Participatory Approach for Ergonomics Intervention: A Review

Yogesh Mishra, M. L. Meena, and G. S. Dangayach

Abstract Recently, Participatory Ergonomics (PE) approach has been broadly accepted as a system to minimize musculoskeletal disorders (MSDs) and associated injuries among the workers. This review emphasizes on specific topics such as critical success factors of PE approach, conceptual framework for implementation of PE programs, effectiveness and measure elements for successful implementation of PE programs. The literature is preferred from reputed ergonomics journals by refining abstracts and titles utilizing selected words such as 'intervention', ' ergonomic', and 'participatory', and by analyzing the abstracts and findings the 62 articles have been preferred for this review. The review aims to analyze the usual elements and obstructions associated with PE intervention program, thereby giving the recommendations for future research.

Keywords Participatory ergonomics (PE) · Intervention · Musculoskeletal disorders (MSDs)

1 Introduction

Participatory Ergonomics (PE) approach is emerging from various trends such as Community involvement, coordination of production activities as per principles of sociotechnical aspect, and ergonomics evolution from 'micro-level' to 'macro-level'. The meaning of the participatory approach includes intervention at a broad extent (macro), e.g., organizational and system levels, and additionally small extent (micro),

Y. Mishra (✉) · M. L. Meena · G. S. Dangayach
Malaviya National Institute of Technology, Jaipur, Rajasthan, India
e-mail: Yogeshmishranhr@gmail.com

M. L. Meena
e-mail: Mlmeenamnit@gmail.com

G. S. Dangayach
e-mail: dangayach@gmail.com

B. Deepak et al. (eds.), *Advanced Manufacturing Systems and Innovative Product Design*,
Lecture Notes in Mechanical Engineering,
https://doi.org/10.1007/978-981-15-9853-1_7

e.g., personal, where employees are accustomed with the freedom and strength to apply their understanding to hold ergonomic issues associated with the work activities they perform [1]. PE could be interpreted as an approach that involves the use of participative methods and different modes of workplace participation [2]. As per Wilson [3], PE is the participation of employees' in planning as well as in controlling a considerable proportion of their individual tasks, accompanying adequate understanding and ability to control both activities and results to attain preferable targets. Participatory techniques are gradually used in the improvement of ergonomics at workplaces. The advantages of such techniques are broadly anticipated as methods for advocating initiatives of individuals and achieving required workplace solutions [4].

A PE program usually engages one or more teams to bring together intending to improve the designing of the task, and the usual aspect is to make sure the use of specialist's ability such employees acquire of their tasks by associating the employees, and others likely concerned with recommended changes [5]. PE programs have been generally concentrated on musculoskeletal injuries though such approaches have focused to build better human-oriented task [6]. Maciel [7] mentioned that PE programs have been used to enhance organizational conditions while Punnett et al. [8] suggested the use of such a framework for health promotion. PE can be treated as an approach related to design a work system and so, basically, an approach of macro-ergonomics [9–13]. The advantages of PE methods are generally acknowledged by encouraging individual's initiatives and attaining desired feasible results [14–20]. Nowadays, PE methods have acquired global attention in developing ergonomics and avoiding workplace injuries. Additionally, such participatory methods were initiated usually to minimize risks related to an individual's experience at the workplace, accidents, and ailment like musculoskeletal disorders.

PE projects have been executed over a wide extent of organizations as well as in industries too [1]. Though, the majority of implementation areas of PE projects have been mentioned by Burgess-Limerick [5]. It includes implementation in construction [21–28], healthcare [29–34], office domains [14, 35–38], mining [39–42] and in various manufacturing concerns [13, 43–53].

There have been plenty of publications (either peer-reviewed or grey literature) that advocated numerous aspects of PE approach such as implementation areas, critical success factors, conceptual framework, effectiveness, and implementation of PE programs. So this review is an attempt to provide significant pieces of information regarding the PE approach on a single platform.

2 Critical Success Factors for Participatory Approach

Critical Success Factors (CSF) is required for any organization to attain the desired goals. These factors help the team members or workers to know the exact requirements or important aspects of ongoing work. As stated by Zink et al. [54], in the case of a participatory approach, the earlier focus was on individual issues like reduction

of cost, process refinement which results in slight success. There are various elements for the failures of such projects that may be detected in the consideration of a few critical factors which are liable for successful implementation of the project:

- Preference of long-term strategy for the deployment of resources along with the availability of required resources;
- Participation of the workers and teams more concerned with the changes;
- The impact of organizational culture must be considered;
- Integrity among various initiatives and conduction of such initiatives with the integral process;
- More priority on an individual's behavior and structures and seeing the reliance among them;
- Initiatives must not be limited to time-bounded program and it should be a transformative process.

