

## Research Article

## Mapping Postural Severity of various manual tasks using P-SVR [Posture – State Variation Report] © method for Job Difficulty Evaluation

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### Abstract

The scope of this paper is to describe the newly defined Posture – State Variation Report [P-SVR] method of postural analysis to highlight the areas for improvement in work posture for operator comfort and to find out quantitative value of severity of work based upon postural video analysis. A compressor manufacturing process was studied for different activities like assembly, testing, material handling, inspection, disassembly and cleaning. These processes were evaluated for mapping severity of postures involved considering the elemental time and frequency. P-SVR method can be used as an extension of any method which is based on static observations of postures for analyzing the severity of work content and which is based upon either random or periodic photographic analysis. The scope of this paper is limited to highlighting these areas, where modifications in the processes can bring down the index of postural severity. In this paper we have compared three jobs being done in one industry in India on the basis of postural severity to guide the management in Industrial Dispute involving job evaluation.

**Keywords:** P-SVR [posture state variation report], ergonomic analysis, elemental breakdown, work posture severity, job evaluation.

### 1. Introduction

Different methods for determining the musculoskeletal disorders due to severity of postures have been studied by Marie-Eve Chiasson, *et. al.* (2012). These are the Quick Exposure Check (QEC), the Ergonomic Workplace Analysis, Hand Activity Level threshold limit values method (HAL), the Job Strain Index (JSI), the OCRA index, the EN 1005-3 standard, the Rapid Upper Limb Assessment (RULA), the Rapid Entire Body Assessment (REBA). These methods are based upon observation by an expert and his perception of work severity.

Lynn McAtamney, and E. Nigel Corlett (1991) gives the details of RULA which is a survey method developed for use in ergonomic investigations of workplaces where work-related upper limb disorders are reported. The assessment commences by observing the operator during work cycles in order to select the tasks and postures for assessment. Selection may be made of the postures held for the greatest amount of the work cycle or where highest load occurred – as envisaged by an observer.

While discussing the method of Strain Index, Jose Miquel Cabecas (2007) mentions that the Strain Index method (Moore and Gard, 1995) suggests estimating the

intensity of exertion using a 1-5 rating scale with verbal descriptors (light, somewhat hard, hard, very hard, near maximal) measuring external force and normalizing the data based on Maximal Strength data (as a percentage of Maximal Vital Capacity) and using Borg CR-10 scale.

While undertaking ergonomic analysis of the work of manual spray painting Gunnar Björing, Goran M Hagg (2000) limited the measurements to the arms and shoulders of the workers, using postural analysis and interview technique.

Peter Budnick (2013), reported that RULA has a strong focus on posture, but a weak focus on repetition and duration. This shortcoming has been overcome by the P-SVR methodology, which considers both these factors. P-SVR will lead to further enhancement of techniques like RULA, REBA, etc. in occupational ergonomists' tool box.

Samata Mujumdar, Varsha Karandikar *et al* (2013), stated that the use of ergonomic principles in automobile assembly and manufacturing operations has become an important part of a comprehensive health and safety process as well as an integral part of the engineering systems. Most of the automobile companies have developed an ergonomics process to manage issues related to injury and illness and to ensure the appropriate use of human resources on the plant shop floor.

Varsha Karandikar and Shriram Sane (2014) defined the Job Difficulty Index (JDI) using Posture-State Variation Report (P-SVR) methodology of postural

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analysis described here helps in evaluating the job difficulty level of work cycle quantitatively. For improving work content, the element of work with highest severity of score and with the longest duration can be highlighted. These work elements can be analyzed further and improved to simplify the work content. Posture – State Variation Report method is used for work simplification through postural analysis.

In this paper the process of compressor assembly was studied in order to decide the areas where improvements are necessary to simplify the physical work content and reduce operator discomfort. The duration of the study was around 4 hours [13,776seconds] during which there were 2143 postural changes. Entire activity included- Assembly, Cleaning, Disassembly, Inspection, Material Handling, Testing & some miscellaneous activities. This was done using P-SVR method of postural analysis.

## 2. P-SVR Methodology

Under this method of ergonomic analysis, analysis of video recordings of a complete work cycle is carried out to determine severity of the postures. This is used to find out the frequencies of different severities of postures as well as the time spent in every severity of posture.

In P-SVR method of ergonomic analysis, any technique of postural severity analysis like RULA - Rapid Upper Limb Analysis or REBA - Rapid Entire Body Analysis or any other method based on instantaneous photographic records, either random or at certain time intervals, can be used in order to analyse the instantaneous severity of the postures.

In this method the postural analysis of entire video recording for any work cycle is carried out. The analysis of the frequency of occurrence of different postural severities as well as total elapsed time for each severity level is done. This analysis gives the P-SVR index which is the weighted value of different levels of work severities for complete work cycle.

### Process to determine P-SVR Index value

- Video recording of activity to represent postures of operator for complete work cycle is taken.
- By observing the video, elemental break up of work cycle based on major postural change is done, noting the time spent at each severity of posture.
- Data is compiled to have frequencies of occurrences for different severities of postures as well as for the cumulative elapsed time for these severities.
- Based on elapsed time for each postural severity level, weighted average of severity of postures based on time is calculated which gives the P-SVR index value.

