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ERGONOMICS FOR WELL-BEING - A REVIEW

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Abstract:

This article examines the numerous Ergonomics studies conducted in various fields, with a primary emphasis on preventing accidents as well as incidents that could result in ergonomic and human factors issues for industrial workers. Researchers have discovered several technologies that can be used to enhance ergonomic treatments and reduce the frequency of incidents. Despite the fact that safety has a significant impact on human parts and ergonomics, this article bases its discussion on the various industrial zones. Following that, the workplace can clearly execute mitigation and prevention strategies. The environment and comfort level zones are interconnected in a workplace that handles machinery. Ergonomics are important human factors, particularly in the manufacturing sector. This paper examined several approaches put forth by different industries, considering the difficult frequencies and postures associated with each occupational activity. Note that various comfort level zones that relate to the workers are defined by each study tool. On the basis of this, only further research was done, and the prior literature thoroughly identified the issues.

Keywords:

Accident Prevention, Ergonomics, Human Factors, Industrial Safety, Workplace Comfort

Introduction

One physical characteristic that addresses how people should position themselves at work is ergonomics. Ergonomics in the workplace brings up several important issues that affect both safety and productivity. One of the main problems is the high number of musculoskeletal disorders (MSDs) caused by poor posture, repetitive tasks, and bad workplace design, leading to pain and injuries. Many workers and employers are not fully aware of the importance of good ergonomic practices, which makes the situation worse. Workspaces with uncomfortable seating, poorly placed tools, and inefficient setups add to these challenges. These issues not only harm employees' health but also reduce productivity, increase absences, and raise healthcare costs. Fixing these ergonomic problems is key to improving both worker safety and business performance. Among the performance factors and possible issues at work, awkward postures rank first (Qutubuddin, Hebbal, & Kuma, 2013). The assessment of the brick manufacturing business was carried out by Qutubuddin et al. (2013). In the brick production industry, they examine task performance. Product production and domestic manufacturing sectors both exhibit uncomfortable postures. It is unknown to them what safe working positions and appropriate postures are. The authors evaluate the workers' posture in light of their continuous working mode in order to research MSDs and implement ergonomic solutions (Karthikeyan, Phebe, Kaliappa, & Chandrasekaran, 2014). The appraisal of the evaluation in the leather apparel sector was carried out by Karthikeyan et al. (2014). This study attempts to detect and categorize Work-related Musculoskeletal Diseases (WMSD) dangers in the garment and leather manufacturing industries (Arroyave-Tobón & Osorio-Gómez, 2017). On the other hand, Arroyave-Tobón and Osorio-Gómez (2017) assessed the ergonomic hazards utilizing various modeling tools with regard to virtual-based analysis in conceptual design mode to decrease the ergonomic hazards (Upadhyay, Desai, Paghdar, & Jhala, 2015). Alternatively, Upadhyay et al. (2015) analyzed the ergonomic dangers existing in various industrial domain sectors as well as the ergonomic interventions available in the workplace (Andreoni, Santambrogio, Rabuffetti, & Pedotti, 2002). Meanwhile, Andreoni et al. (2002) developed the method with regard to the ergonomic interfaces as well as posture assessments' analysis with the car drivers' novel work investigations (Buchholz, Paquet, Punnett, Lee, & Moir, 1996). In addition to that, Buchholz et al. (1996) assessed the construction sector utilizing the job sampling method. On the other hand, Jones and Kumar (2010) performed an ergonomics risk assessment on a saw ball mill, evaluating four activities. Subsequently, the results identify areas requiring ergonomic interventions (Perez, De Looze, Bosch, & Neumann, 2014). Similarly, Perez et al. (2014) integrated the idea of system design modification and improvement into a workplace simulation for ergonomics analysis (Dukic, Rönnäng, & Christmansson, 2007). In 2007, Dukic et al. looked at the ergonomic risks of working in a virtual mode in the manufacturing industry (Ali, Qutubuddin, Hebbal, & Kumar, 2012). As Ali et al. (2012) did ergonomic studies in traditional Indian sawmills, they looked at the risks of musculoskeletal disorders at work and how the workers dealt with them. Every task in this work is assessed for a seamless ergonomic intervention process, then critically viewed and recorded (Li & Buckle, 1999). Li and Buckle (1999) focused on the physical factors considered during the ergonomic evaluation. This particular piece of work is among the assessments taken to determine the discomfort level zone with regard to the assessment category (Ozsoy, Ji, Yang, Gragg, & Howard, 2015). In 2015, Ozsoy et al. investigated the ergonomic risks present in the simulation mode to improve the virtual graphics with respect to each work activity. Additionally, they simulated drivers' performance referring to the interior seating design with regard to each work activity (Mali & Vyavahare, 2015). Correspondingly, Mali and Vyavahare (2015) presented the various ergonomic evaluation procedures that were carried out for the industrial workplace