Critical Success Factors are firmly associated with the objectives of the ongoing project/project. These facilitate to trace and compute the progress of the running projects and provide a unique platform of references where an individual or team can access the significant requirements of the project. As per Zink et al. [54], at a brief look, the critical success factors can appear to be extremely distinctive, but on a further conceptual level, it found more challenging to integrate every initiative with subjective and objective dimensions which is shown in Fig. 1. In the logical (or objective) dimension, a crucial adjustment of all actions has to be executed as per the overall integrated concept. In most of the cases, production systems merely targeting manufacturing only and other organizational subsystems are not considered in their long-term strategy. Hence, models based on international merit can provide an additional appropriate framework that has to be implemented as per the specific requirement of the organization.

The prerequisite of subjective dimension is to develop an understanding among the workers about the association between the strategic goals of the organization and projected change actions which leads to certain changes into the routine practice. Further, the employees should be aware of the incorporation of individual actions into an overall approach. So, the participatory approach can develop a better flow of information and promote an advanced understanding of the system. Adequate cooperation of the workers leads to the success of the expert-driven techniques. The participation of the employees is required in expert-driven techniques because the measure focus of such approaches is on logical dimensions only and it neglects the issues of subjective incorporation against the worker's perspective. In this manner, there is a requirement of an administrative approach which aims particularly on the responsibility of administrators to control innovative changes and on effective participation employees at different organizational levels.

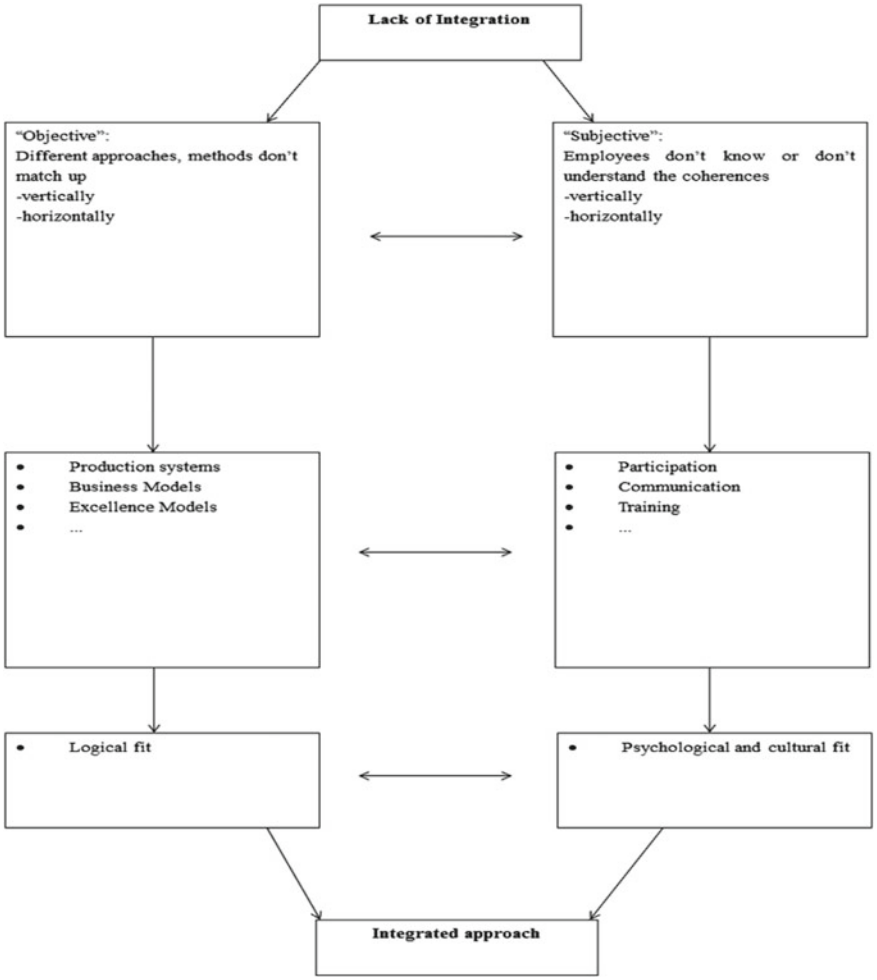

Fig. 1 Dimensions of integration [54]