## 3. Case Study - Application of P-SVR Methodology in an automobile industry

This paper relates to a real life analysis carried out in a large scale manufacturing unit. There are three jobs being undertaken by three different workers and there was a need to convince the workers' union about comparative difficulty in undertaking the tasks.

In order to evaluate comparative postural severity of the jobs, video recording of these jobs was done. The videos were used for the P-SVR analysis. In order to have representation of the tasks involved the following are the photographs of these three jobs.



**Photograph 1:** Machining of a casting

This operation involved machining of a casting on a CNC machine; involving the loading of the casting, closing the door of the machine and starting the machine, opening of the machine door once one face is over, unload the casting and rotate it to have machining of another surface and then again closing the machine, starting the machine. After the machining of the second surface, the operator removes the casting, keeps it in the storage meant for it, cleans the casting to remove coolant. When he keeps the casting in the rack, the casting is rotated once again. The weight of the casting is about 3 kg. Cycle time was about 6 minutes and the operator was operating two machines. Photograph 1 gives representative idea of the task involved.



**Photograph 2:** Seat assembly

This job involved seat assembly in a vehicle. Seats are stored in a rack near the work place. Operator lifts a seat from a storage, for which he has to bend and arise and lift the weight of the seat. The seat is carried to the vehicle, door for which is open, the operator locates the seat in the position, uses necessary pneumatic tools and assembles the seat in place, for which he has to undergo bending and has to have difficult postures due to space constraints. The cycle time for this job is about 5 minutes. Photograph 2 gives representative idea of the task.

This is a short cycle job, where the operator lifts two small components of few gm and loads these on machine, closes the machine door. Once the machining is complete he has to remove the job from the machine, keep it in the

storage, for which he has to turn his body. He lifts another pair of jobs from nearby stack. The cycle time for this job is about 3 minutes. Photograph 3 is representative photograph of the job.



Photograph 3: Micro machining

4. Analysis using P-SVR methodology

Table 1P-SVR Analysis using RULA for machining of casting

P-SVR Analysis using RULA for machining of casting				
RULA Score	Frequency	Total Elapsed time	% of total time	Total El T * Score
1	0	0	0.0	8.166
2	7	8.166	6.5	90.322
3	29	45.161	35.8	64.077
4	14	21.359	16.9	5.404
5	2	1.351	1.1	6.755
6	4	3.244	2.6	19.464
7	36	48.517	38.4	339.619
<b>Total</b>		127.798	101.277	533.807
<b>P-SVR</b>				<b>4.2</b>

Table 2P-SVR Analysis using RULA for seat assembly

RULA ANALYSIS for Seat Assembly				
RULA Score	Frequency	Total elapsed time	% of total time	total elapsed time *RULA score
1	0	0	0	0
2	7	27.64	8.97	55.28
3	11	20.18	6.55	60.54
4	8	21.64	7.02	86.56
5	12	26.97	8.75	134.85
6	40	141.01	45.75	846.06
7	25	70.77	22.96	495.39
<b>Total</b>		308.21	100.00	1678.68
<b>P-SVR [RULA]</b>				<b>5.4</b>

From Table 4 it is clear as to how the P-SVR Index Value can give comparative analysis of the postural severities involved in different jobs. In this case the workers’ union claimed that the machining of castings is the most difficult job, considering the fact that the job involved manual

indexing of casting. When P-SVR methodology was applied to find out relative postural severities of these three jobs, considering the time spent by an operator in different postural severities it could be proved that the most difficult job is that of seat assembly rather than the machining of casting.

Table 3P-SVR Analysis using RULA for micro machining

P-SVR Analysis using RULA for micro machining				
RULA Score	Frequency	Total Elapsed time	% of total time	Total El T * Score
1	0	0	0	0
2	1	1.681	9.324384	3.362
3	10	10.651	59.08032	31.953
4	5	5.696	31.5953	22.784
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
<b>Total</b>		18.028	100	58.099
<b>PSVR</b>				<b>3.2</b>

Table 4 Summary of P-SVR analysis

Summary of P-SVR analysis		
Job	Cycle Time in seconds	P-SVR Index
Machining of casting	127.798	4.2
Seat Assembly	308.21	5.4
Micro machining	18.028	3.2

Conclusion

The P-SVR methodology leads to mapping of postural severity of complete work cycle considering elemental time and frequency. Due to this one can locate the problem areas exactly and can be improved, leading to workman comfort and improved performance level.

As discussed above the P-SVR methodology can be used to evaluate comparative postural severity of different jobs, which can be of great help in solving industrial disputes regarding productivity norm fixation or wage fixation.

Using P-SVR method review of elemental analysis is possible. Due to the fact that the postural analysis has been converted in quantitative parameters irrespective of analyst the results are expected to be the same.

The benefit of the P-SVR method is that the postural analysis can be carried out considering different factors like Operators, Processes, and Equipment being used. Hence this method is useful for an ergonomist to convince both the workers’ unions as well as management representatives about improvements required to have higher job comfort leading to higher output.

The P-SVR method can be used to decide upon the comparative job difficulty involved in different operations. Since this method does holistic analysis of human work postures, the P-SVR indices in turn quantify the job difficulty level.

As discussed above it can be seen that this method provides comprehensive analysis of work posture severity to locate exact areas where improvements need to be

undertaken in order to minimize postural discomfort leading to increased level of productivity.

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