activities that were conducted. These procedures utilized a variety of reviews and methodology tools. In 2021, Koppiahraj, Bathrinath and Saravanasankar utilized the Fuzzy VIKOR methodology to identify appropriate ergonomic risk assessment methods aimed at minimizing industrial workers' exposure. Rajakarunakaran, Kumar and Prabhu (2015) employed the Fuzzy Expert framework in 2014 to determine the level of danger posed by LPG refueling stations. Karuppiyah, Sankaranarayanan, Ali and Kabir (2020) used the SME methodology to identify ergonomic evaluation factors in the workplace at Leather Garment Productions. Additionally, Bhalaji, Bathrinath, Ponnambalam and Saravanasankar (2019) applied Fuzzy Decision-Making methodologies to assess risk factors and environmental health in the healthcare industries. Ortega Marchisio and Collao-Diaz (2023) conducted a systematic review, showing how ergonomic practices enhance productivity in manufacturing companies. Similarly, Maheshkumar et al. (2015) demonstrated that ergonomic improvements at workstations lead to increased comfort and operational efficiency. Additionally, Bindhu and Rao (2024) assessed workplace ergonomics, highlighting key factors that affect worker well-being and suggesting interventions to improve performance. These studies collectively highlight the positive impact of ergonomics in manufacturing environments. The table below (Table 1) illustrates the statistics on ergonomic issues in industrial settings.

Table 1: Statistics on Ergonomic Issues in Industrial Settings

Table 1: Statistics on Ergonomic Issues in Industrial Settings						
Category		Industry		Statistics		Reference
Incidence of WMSDs		Brick Manufacturing		40% of workers reported discomfort in back and shoulders due to awkward postures		Qutubuddin et al. (2013)
Ergonomic (MSDs)	Risk	Leather Industry	Apparel	35% of workers experienced musculoskeletal disorders related to repetitive tasks and improper posture		Karthikeyan et al. (2014)
Productivity Loss due to MSDs		General Sector	Industrial	20% loss in productivity due to absenteeism caused by ergonomic-related injuries		Upadhyay et al. (2015)
Impact of Ergonomic Interventions		Construction Industry		25% reduction in reported back pain after implementing ergonomic seating solutions		Buchholz et al. (1996)
Cost of Ergonomic Injuries (MSDs)		Healthcare Industry		Annual cost of \$20 billion for ergonomic-related workplace injuries		Bhalaji et al. (2019)
Effectiveness of Ergonomic Interventions		Manufacturing Sector		Fuzzy VIKOR methodology reduced ergonomic risk exposure by 15% after assessment		Koppiahraj et al. (2021)

Methodology

In terms of the instruments and methods employed in each ergonomic assessment, the numerous methodologies offered for ergonomics risk assessments are notable and innovative. The approach may vary depending on the many industries utilized to adopt and assess the various kinds of difficult postures associated with each activity. Here, the flowchart below (Fig. 1) illustrates the most straightforward manner of providing the reviewed technique for each task before discussing the assessment instruments. Based on this review workflow, some ergonomics analysis tools and apps can be studied and applied in various applications and domains. Note that the sample data illustrates the many kinds of tools utilized for various purposes (Table 1- Ergonomics Tools).

