most functions. Therefore, the ergonomic assessment of the workplace, regulated by NR 17, is becoming more popular as a form of prevention. The assessment is carried out, according to the standard, through a study called Ergonomic Work Analysis (EWA) in which we observe the various conditions of the work environment as noise, temperature, illuminance, pace and organization of work, postures, furniture, equipment and other factors affecting the workplace.

This paper presents an Ergonomic Work Analysis (EWA) held in sectors considered most critical in a small meat processing company. This study develops a comparison between the times set for rest breaks by NR 36, with the values of the fatigue recovery time encountered in applying ergonomic assessment software TOR-TOM. This research aims to perform ergonomic evaluation EWA and verify the applicability of NR 36 to small meat processing companies in relation to their rest breaks.

2.LITERATURE REVIEW

2.1. Ergonomic Work Analysis (EWA)

According to Xavier (2013) the Ergonomic Work Analysis is a methodological study to evaluate the man-labor relationship. They are quantitative and qualitative analysis to the description and interpretation of what happens in the reality of focused activity. According to the NR 17, it is up to the employer to carry out Ergonomic Work Analysis (BRAZIL, 2013).

Ergonomics works in a multidisciplinary way in several areas of knowledge. There is no specific domination of an area of knowledge regarding ergonomics, however, in a EWA an excessive number of people involved should be avoided because it makes that the document routes more complicated (Couto, 2012).

The systematic and organized application according to Iida (1997) is performed by identifying the occurrence of sites. Behind the evidence it may be experiencing a lack of adaptation to machines, failures in work organization or environmental deficiencies. For Santos (1997), the EWA has three phases: demand analysis, task analysis and analysis of activities. A very important factor is the choice of methodology to evaluate jobs which depend on the applicability according to each case. In this paper we present the most traditional EWA methods:

·NIOSH Method (National Institute for Occupational Safety and Health): according to Couto (2012) the main feature of this method is that it carries a charge of assessing getting calculate the weight limit to be raised in a safe condition

·RULA Method (Rapid Upper Limb Assessment): performs an assessment to analyze the overhead concentrated in the neck, arms and legs. In the evaluation, the method uses posture diagrams and three tables to assess the exposure to risk factors (MCATAMNEY & CORLETT, 1993).

·OWAS Method (Ovako Working Posture Analysis System): this methodology considers the percentage of time that the employee remains in a poor posture and consists of a standardized system of classification of positions establishing trunk postures combinations, arms and legs (CARDOSO, 2006).

·Method REBA (Rapid Entire Body Assessment): is a derivation of OWAS and RULA. Establishes a "catch Factor" table on the arm of the group, forearm and wrist to check the quality of "catch" and its parameters varies from zero to determine an "gets" good to the three value to register an unacceptable situation (CARDOSO, 2006).

·TOR-TOM Method performs a complete approach to the job taking into consideration several factors such as repetition, strength of the upper limbs, cargo handling, postural deviations, mental load and physical environment and enables the calculation of the fatigue recovery time through values as Real Occupancy Rate (TOR) with Maximum Occupancy rate (TOM) (Couto, 2012).

For the present work was considered the provisions of the Regulatory Standard (NR) 17 regulating on ergonomics and NR 36 which regulates the slaughter industry and meat processing (BRAZIL, 2014).

In EWA, shows a comparison between the fatigue recovery time found via TOR-TOM method with pause time by the proposed legislation, NR 36, 36.13 item. Table 1 refers to this provision.

Table 1 – Time for rest break under the working day

Working hours	Tolerance time to pause the application	Pause time
Up to 6h	Up to 6h20	20 minutes
Up to 7h20	Up to 7h40	45 minutes
Up to 8h48	Up to 9h10	60 minutes

Source: Brasil (2013)

3. METHODS

The object of study now works in the segment derived from pigs. Small considered has 11 product lines following the standards of the Federal Inspection System that determines the overall cleaning process. With 183 employees follows the decisions of the Ministry of Labor and has a safety technician as well as a total of 16 participating members of the Internal Committee for Accident Prevention (CIPA). For this work we evaluated the most critical productive sectors. These are the casings preparation , inlay and Bones .