3 A Conceptual Framework for Execution of PE Programs

A conceptual framework is required to recognize and evaluate the mentioned changes in the creative activities of organizations. Haines et al. [55] proposed a theoretical framework for PE programs. The importance of workers' involvement is highlighted by the ranked dimensions. The top two dimensions imply the workers' involvement in decision-making as well as at every level of an organization. The stability of the input related to ergonomics is given as the low rank which indicates that such addition is project-specific. Hignett et al. [1] also stated that this framework defines the range of

variations while implementing a PE program. Further, Burgess-Limerick [5] defined these dimensions as per their importance stated as:

1. Position of decision-making capability—either maintained at management level and directed to specific employees or their teams;
2. A combination of participating candidates—the inclusion of staff from every level of organization;
3. Remit—involvement of the participants in the PE process, problem identification, interpretation, and suggestions for effective implementation;
4. Responsibility of ergonomics consultant—recognized as dynamic and developing over some time, extensive scope, i.e., as an organizer, instructor, specialist, or consultant;
5. Type of task involvement—involvement of all concerned workers or selected individual workers;
6. Focus—either intended to task design or issues related to the organization of work;
7. Level of influence—change in the organizational level where the intervention occurs, either department level, or across the entire organization;
8. Requirement—entirely depends upon the kind of participation, observing that it may change as per the members of the group;
9. Permanence—scope for both temporary and permanent problem-solving programs, entirely depends on the kind of task which is to be performed.

The capability of a PE intervention can vary due to the various combinations of the above-stated dimensions. Nature and commitment level of the organizations plays a significant role in the success of PE programs and it also impacts the results of such programs. PE programs may vary in connection with the involvement of the designs with which the tasks are fixed.

4 Effectiveness and Implementation of PE Approach

Rivilis et al. [56] stated such a decent implementation of PE programs results in the improvement of specific health issues, also associated with depletion of symptoms related to musculoskeletal disorders (MSDs), injuries, and claims related to compensation of workers. Tompa et al. [18] identified further confirmation that PE programs are productive and are related to the health and work-related outcomes along with their economic effect. Successful implementation of PE programs follows the reduction in cases related to first aid and modified duty, reduction in the unusual absence of workers, and increment in financial and economic benefits. Van Eerd et al. [57] suggested nine elements for successful implementation of PE programs as:

1. Obtain assistance and support in-favor-of the program from every level of organization

2. Formation of a panel for mentoring the process by including people from different levels of the organization.
3. Make management liable for maintaining sufficient resources.
4. Build small groups of devoted people to conduct intervention by including ergonomists, supervisors, and workers.
5. Aware team members about the organizational culture.
6. Provide ergonomics instructions and training to the team members for the assessment of risks related to the workplace.
7. Set up definite roles and responsibilities for the workers.
8. Preference for group decisions instead of individual decisions.
9. Promote effective communication between all the team members during the whole intervention period.

The recent study of Cuny-Guerrier et al. [58] has described the required procedure and strategies which led to the commitment of senior managers during the implementation of PE intervention in the context of subcontractors. The focus was on prevention of MSDs in the meat processing sector by using the reflexive practice approach and obtained the results which emphasize the significance of stakeholder during the commitment of strategies in PE. Mahdavi et al. [59] conducted a study in a resin manufacturing company of Iran and stated the implementation steps of the PE program to manage factors related to ergonomic risks of human work. The emphasis was on to minimize the risks of human-work related injuries within the organization. Similarly, Capodaglio [60] implemented a PE project in an Italian wool processing company for the improvement of strategies related to the prevention of MSDs in maintenance workers and identified that PE program can be helpful in the management of crucial maintenance activities by the worker's empowerment and recognition of suitable solutions related to MSDs problems of maintenance environment. Narsia and Raj [61] executed a PE program in Indian cashew nut factories to avoid occurrence of Work-Related Musculoskeletal Disorders (WRMSD) in workers and determined that PE programs can also be beneficial to lessen the amount of worker's leaves which leads to productivity improvement. Bernardes et al. [62] conducted a PE intervention in a Brazilian garment company and stated the feasibility and effectiveness of PE intervention approach to minimize the risk of WRMSDs in industries. Hence, for the effective execution of PE programs, the analysis about risk and the control of information must be easily accessible throughout all levels of the organization.

5 Result and Discussion

Most of the studies concerning effectiveness of PE approach emphasized only on outcomes related to health of workers which comprised of assessment of symptoms related to MSDs, severity of injury, or pain along with the spot of manifestation through body part [8, 12–14, 19, 20, 24, 31, 32, 38, 40, 43, 48, 56, 60–62]. The

effectiveness of PE programs is also assessed by economic evaluation of PE interventions that leads to quality and productivity improvement [17, 18, 50]. So, for the assessment of the effectiveness of the PE program, this study emphasizes on further characteristics such as PE intervention process, recognition, and implementation of changes concerning ergonomic intervention along with the study of risk elements.