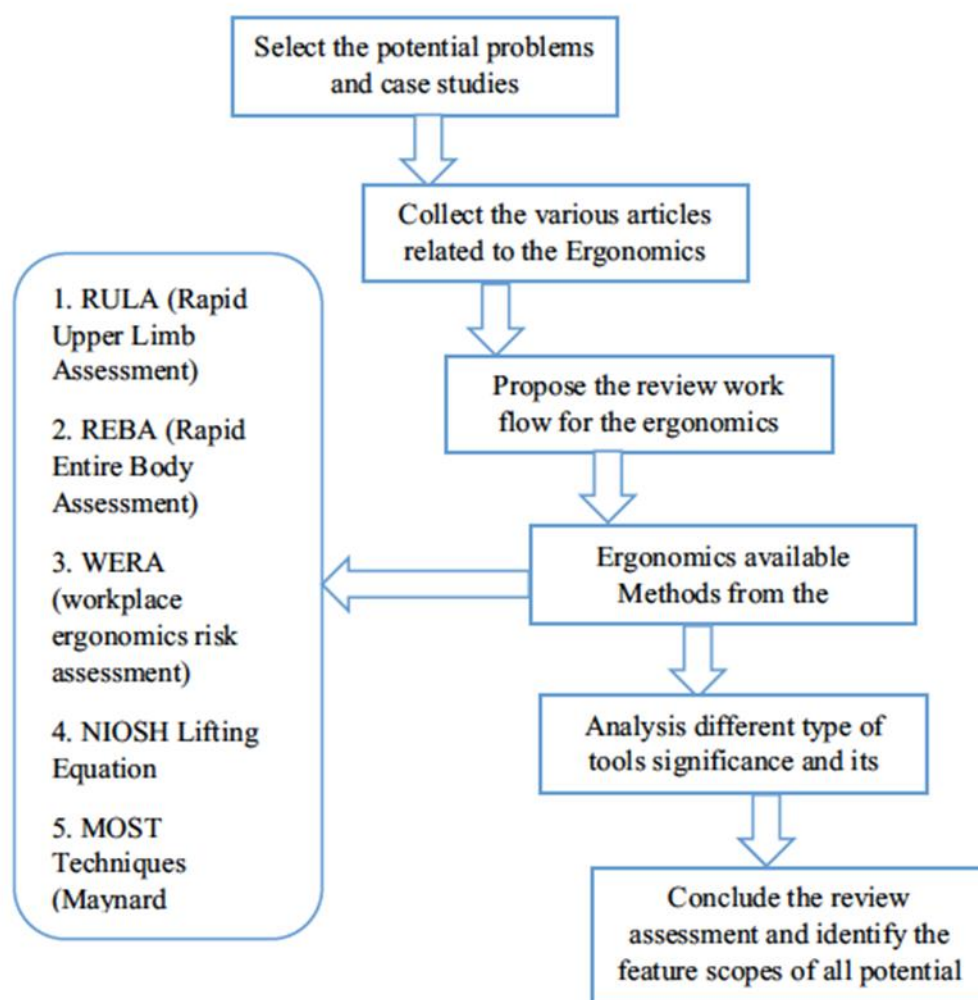
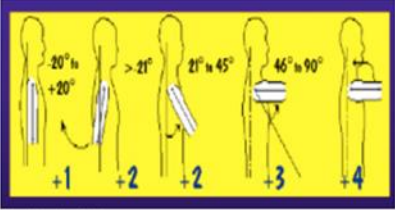
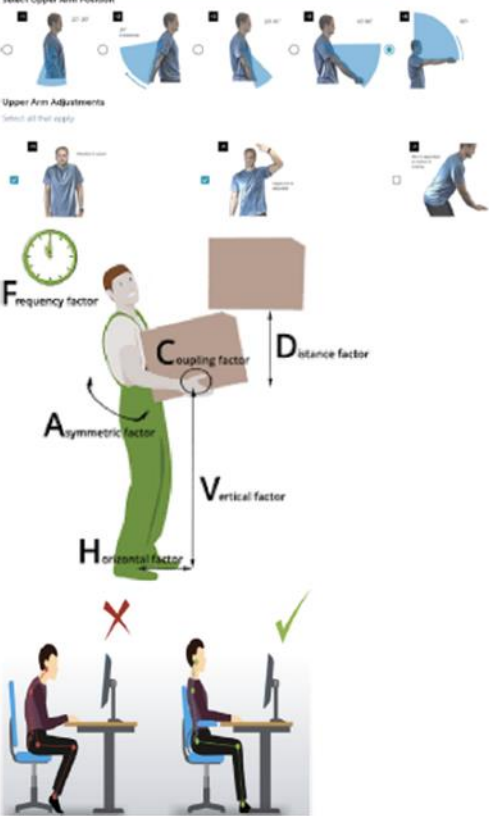
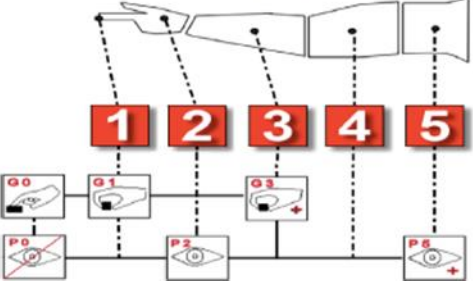


Figure 1: Ergonomic Tool's Flow Process

Table 2: Tools of Ergonomics

Type of activities representations	Ergonomics assessments Tools and Applications
	<p>RULA (Rapid Upper Limb Assessments) is used for analyses the upper body parts assessments such as hand, twist neck and limbs.</p>
	<p>REBA (Rapid Entire Body Assessments) is used for analyses the entire body postures such as neck, hand, shoulder, leg and twist.</p> <p>NIOSH Lifting Equations is used for analyses the manual handling posture inside the workplace such as lifting lowering etc.</p>
	<p>WEBA (Workplace Ergonomics Risk Assessment) used to analysis the observational good working postures and identify the awkward working postures.</p> <p>MOST Technique (Maynard Operational Sequence Technique) is used for analysis step by step operation of all activities in a single calculation to identify the risk factors involved in the workplace.</p>

RULA

These methods were applied in order to evaluate ergonomic risk factors. The Rapid Upper Limb Assessment (RULA) survey technique was developed by McAtamney and Corlett (2009) to be used in industrial ergonomics assessment processes to look into specific possible issues, including stress, strain, and fatigue during work that might result in physical injury (McAtamney & Corlett, 2009). Research and testing methodologies are able to forecast uncomfortable postures and analyze body postures, including those of the hand, wrist, chest, shoulder, leg, as well as neck. Note that this tool is mainly employed to evaluate ergonomic

hazards and reduce workplace risks, with three levels of hazard: Low, High, as well as Medium (refer to Fig. 2).

RULA Employee Assessment Worksheet

Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee's personnel folder for future reference.

A. Arm & Wrist Analysis

Step 1: Locate Upper Arm Position

0° to 10° = 1, 10° to 20° = 2, 20° to 45° = 3, 45° to 90° = 4, 90°+ = 5

Step 1a: Adjust...

If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Final Upper Arm Score = []

Step 2: Locate Lower Arm Position

0° to 100° = 1, 100° to 120° = 2, 120° to 140° = 3, 140° to 160° = 4, 160° to 180° = 5

Step 2a: Adjust...

If arm is working across midline of the body: +1
If arm out to side of body: +1

Final Lower Arm Score = []

Step 3: Locate Wrist Position

0° = 1, 0° to 15° = 2, 15° to 30° = 3, 30° to 45° = 4, 45° to 60° = 5, 60° to 75° = 6, 75° to 90° = 7, 90° to 105° = 8, 105° to 120° = 9, 120° to 135° = 10, 135° to 150° = 11, 150° to 165° = 12, 165° to 180° = 13

Step 3a: Adjust...