All ergonomic assessments were performed using the TOR-TOM method. To collect information were observed the activities carried out in the workplace, as well as the description of the equipment and furniture, body movements, breaks, sprains

and illuminance values, temperature, humidity and noise. With this information the method evaluates the requirements and enabling efforts to define the existence of ergonomic risk.

For the calculation carried out a comparison between the TOR rate (Real Occupancy Rate) and TOM (Maximum Occupancy Rate) where TOR represents the proportion of the journey where the employee performs the activity and TOM represents the percentage of the journey where working without fatigue and overload. The TOM value adopts the lower of the TOMCAR rate (Occupancy Rate Maximum considering Repetitive activities) and TOMCAMP rate (Occupancy Rate Maximum considering Environment, Metabolism and Basic Stance). In interpreting the results, when the TOR is greater than TOM, should promote setting. Good management always seek to increase the TOM (by weight reduction, posture adjustment, reduced mental load or decrease the degree of process complexity) maintaining the TOR-TOM index closest to zero. If there is the possibility of increasing the TOM correct for the balance would decrease the TOR conducting effective casters between tasks, reduced working hours, staff increases, fatigue recovery times and more. Interpretation of the results is carried out according to Table 2.

Table 2 – TOR-TOM interpretation of results

Value TOR-TOM	Interpretation
TOR-TOM = zero	Work situation without ergonomic risk. Optimal use of the workforce.
TOR >TOM (0,1up to 5)	Work situation causing discomfort, but without risk of injury.
TOR >TOM (5,1up to 15)	Work situation with ergonomic risk.
TOR >TOM (above 15)	Work situation with ergonomic risk.

Source: Adapted from Couto (2012)

In the case of obtaining the fatigue recovery time TOR-TOM method is a tool that allows calculation of specific activity. In this work this time were found in all evaluated areas and were then compared with the times set in NR 36.

4. RESULTS

4.1. Guts Preparation Sector

4.1.1. Description of the activities and analysis of movement and pauses

Two employees, cleaner casings and sausage storage, perform their functions. The activities of the cleaner are: collection and transportation of guts in 10-gallon bucket with coarse offset 200 meters. Washing, sorting and cleanup. The sausage storage operates the gut bagger for sausage preparation and assists in cleanup. Observing ergonomic risks there is the transport activity of the gut which is performed manually and daily lasting about 40 minutes. In another function also stands out the monotonous and repetitive work in the bagger machine. There is no rotation function.

Regarding the furniture, tools and equipment to cleaner uses knife to cut the guts and trolleys. The sausage storage uses no knife, it only operates bagger machine in a bank of 78 cm high.

The two employees remain during the whole work up, the first of which in its function, quite walks through the second sector and remains in a static position during most of the day. The two perform many movements with his hands and fists. For sausage storage, it observed a slight flexion of the neck and a rapid pace, and a slight curvature of the spine, in time to put the guts in the bucket. The lunch breaks are 90 minutes, 10 minutes and bathroom twice turn, water 5 min and twice round and uniform exchange of 7 minutes and twice round. The same time for all sectors, varying only the distance to the industry were considered. These breaks were used to calculate the Real Occupancy Rate (TOR).

4.1.2. Values of illuminance, temperature, relative humidity and noise

As for the environmental conditions of work, follow in Table 3 the values found for the guts preparation sector.

Table 3 – Values of illuminance, temperature, relative humidity and noise guts preparation sector

illuminance	Temperature	Relative humidity	Noise
340 Lux	14 °C	77,5%	75 dB(A)

4.1.3. Results obtained from the TOR-TOM method

With the entry in the TOR-TOM software, all the information described, it found a result for the job "washer casings" and the sausage storage job. For the function of the washer casings were found the results of Figure 1.