6 Conclusion

The review has provided significant information's regarding critical success factors of PE approach, the conceptual framework for the implementation of PE programs, effectiveness, and measure elements for the effective execution of PE programs. Attainment of these usual elements and obstructions can be helpful in the promotion of a successful PE intervention program. The measure strength of the PE approach is the flexibility to the situation and workplace requirements, project assignments, and workers. The review has also identified the following research gaps that can also be treated as directions for future research.

- Due to the variety of PE research methods; limited information is available in the studies regarding the effectiveness of PE programs in the improvement of various outcomes related to worker's health. The primary logic behind that is the availability of less number of systematically sound researches in the concerned literature.
- In most of the PE intervention studies, the measure focus was on the physical facet of the task, in spite of factors related to the psychosocial aspect.
- Still, there is a need for an effective framework for the conduction of the PE intervention program which ensures adequate involvement of workers and nurturing interest to assure sustainability.
- Due to the lack of time and unavailability of necessary resources, a more extended review can be done in future by including grey literature related to PE intervention.

References

1. Hignett, S., Wilson, J.R., Morris, W.: Finding ergonomic solutions—participatory approaches. Occup. Med. **55**(3), 200–207 (2016)
2. Vink, P., Wilson, J.R.: Participatory ergonomics. In: Proceedings of the XVth Triennial Congress of the International Ergonomics Association and the 7th Joint conference of the Ergonomics Society of Korea/Japan Ergonomics Society, 'Ergonomics in the Digital Age', Seoul, Korea, pp. 24–29 (2003)
3. Wilson, J.R.: Ergonomics and participation. Eval. Hum. Work A Pract. Ergon. Methodol. **2**, 1071–1096 (1995)
4. Kogi, K.: Advances in participatory occupational health aimed at good practices in small enterprises and the informal sector. Ind. Health **44**(1), 31–34 (2006)

5. Burgess-Limerick, R.: Participatory ergonomics: evidence and implementation lessons. Appl. Ergon. **68**, 289–293 (2018)
6. Imada, A.: Participatory Ergonomics: a strategy for creating human-centred work. J. Sci. Labour **76**(3), 25–31 (2000)
7. Maciel, R.: Participatory ergonomics and organisational change. Int. J. Ind. Ergon. **22**, 4–5 (1998)
8. Punnett, L., Warren, N., Henning, R., Nobrega, S., Cherniack, M.: Participatory ergonomics as a model for integrated programs to prevent chronic disease. J. Occup. Environ. Med. **55**, 19–24 (2013)
9. Hendrick, H.W.: An overview of macroergonomics. Macroergonomics: Theory Methods Appl. 1–23 (2002)
10. Kleiner, B.M.: Macroergonomics: analysis and design of work systems. Appl. Ergon. **37**(1), 81–89 (2006)
11. Kleiner, B.M.: Macroergonomics: work system analysis and design. Hum. Factors **50**(3), 461–467 (2008)
12. Guimarães, L.D.M., Ribeiro, J.L.D., Renner, J.S., De Oliveira, P.A.B.: Worker evaluation of a macroergonomic intervention in a Brazilian footwear company. Appl. Ergon. **45**(4), 923–935 (2014)
13. Guimarães, L.D.M., Anzanello, M.J., Ribeiro, J.L.D., Saurin, T.A.: Participatory ergonomics intervention for improving human and production outcomes of a Brazilian furniture company. Int. J. Ind. Ergon. **49**, 97–107 (2015)
14. Vink, P., Peeters, M., Gründemann, R.W.M., Smulders, P.G.W., Kompier, M.A.J., Dul, J.: A participatory ergonomics approach to reduce mental and physical workload. Int. J. Ind. Ergon. **15**(5), 389–396 (1995)
15. Zalk, D.M.: Grassroots ergonomics: initiating an ergonomics program utilizing participatory techniques. Ann. Occup. Hyg. **45**(4), 283–289 (2001)
16. Khai, T.T., Kawakami, T., Kogi, K.: Participatory action oriented training: PAOT programme trainer's manual. Centre for Occupational Health and Environment, Cantho (2005)
17. Tompa, E., Dolinschi, R., Laing, A.: An economic evaluation of a participatory ergonomics process in an auto parts manufacturer. J. Saf. Res. **40**(1), 41–47 (2009)
18. Tompa, E., Dolinschi, R., Natale, J.: Economic evaluation of a participatory ergonomics intervention in a textile plant. Appl. Ergon. **44**(3), 480–487 (2013)
19. Hongsranagon, P., Somana, Y., Maha-Udomporn, S.O.M.K.I.E.T., Siriwong, W., Havanond, P., Deelertyuenyong, N., Saksri, P.: Participatory ergonomics intervention for improving work-related musculoskeletal disorders in the 'one tambon one product' industry in Thailand. J. Hum. Ergol. **40**(1_2), 11–18 (2011)
20. Tappin, D.C., Vitalis, A., Bentley, T.A.: The application of an industry level participatory ergonomics approach in developing MSD interventions. Appl. Ergon. **52**, 151–159 (2016)
21. Vink, P., Urlings, I.J., van der Molen, H.F.: A participatory ergonomics approach to redesign work of scaffolders. Saf. Sci. **26**(1–2), 75–85 (1997)
22. De Jong, A.M., Vink, P.: The adoption of technological innovations for glaziers; evaluation of a participatory ergonomics approach. Int. J. Ind. Ergon. **26**(1), 39–46 (2000)
23. De Jong, A.M., Vink, P.: Participatory ergonomics applied in installation work. Appl. Ergon. **33**(5), 439–448 (2002)
24. Dennis, G., Burgess-Limerick, R.: Participative ergonomics in civil construction handbook: reducing the risk of musculoskeletal injury in the civil construction industry. Department of Employment and Industrial Relations (2007)
25. Jaegers, L., Dale, A.M., Weaver, N., Buchholz, B., Welch, L., Evanoff, B.: Development of a program logic model and evaluation plan for a participatory ergonomics intervention in construction. Am. J. Ind. Med. **57**(3), 351–361 (2014)
26. Dale, A.M., Jaegers, L., Welch, L., Gardner, B.T., Buchholz, B., Weaver, N., Evanoff, B.A.: Evaluation of a participatory ergonomics intervention in small commercial construction firms. Am. J. Ind. Med. **59**(6), 465–475 (2016)