If wrist is bent from the midline: +1

Final Wrist Score = []

Step 4: Wrist Twist

If wrist is twisted mainly in mid-range = 1
If twist at or near end of twisting range = 2

Wrist Twist Score = []

Step 5: Look-up Posture Score in Table A

Use values from steps 1, 2, 3 & 4 to locate Posture Score in table A

Posture Score A = []

Step 6: Add Muscle Use Score

If posture mainly static (i.e. held for longer than 1 minute) or:
If action repeatedly occurs 4 times per minute or more: +1

Muscle Use Score = []

Step 7: Add Force/load Score

If load less than 2 kg (intermittent): +0
If 2 kg to 10 kg (intermittent): +1
If 2 kg to 10 kg (static or repeated): +2
If more than 10 kg load or repeated or shocks: +3

Force/load Score = []

Step 8: Find Row in Table C

The completed score from the Arm/Wrist analysis is used to find the row on Table C

Final Arm & Wrist Score = []

SCORES

Table A

Upper Arm	Lower Arm	Wrist	Wrist Twist	Posture Score A	Muscle Use	Force/load
1	1	1	1	1	0	0
1	1	2	1	2	0	0
1	1	3	1	3	0	0
1	1	4	1	4	0	0
1	1	5	1	5	0	0
1	1	6	1	6	0	0
1	1	7	1	7	0	0
1	1	8	1	8	0	0
1	1	9	1	9	0	0
1	1	10	1	10	0	0
1	1	11	1	11	0	0
1	1	12	1	12	0	0
1	1	13	1	13	0	0
1	2	1	1	14	0	0
1	2	2	1	15	0	0
1	2	3	1	16	0	0
1	2	4	1	17	0	0
1	2	5	1	18	0	0
1	2	6	1	19	0	0
1	2	7	1	20	0	0
1	2	8	1	21	0	0
1	2	9	1	22	0	0
1	2	10	1	23	0	0
1	2	11	1	24	0	0
1	2	12	1	25	0	0
1	2	13	1	26	0	0
1	3	1	1	27	0	0
1	3	2	1	28	0	0
1	3	3	1	29	0	0
1	3	4	1	30	0	0
1	3	5	1	31	0	0
1	3	6	1	32	0	0
1	3	7	1	33	0	0
1	3	8	1	34	0	0
1	3	9	1	35	0	0
1	3	10	1	36	0	0
1	3	11	1	37	0	0
1	3	12	1	38	0	0
1	3	13	1	39	0	0
1	4	1	1	40	0	0
1	4	2	1	41	0	0
1	4	3	1	42	0	0
1	4	4	1	43	0	0
1	4	5	1	44	0	0
1	4	6	1	45	0	0
1	4	7	1	46	0	0
1	4	8	1	47	0	0
1	4	9	1	48	0	0
1	4	10	1	49	0	0
1	4	11	1	50	0	0
1	4	12	1	51	0	0
1	4	13	1	52	0	0
1	5	1	1	53	0	0
1	5	2	1	54	0	0
1	5	3	1	55	0	0
1	5	4	1	56	0	0
1	5	5	1	57	0	0
1	5	6	1	58	0	0
1	5	7	1	59	0	0
1	5	8	1	60	0	0
1	5	9	1	61	0	0
1	5	10	1	62	0	0
1	5	11	1	63	0	0
1	5	12	1	64	0	0
1	5	13	1	65	0	0
2	1	1	2	66	1	0
2	1	2	2	67	1	0
2	1	3	2	68	1	0
2	1	4	2	69	1	0
2	1	5	2	70	1	0
2	1	6	2	71	1	0
2	1	7	2	72	1	0
2	1	8	2	73	1	0
2	1	9	2	74	1	0
2	1	10	2	75	1	0
2	1	11	2	76	1	0
2	1	12	2	77	1	0
2	1	13	2	78	1	0
2	2	1	2	79	1	0
2	2	2	2	80	1	0
2	2	3	2	81	1	0
2	2	4	2	82	1	0
2	2	5	2	83	1	0
2	2	6	2	84	1	0
2	2	7	2	85	1	0
2	2	8	2	86	1	0
2	2	9	2	87	1	0
2	2	10	2	88	1	0
2	2	11	2	89	1	0
2	2	12	2	90	1	0
2	2	13	2	91	1	0
2	3	1	2	92	1	0
2	3	2	2	93	1	0
2	3	3	2	94	1	0
2	3	4	2	95	1	0
2	3	5	2	96	1	0
2	3	6	2	97	1	0
2	3	7	2	98	1	0
2	3	8	2	99	1	0
2	3	9	2	100	1	0
2	3	10	2	101	1	0
2	3	11	2	102	1	0
2	3	12	2	103	1	0
2	3	13	2	104	1	0
2	4	1	2	105	1	0
2	4	2	2	106	1	0
2	4	3	2	107	1	0
2	4	4	2	108	1	0
2	4	5	2	109	1	0
2	4	6	2	110	1	0
2	4	7	2	111	1	0
2	4	8	2	112	1	0
2	4	9	2	113	1	0
2	4	10	2	114	1	0
2	4	11	2	115	1	0
2	4	12	2	116	1	0
2	4	13	2	117	1	0
2	5	1	2	118	1	0
2	5	2	2	119	1	0
2	5	3	2	120	1	0
2	5	4	2	121	1	0
2	5	5	2	122	1	0
2	5	6	2	123	1	0
2	5	7	2	124	1	0
2	5	8	2	125	1	0
2	5	9	2	126	1	0
2	5	10	2	127	1	0
2	5	11	2	128	1	0
2	5	12	2	129	1	0
2	5	13	2	130	1	0
3	1	1	3	131	2	0
3	1	2	3	132	2	0
3	1	3	3	133	2	0
3	1	4	3	134	2	0
3	1	5	3	135	2	0
3	1	6	3	136	2	0
3	1	7	3	137	2	0
3	1	8	3	138	2	0
3	1	9	3	139	2	0
3	1	10	3	140	2	0
3	1	11	3	141	2	0
3	1	12	3	142	2	0
3	1	13	3	143	2	0
3	2	1	3	144	2	0
3	2	2	3	145	2	0
3	2	3	3	146	2	0
3	2	4	3	147	2	0
3	2	5	3	148	2	0
3	2	6	3	149	2	0
3	2	7	3	150	2	0
3	2	8	3	151	2	0
3	2	9	3	152	2	0
3	2	10	3	153	2	0
3	2	11	3	154	2	0
3	2	12	3	155	2	0
3	2	13	3	156	2	0
3	3	1	3	157	2	0
3	3	2	3	158	2	0
3	3	3	3	159	2	0
3	3	4	3	160	2	0
3	3	5	3	161	2	0
3	3	6	3	162	2	0
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3	3	8	3	164	2	0
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3	3	10	3	166	2	0
3	3	11	3	167	2	0
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3	5	4	3	186	2	0
3	5	5	3	187	2	0
3	5	6	3	188	2	0
3	5	7	3	189	2	0
3	5	8	3	190	2	0
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3	5	10	3	192	2	0
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3	5	12	3	194	2	0
3	5	13	3	195	2	0
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4	1	2	4	197	3	0
4	1	3	4	198	3	0
4	1	4	4	199	3	0
4	1	5	4	200	3	0
4	1	6	4	201	3	0
4	1	7	4	202	3	0
4	1	8	4	203	3	0
4	1	9	4	204	3	0
4	1	10	4	205	3	0
4	1	11	4	206	3	0
4	1	12	4	207	3	0
4	1	13	4	208	3	0
4	2	1	4	209	3	0
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4	2	3	4	211	3	0
4	2	4	4	212	3	0
4	2	5	4	213	3	0
4	2	6	4	214	3	0
4	2	7	4	215	3	0
4	2	8	4	216	3	0
4	2	9	4	217	3	0
4	2	10	4	218	3	0
4	2	11	4	219	3	0
4	2	12	4	220	3	0
4	2	13	4	221	3	0
4	3	1	4	222	3	0
4	3	2	4	223	3	0
4						