In a general interpretation, the method reports that there are moderate ergonomic requirements with risk of injury or fatigue to the washing machine casings. It means that the organization of work is inadequate, which is likely to occur discomfort complaints, fatigue, pain and even get to removal. Should be performed casters with different tasks or make the necessary breaks. As for factors related to energy expenditure, physical environment and posture TOR-TOM indicates that should be studied some way to reduce discomfort related to the existence of stressful posture for the legs during the workday.

For the activities of the sausage storage, it found the result of Figure 2. The interpretations found for sausage storage were the same as those found in the guts Washer, showing that if performed rotated among the activities carried out between them, this will not be effective since both functions have similar risks.

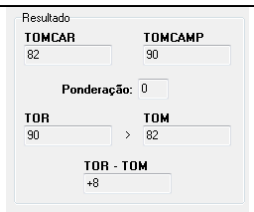

Figure 1 - TOR-TOM result for activities of the washer casings

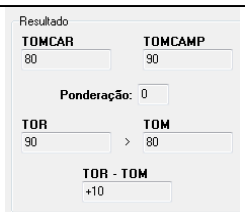

Figure 2 – TOR-TOM result for activities carried out by sausage storage

4.1.4. Comparison - fatigue recovery time and rest break (NR 36)

Through the TOR-TOM is possible to perform the calculation of the fatigue recovery time for the activity analyzed and compared with the time required by NR 36. As the sum of the travel time to the sector and uniform switching time is 18 minutes and

discounted the 8-hour day are higher than 7h40min, must be used for 60-minute breaks. Table 4 compares the prescribed time for breaks as the NR 36 and found the time to fatigue recovery via TOR-TOM method for the two functions analyzed.

Table 4 – Comparison of the break provided for in NR 36 and the fatigue recovery time found by TOR-TOM method in casings preparation sector

Function	Break planned by NR 36	Fatigue Recovery time obtained by TOR-TOM method
Casings washer	60 minutes	29 minutes
Sausage storage	60 minutes	48 minutes

4.2. Inlay Sector

4.2.1. Description of the activities and analysis of movement and pauses

The activities are conducted by 18 employees, all production aids, mostly female. The process consists of sausages mooring for 7 hours per day for 7 seconds cycles. The operation with inlay machine is for 20 minutes per day and the final operating weight, sealing and packaging in 40 minutes per day with these approximate values. In general are low ergonomic requirement activities except the sausages mooring operation because it is an activity that requires quick, repetitive hand movements. There is the application of rotation, though most remain in the mooring activity.

Regarding the tools, knives are underused. The main equipment is inlay machine and the sealing. The bench features of this 87 cm high, and the countertop sealer is 95 centimeters tall.

The employees of this sector remain throughout the workday standing, with little movement in the sector. In sausages mooring activity both hands and wrists, are required. Higher workers have neck bending in the operation.

4.2.2. Values of illuminance, temperature, relative humidity and noise

They are presented in Table 5 the values found for the inlay industry.

Table 5 – Values of illuminance, temperature, relative humidity and noise inlay sector

illuminance	Temperature	Relative humidity	Noise
220 Lux	13 °C	70,4%	80 dB(A)

4.2.3. Results obtained from the TOR-TOM method

Figure 3 shows the results for the industry's production assistant function Inlay.

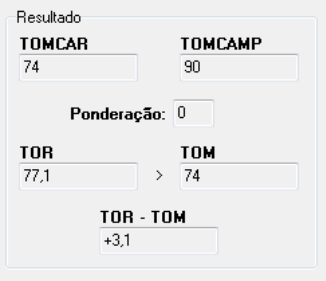

Figure 3 – TOR-TOM Result for activities carried out by the production assistant

With this result is the following interpretations: Intense ergonomic requirement caused by very short cycles in sausages mooring activity. Low risk of injury, because the workers do not exercise the repetitive activity of sausages mooring throughout the workday. There may be symptoms of discomfort and fatigue, especially among people most likely. Similar to that found in the guts of preparation industry TOR-TOM method indicates the need to reduce the discomfort related to stressful posture for the legs.