particular work performances. The data sheet below provides the format for this procedure. The light grey-colored sections of the datasheet are designated for data entry. It evaluates the right as well as left postures in Groups A (Legs, Neck, and Trunk) as well as B (Wrists, Lower Arms, and Upper Arms). Each region has modification remarks and a posture score scale for extra considerations. After that, the factors for coupling and load/force are scored. Lastly, it assigns a score to the postural activities for Groups A as well as B from Tables A and B, correspondingly. Only the table comes after the data-gathering sheet. The total of the Load/Force as well as Table A scores, is called Score A. The total with respect to each hand's Table B as well as Coupling scores, is called Score B. After reading Score C from Table C, enter it next to Scores A and B. The result of multiplying Score C by Activity is the REBA score. Note that the level of risk is displayed in the REBA decision table. The REBA scoring sheet (Hignett & McAtamney, 2000) is based on the work of Highnett and McAtamney (Fig. 3).

REBA Employee Assessment Worksheet

based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

 Step 1a: Adjust...
 If neck is twisted: +1
 If neck is side bending: +1
 Neck Score

Step 2: Locate Trunk Position

 Step 2a: Adjust...
 If trunk is twisted: +1
 If trunk is side bending: +1
 Trunk Score

Step 3: Legs

 Adjust: 30-60° (+1), 60-90° (+2), 90-120° (+3), 120-150° (+4)
 Leg Score

Step 4: Look-up Posture Score in Table A
 Using values from steps 1-3 above, locate score in Table A

Step 5: Add Force/Load Score
 If load < 11 lbs: +0
 If load 11 to 22 lbs: +1
 If load > 22 lbs: +2
 Adjust: If shock or rapid build up of force: add +1
 Force/Load Score

Step 6: Score A, Find Row in Table C
 Add values from steps 4 & 5 to obtain Score A.
 Find Row in Table C.