4.2.4. Comparison - fatigue recovery time and rest break (NR 36)

As the sum of travel time to the industry and the uniform changeover time is 20 minutes and discounted the 8-hour day are equivalent to 7h40min, must be the 45-minute breaks.

Table 6 has the prescribed time for breaks as NR 36 compared to the time found for fatigue recovery to production assistant function.

Table 6 – Comparison of the break provided for in NR 36 and the fatigue recovery time found by TOR-TOM method in inlay sector

Function	Break planned by NR 36	Fatigue Recovery time obtained by TOR-TOM method
Production assistant	45 minutes	22 minutes

4.3. Boning Sector

4.3.1. Description of the activities and analysis of movement and pauses

The staff operating in the 19 pork and beef bones function perform the work in cycles of 16 to 30 seconds. Usually proceed to sharpen knives and chairas. Cleaning the stands at the beginning and end of the journey are also activities in this sector. Days of high production is carried out boning up to 200 parts, totaling 25 pieces per hour. Already in normal days are boneless around 130 pieces, about 17 per hour. There caster, but is performed only in the exchange of position at the table cuts, not considered efficient because the movements performed with the hands are pretty much the same. The use of knives and tools chairas was checked continued use and large amount of sharpening operation. This facilitates development work, diminishing the efforts made by hand. In the bench height of 93 cm, there is a mat where products are moved to perform the cutting.

Employees work standing in a static position for most of the journey. To perform the boning perform many movements with his hands and wrists, with ulnar deviation as a slight flexion of the neck. It is apparent that the pace of work is not accelerated,

but the activity is repetitive cycles since the last 16 to 30 seconds, and the employee performs approximately 15 different movements. Boning activity has a high impact on the quality of the final product and this was the sector where more was reported symptoms of discomfort.

4.3.2 Values of illuminance, temperature, relative humidity and noise

Table 7 presents the collected values.

Table 7 – Values of illuminance, temperature, relative humidity and noise in boning sector

illuminance	Temperature	Relative Humidity	Noise
380 Lux	12 °C	65%	81 dB(A)

4.3.4 Results obtained from the TOR-TOM method

A Figure 4 shows the result for boning activity.

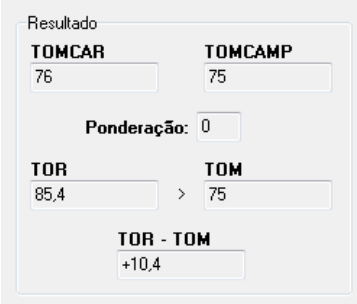

Figure 4 – TOR-TOM result for activities in boning sector

From the result we have the following interpretation: Intense ergonomic requirements, with risk of injury to deboner function. This means that the organization of work is inadequate, it is likely to be discomfort complaints, difficulty, fatigue and pain, absences and injuries to the worker must be taken urgent measures to improve conditions in the workplace. It is necessary to urgently implement the rotation with different tasks and appropriate breaks. The TOR-TOM shows that should be studied ways to reduce discomfort related to the existence of stressful posture for the legs during the workday.

4.3.4 Comparison - fatigue recovery time and rest break (NR 36)

With TOR-TOM method was calculated fatigue recovery time for this activity. Subsequently a comparison with the time determined by NR 36. Considering the sum of travel time to the industry and the uniform exchange time is 20.4 minutes presents itself, and discounted the 8-hour day are lower than 7h40min, must be 45-minute breaks used as shown in Table 8.

Table 8 – Comparison of the break provided for in NR 36 and the fatigue recovery time found by TOR-TOM method in boning sector

Function	Break planned by NR 36	Fatigue Recovery time obtained by TOR-TOM method
Deboner	45 minutes	36 minutes

5. CONCLUSION

Even though the object of study now a small refrigerator where it is estimated that working routines are more flexible, the EWA carried out demonstrates that the activities in the observed sectors, have ergonomic deficiencies. From the results, the refrigerator should make adjustments. One of the most critical points refers to the fact that in all sectors in the performance of the employee functions remains standing. Ways to reduce and cancel the discomfort should be studied. As a suggestion, a measure is to put to rest seats next to workers. There are chairs model "semi-sitting" that are very effective in this situation.

The casings preparation sector noted the difficulty in handling the raw material is the overweight or the distances covered. Ways to mechanize the process and shorten distances should be studied. Special attention to the possibility of changing the site layout.

Also in all sectors was seen working with repetitive movements especially the hands. They are due to take rest breaks as envisaged in the NR 36. Regarding the comparative study breaks down in legislation, the NR 36 and the determined fatigue recovery times by the method used TOR-TOM, it is observed that the numbers are close, getting confirmed the need for application of rest breaks in if, following the determination of current regulations.

REFERENCES

BRASIL, Ministério da Previdência e Assistência Social. Anuário Estatístico. 2014. Available in: <http://www.previdencia.gov.br/estatisticas/aeps-2012-anuario-estatistico-da-previdencia-social-2012/aeps-2012-secao-iv-acidentes-do-trabalho/aeps-2012-secao-iv-acidentes-do-trabalho-tabelas/>.Access on 05 Mai.2014

BRASIL, Ministério do Trabalho e Emprego. Norma Regulamentadora NR17 (Ergonomia). Manual de Legislação Atlas. 71ª. Edição, 2012.

BRASIL, Ministério do Trabalho e Emprego. Norma Regulamentadora NR36 (Segurança e Saúde no trabalho em empresas de abate e processamento de carnes e derivados). Manual de Legislação Atlas. 72ª. Edição, 2013.

CARDOSO, M. M. Avaliação Ergonômica: Revisão dos Métodos para Avaliação Postural. Revista Produção Online, Florianópolis, v.6, n.3,p.142, set./dez., 2006. Available in: <www.producaoonline.org.br/rpo/article/download/630/668>. Access on: March, 18, 2014.

COUTO, H. A. Índice TOR-TOM: 25 aplicações práticas na análise ergonômica, na avaliação do risco ergonômico, na prescrição de ações corretivas e no gerenciamento da produtividade segura. 2. ed. Belo Horizonte: Ergo, 2012.

MCATAMNEY, L.; CORLETT, E.N. RULA: a survey method for the investigation of work-related upper limb disorders. Applied Ergonomics, v. 24, n.2 p. 91-99, 1993.

SANTOS, Francisco Fialho. Manual de Análise Ergonômica do Trabalho. Curitiba: Genesis editora, 1997. 316 p.

XAVIER, Antonio Augusto de Paula. Apostila: Ergonomia. Curso de Especialização em Engenharia de Segurança do Trabalho, 2013.

Prof. Dr. Rodrigo Eduardo Catai - Rua Deputado Heitor de Alencar Furtado, 4900
Bairro: Ecoville - CEP 81280-340 - Curitiba - PR – Brasil

ERGONOMIC ANALYSIS USING THE TOR-TOM METHOD ON A MEAT PROCESSING INDUSTRY

ABSTRACT

One of the industry sectors that have been emphasized by poor working conditions and lack of security for workers is the sector of slaughterhouse and meat processing companies. This article aims to conduct an Ergonomic Work Analysis (EWA) by TOR-TOM methodology in various sectors of a small meat processing industry, as well as compare the times found for fatigue recovery determined by the method with breaks of values for rest stipulated by NR 36. Therefore, we made several visits to the analyzed sectors and applied a checklist based on the NR 17 and NR 36 in order to verify some of the items that the meat processing would need to adjust according to the Standards requisites. The results proved that the company must urgently adapt Standards (17 and 36) both to provide better working conditions, and to avoid fines and even the closure of the establishment. It was concluded that the activities in sectors considered more critical in the process had large ergonomic problems.

KEYWORDS: Ergonomic Analysis of Work, Meat processing, TOR-TOM.