Scoring:
 1 = negligible risk
 2 or 3 = low risk, change may be needed
 4 to 7 = medium risk, further investigation, change soon
 8 to 10 = high risk, investigate and implement change
 11+ = very high risk, implement change

SCORES

Table A: Neck

	Neck											
	1				2				3			
Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	2	3	4	1	2	3	4	1	2	3	4
Score A	1	2	3	4	1	2	3	4	1	2	3	4

Table B: Lower Arm

	1						2					
Wrist	1	2	3	4	5	6	1	2	3	4	5	6
Upper Arm Score	1	2	3	4	5	6	1	2	3	4	5	6
Score B	1	2	3	4	5	6	1	2	3	4	5	6

Table C: Score B, (table B value + coupling score)

	Score B														
	1 2 3 4 5 6 7 8 9 10 11 12														
1	1	1	1	1	2	3	3	4	4	5	6	7	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8	8	8	8
3	2	3	3	3	4	5	6	7	7	8	8	9	9	9	9
4	3	4	4	4	5	6	7	8	8	9	9	10	10	10	10
5	4	4	4	5	6	7	8	8	9	9	10	10	11	11	11
6	5	5	5	6	7	8	9	9	10	10	11	11	12	12	12
7	6	6	6	7	8	9	10	10	11	11	12	12	12	12	12
8	7	7	7	8	9	10	10	11	11	12	12	12	12	12	12
9	8	8	8	9	10	10	11	11	12	12	12	12	12	12	12
10	9	9	9	10	10	11	11	12	12	12	12	12	12	12	12
11	10	10	10	11	11	12	12	12	12	12	12	12	12	12	12
12	11	11	11	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + **Activity Score** = **Final REBA Score**

B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position:

 Step 7a: Adjust...
 If shoulder is raised: +1
 If upper arm is abducted: +1
 If arm is supported or person is leaning: -1
 Upper Arm Score

Step 8: Locate Lower Arm Position:

 Lower Arm Score

Step 9: Locate Wrist Position:

 Step 9a: Adjust...
 If wrist is bent from midline or twisted: Add +1
 Wrist Score

Step 10: Look-up Posture Score in Table B
 Using values from steps 7-9 above, locate score in Table B

Step 11: Add Coupling Score
 Well fitting Handle and mid range power grip: good: +0
 Acceptable but not ideal hand hold or coupling acceptable with another body part: fair: +1
 Hand hold not acceptable but possible: poor: +2
 No handles, awkward, unsafe with any body part: Unacceptable: +3
 Coupling Score

Step 12: Score B, Find Column in Table C
 Add values from steps 10 & 11 to obtain Score B. Find column in Table C and match with Score A in row from step 6 to obtain Table C Score.

Step 13: Activity Score
 +1 1 or more body parts are held for longer than 1 minute (static)
 +1 Repeated small range actions (more than 4x per minute)
 +1 Action causes rapid large range changes in postures or unstable base

Figure 3: REBA Table

WERA Assessment

Here, the Workplace Ergonomic Risk Assessment (WERA) represents a method that involves recording as well as monitoring techniques to revise the way activities are monitored for factors related to manual handling and WMSDs. Note that the WERA tool method identifies six factors that contribute to the consequences of manual handling. These factors are time of work, continuous fatigue, shaking activities, mandatory factors, continuous behaviors of workers, as well as attitude performance. The consequences primarily affect five main body regions: leg,

neck, back, wrist, as well as shoulder. The system incorporates a scoring mechanism as well as activity levels to determine the risk level and the necessity for further detailed assessments. This tool's reliability, validity, as well as usability were assessed during its development (Fig. 4).

WORKPLACE ERGONOMIC RISK ASSESSMENT (WERA)

PHYSICAL RISK FACTOR		LOW	MEDIUM	HIGH	SCORING SYSTEM																
1. Shoulder	1a. Posture				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>1a. POSTURE</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>1b. REPETITION</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>1c. DURATION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	1a. POSTURE	2	3	4	1b. REPETITION	3	4	5	1c. DURATION	4	5	6
	Risk Level	LOW	MED	HIGH																	
1a. POSTURE	2	3	4																		
1b. REPETITION	3	4	5																		
1c. DURATION	4	5	6																		
1b. Repetition	Light movement with more pauses	Moderate movement with some pauses	Heavy movement with no rest	Score 1																	
2. Wrist	2a. Posture				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>2a. POSTURE</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>2b. REPETITION</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>2c. DURATION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	2a. POSTURE	2	3	4	2b. REPETITION	3	4	5	2c. DURATION	4	5	6
	Risk Level	LOW	MED	HIGH																	
2a. POSTURE	2	3	4																		
2b. REPETITION	3	4	5																		
2c. DURATION	4	5	6																		
2b. Repetition	0-10 times per minute	11-20 times per minute	Over 20 times per minute	Score 2																	
3. Back	3a. Posture				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>3a. POSTURE</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>3b. REPETITION</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>3c. DURATION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	3a. POSTURE	2	3	4	3b. REPETITION	3	4	5	3c. DURATION	4	5	6
	Risk Level	LOW	MED	HIGH																	
3a. POSTURE	2	3	4																		
3b. REPETITION	3	4	5																		
3c. DURATION	4	5	6																		
3b. Repetition	0-3 times per minute	4-8 times per minute	9-12 times per minute	Score 3																	
4. Neck	4a. Posture				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>4a. POSTURE</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>4b. REPETITION</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>4c. DURATION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	4a. POSTURE	2	3	4	4b. REPETITION	3	4	5	4c. DURATION	4	5	6
	Risk Level	LOW	MED	HIGH																	
4a. POSTURE	2	3	4																		
4b. REPETITION	3	4	5																		
4c. DURATION	4	5	6																		
4b. Repetition	Light movement with more pauses	Moderate movement with some pauses	Heavy movement with no rest	Score 4																	
5. Leg	5a. Posture				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>5a. POSTURE</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>5b. REPETITION</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>5c. DURATION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	5a. POSTURE	2	3	4	5b. REPETITION	3	4	5	5c. DURATION	4	5	6
	Risk Level	LOW	MED	HIGH																	
5a. POSTURE	2	3	4																		
5b. REPETITION	3	4	5																		
5c. DURATION	4	5	6																		
5b. Repetition	Light movement with more pauses	Moderate movement with some pauses	Heavy movement with no rest	Score 5																	

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PHYSICAL RISK FACTOR		LOW	MEDIUM	HIGH	SCORING SYSTEM																
6. Forceful	Lifting the load				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>6. FORCEFUL</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>6a. POSTURE</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>6b. REPETITION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	6. FORCEFUL	2	3	4	6a. POSTURE	3	4	5	6b. REPETITION	4	5	6
	Risk Level	LOW	MED	HIGH																	
6. FORCEFUL	2	3	4																		
6a. POSTURE	3	4	5																		
6b. REPETITION	4	5	6																		
6a. Posture	Lifting the load 0-5kg	Lifting the load 5-10kg	Lifting the load more than 10kg	Score 6																	
7. Vibration	Using of vibration tool				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>7. VIBRATION</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>7a. POSTURE</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>7b. REPETITION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	7. VIBRATION	2	3	4	7a. POSTURE	3	4	5	7b. REPETITION	4	5	6
	Risk Level	LOW	MED	HIGH																	
7. VIBRATION	2	3	4																		
7a. POSTURE	3	4	5																		
7b. REPETITION	4	5	6																		
7a. Posture	Never used of vibration tool OR Used vibration tool < 1hrs per day	Occasional used of vibration tool WITH 1-4hrs per day	Constant used of vibration tool WITH >4hrs per day	Score 7																	
8. Contact stress	Using of tool handle Or wearing hand gloves				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>8. CONTACT STRESS</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>8a. POSTURE</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>8b. REPETITION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	8. CONTACT STRESS	2	3	4	8a. POSTURE	3	4	5	8b. REPETITION	4	5	6
	Risk Level	LOW	MED	HIGH																	
8. CONTACT STRESS	2	3	4																		
8a. POSTURE	3	4	5																		
8b. REPETITION	4	5	6																		
8a. Posture	Soft/curved shape of tool handle OR Using a full cover of hand gloves	Hard/straight shape of tool handle OR Using a half cover of hand gloves	No/Without of tool handle OR Never used hand gloves	Score 8																	
9. Task duration	Task-hr/day				<table border="1"> <tr><th>Risk Level</th><th>LOW</th><th>MED</th><th>HIGH</th></tr> <tr><td>9. TASK DURATION</td><td>2</td><td>3</td><td>4</td></tr> <tr><td>9a. POSTURE</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>9b. REPETITION</td><td>4</td><td>5</td><td>6</td></tr> </table>	Risk Level	LOW	MED	HIGH	9. TASK DURATION	2	3	4	9a. POSTURE	3	4	5	9b. REPETITION	4	5	6
	Risk Level	LOW	MED	HIGH																	
9. TASK DURATION	2	3	4																		
9a. POSTURE	3	4	5																		
9b. REPETITION	4	5	6																		
9a. Posture	< 2hrs per day	2-4hrs per day	> 4hrs per day	Score 9																	
FINAL SCORE																					
Job/Task : _____		<table border="1"> <tr><th>Risk Level</th><th>Final Score</th><th>Action</th><th>Task (Y)</th></tr> <tr><td>LOW</td><td>10-27</td><td>Task is acceptable</td><td><input type="checkbox"/></td></tr> <tr><td>MED</td><td>28-44</td><td>Task is need to further investigate & required change</td><td><input type="checkbox"/></td></tr> <tr><td>HIGH</td><td>45-54</td><td>Task is not accepted, immediately change</td><td><input type="checkbox"/></td></tr> </table>			Risk Level	Final Score	Action	Task (Y)	LOW	10-27	Task is acceptable	<input type="checkbox"/>	MED	28-44	Task is need to further investigate & required change	<input type="checkbox"/>	HIGH	45-54	Task is not accepted, immediately change	<input type="checkbox"/>	
Risk Level	Final Score	Action	Task (Y)																		
LOW	10-27	Task is acceptable	<input type="checkbox"/>																		
MED	28-44	Task is need to further investigate & required change	<input type="checkbox"/>																		
HIGH	45-54	Task is not accepted, immediately change	<input type="checkbox"/>																		
Date : _____																					
Observer : _____																					

Based on WERA: An observational tool develop to investigate the physical risk factor associated with WMGD, Mohd Norul Hafid Rahman, Mohd Rizal Abdul Razak and Naji Mohd Rahim, Journal of Human Ergology, 2011, 40(2), 19-30