ANALYSE ERGONOMIQUE UTILISANT LA MÉTHODOLOGIE TOR-TOM SUR UNE INDUSTRIE DE LA VIANDE

RÉSUMÉ

L'un des secteurs de l'industrie qui ont été soulignés par mauvaises conditions de travail et le manque de sécurité pour les travailleurs est le secteur des abattoirs et les entreprises de transformation de viande. Cet article vise à procéder à une analyse du travail ergonomique (ATE) par une méthodologie TOR-TOM dans divers secteurs d'une petite industrie de transformation de la viande, ainsi que comparer les temps trouvés pour la récupération de la fatigue déterminée par la méthode avec des pauses de valeurs pour le repos prévues par la NR 36. par conséquent, nous avons effectué plusieurs visites dans les secteurs analysés et appliqué une liste de contrôle sur la base du NR 17 et NR 36 afin de vérifier certains des éléments que la transformation de la viande, il faudrait ajuster selon les conditions requises normes. Les résultats ont prouvé que la société doit s'adapter d'urgence des normes (17 et 36) à la fois pour fournir de meilleures conditions de travail, et pour éviter les amendes et même la fermeture de l'établissement. Il a été conclu que les activités dans les secteurs jugés les plus critiques dans le processus avaient de grands problèmes ergonomiques.

MOTS-CLÉS: Analyse Ergonomique du Travail, Industrie de la viande, TOR-TOM.

ANÁLISIS ERGONÓMICO UTILIZANDO EL MÉTODO TOR-TOM EN UNA INDUSTRIA FRIGORÍFICA

RESUMEN

Uno de los sectores de la industria que se ha destacado por sus malas condiciones de trabajo y la falta de seguridad para los trabajadores es el sector de los frigoríficos industrializadores de carne. Este artículo tiene como objetivo llevar a cabo un trabajo de Análisis Ergonómico (AET) mediante la metodología de TOR-TOM, en diversos sectores de una pequeña industria frigorífica, así como comparar los tiempos encontrados para la recuperación de la fatiga determinado por el método de descansos, con valores estipulados por la norma NR 36. Para el estudio, hemos hecho varias visitas a los sectores analizados y aplicamos una lista de verificación basada en la NR 17 y la NR 36 con el fin de verificar algunos de los tópicos que necesitaría esta empresa procesadora de carnes para ajustarse de acuerdo a los requisitos de las Normas. Los resultados mostraron que el frigorífico debe adaptarse urgentemente a las Normas (NR 17 y NR 36), tanto para proporcionar mejores condiciones de trabajo, y para evitar multas e incluso el cierre del establecimiento. Se concluyó que en pequeños frigoríficos existen actividades críticas que tienen problemas ergonómicos.

PALABRAS CLAVE: Análisis Ergonómico del Trabajo, Frigoríficos, TOR-TOM.

ANÁLISE ERGONÔMICA UTILIZANDO A METODOLOGIA TOR-TOM EM UM FRIGORÍFICO

RESUMO

Um dos setores da indústria que vem ganhando destaque pelas precárias condições de trabalho e a falta de segurança aos trabalhadores é o setor dos frigoríficos. Este artigo tem como objetivo realizar uma Análise Ergonômica do Trabalho (AET) através da metodologia TOR-TOM em vários setores de um frigorífico de pequeno porte, assim como comparar os tempos encontrados para recuperação de fadiga determinados através do método com os valores de pausas para descanso estipulados pela NR 36. Para tanto foram feitas várias visitas aos setores analisados e foi aplicado um check list com base na NR 17 e NR 36 com o intuito de verificar alguns dos itens que o frigorífico precisaria se adequar de acordo com os quesitos das Normas. Os resultados mostraram que o frigorífico deve se adequar urgentemente as Normas (17 e 36) tanto para proporcionar melhores condições de trabalho, quanto para evitar multas e até mesmo o fechamento do estabelecimento. Concluiu-se que as atividades desenvolvidas nos setores considerados mais críticos do frigorífico de pequeno porte apresentavam grandes problemas ergonômicos.

PALAVRAS-CHAVE: Análise Ergonômica do Trabalho, Frigoríficos, TOR-TOM.