Figure 4: WERA

NIOSH Lifting Equation

In the year 1985, the National Institute of Occupational Safety and Health established a new committee to develop solutions to reduce the issues related to manual material handling in organisations. Following the committee's recommendation, a formal document was established for the revised lifting equation in 1991. Note that the equation was subsequently provided to the NIOSH personnel as well as the general public so that a methodology could be formulated and the risks associated with manual handling with regard to the workplace reduced. Subsequently, Waters et al. (1999) introduced the improvised NIOSH lifting equations, which were developed to address the industry's specific requirements and accommodate the growth of organizational setups. The updated lifting equations are employed to assess lifting activities, while the assessment of manual handling activities is conducted by workers on-site. The NIOSH lifting equations can be determined by utilizing the parameters listed below:

$$RWL = LC \cdot HM \cdot VM \cdot DM \cdot AM \cdot FM \cdot CM.$$

Recommended Weight Limit (RWL)
Load Constant (LC)

Horizontal Multiplier (HM)
Vertical Multiplier (VM)
Distance Multiplier (DM)
Asymmetric Multiplier (AM)
Frequency Multiplier (FM)
Coupling Multiplier (CM)

Table 3: Standard Values Provided by NIOSH

		METRIC	U.S. CUSTOMARY
Load Constant	LC	23 kg	51 lb
Horizontal Multiplier	HM	(25/H)	(10/H)
Vertical Multiplier	VM	$1 - (.003 V - 75)$	$1 - (.0075 V - 30)$
Distance Multiplier	DM	$.82 + (4.5/D)$	$.82 + (1.8/D)$
Asymmetric Multiplier	AM	$1 - (.0032A)$	$1 - (.0032A)$
Frequency Multiplier	FM	From Table 5	From Table 5
Coupling Multiplier	CM	From Table 7	From Table 7

Source: (Waters et al., 1999)

Table 4: Frequency Multiplier (FM) Table

Frequency Lifts/min (F) ‡	Work Duration					
	≤ 1 Hour		>1 but ≤ 2 Hours		>2 but ≤ 8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

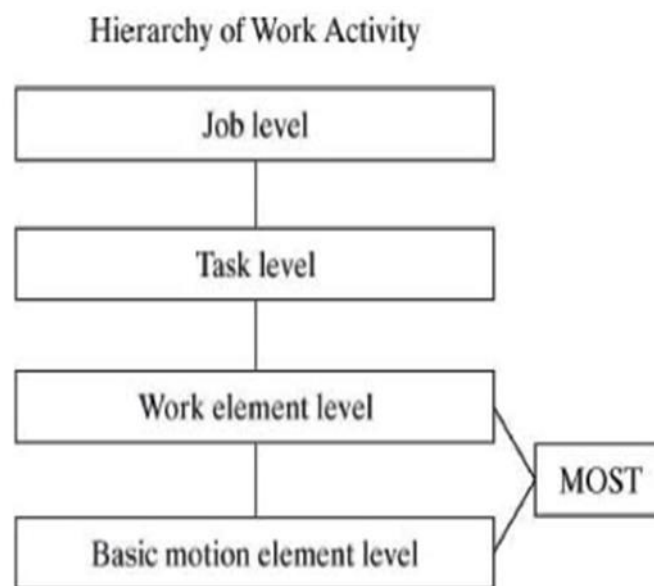
†Values of V are in inches. ‡For lifting less frequently than once per 5 minutes, set F = lifts/minute.

Table 5: Coupling Multiplier (CM)

Coupling Type	Coupling Multiplier	
	V < 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

MOST Techniques

The Maynard Operation Sequence Technique (MOST), a work measuring method first created by H. B. Maynard in the United States, was reviewed by Gadakh, Ahire, Karad and Student (2017). This technique is mostly utilized to examine a broad spectrum of industrial applications, for example, the automotive, household appliance, and aircraft industries. The main flaw of the ergonomics intervention was the laborious and difficult techniques it employed. It can be applied in various industrial sectors, encompassing administrative and corporate techniques as well as strategies to enhance human productivity and optimize time constraints in assembly sections across all industries. Researchers and industry experts have suggested that the MOST technique be utilized to measure different workplace activities and conveniently monitor them in all kinds of industrial manufacturing and assembly sectors due to the issues they have uncovered. This method is essential for tracking difficulty as well as work-measurement jobs in terms of several versions, such as Fundamental, Small, including Enlargement assessments, in the field of Industrial Engineering. This technique is primarily used to rectify and detect issues in the production process as well as conduct an analysis for enhancing ergonomics. This technique is also implemented in the optimized process application (Fig. 5).

**Figure 5: Flow with Regard to MOST Techniques**

Conclusion

It is advisable to utilize the most effective techniques and dependable tools to assess workers' job performance in the industrial setting. Only potential risks associated with manual handling and ergonomics may be countered by implementing and highlighting different levels of zones in the workplace. Nevertheless, the review may only be addressed using specific techniques. Through the analysis of reviews, we can identify and highlight each problem, as well as determine potential issues based on the frequency of incidents and accidents within the industry category. The task can be transformed into a tangible assessment to be used as a benchmark for identifying potential issues within a particular field. Future work can be thoroughly examined by utilising various tools to evaluate ergonomic hazards as well as developing the appropriate methodology to mitigate potential issues in the industry. Hence, the extent of work growth may be evaluated in any manufacturing sector by performing an initial assessment of safety and ergonomics within the workplace. Correspondingly, the review analysis serves as the foundational framework for future work to be conducted in a more practical evaluation.

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