27. Brandt, M., Madeleine, P., Samani, A., Ajslev, J.Z., Jakobsen, M.D., Sundstrup, E., Andersen, L.L.: Effects of a participatory ergonomics intervention with wearable technical measurements of physical workload in the construction industry: cluster randomized controlled trial. J. Med. Internet Res. **20**(12), e10272 (2018)
28. Lowe, B.D., Albers, J., Hayden, M., Lampl, M., Naber, S., Wurzelbacher, S.: Review of construction employer case studies of safety and health equipment interventions. J. Constr. Eng. Manag. **146**(4), 04020012 (2020)
29. Bohr, P.C., Evanoff, B.A., Wolf, L.D.: Implementing participatory ergonomics teams among health care workers. Am. J. Ind. Med. **32**(3), 190–196 (1997)
30. Evanoff, B.A., Bohr, P.C., Wolf, L.D.: Effects of a participatory ergonomics team among hospital orderlies. Am. J. Ind. Med. **35**(4), 358–365 (1999)
31. Carrivick, P.J., Lee, A.H., Yau, K.K., Stevenson, M.R.: Evaluating the effectiveness of a participatory ergonomics approach in reducing the risk and severity of injuries from manual handling. Ergonomics **48**(8), 907–914 (2005)
32. Rasmussen, C.D.N., Holtermann, A., Bay, H., Sogaard, K., Jorgensen, M.B.: A multifaceted workplace intervention for low back pain in nurses' aides: a pragmatic stepped wedge cluster randomised controlled trial. Pain **156**(9), 1786 (2015)
33. Chin, W., Kurowski, A., Chen, G., Gore, R., Punnett, L.: Enhancing the usability of a mobile app for process evaluation in a participatory ergonomics healthcare intervention. In: Congress of the International Ergonomics Association, Springer, Cham, pp. 523–530 (2018)
34. Jakobsen, M.D., Aust, B., Kines, P., Madeleine, P., Andersen, L.L.: Participatory organizational intervention for improved use of assistive devices in patient transfer: a single-blinded cluster randomized controlled trial. Scand. J. Work Environ. Health **45**(2), 146–157 (2019)
35. Haims, M.C., Carayon, P.: Theory and practice for the implementation of 'in-house', continuous improvement participatory ergonomic programs. Appl. Ergon. **29**(6), 461–472 (1998)
36. Bohr, P.C.: Office ergonomics education: a comparison of traditional and participatory methods. Work **19**(2), 185–191 (2002)
37. Polanyi, M.F., Cole, D.C., Ferrier, S.E., Facey, M.: Paddling upstream: a contextual analysis of implementation of a workplace ergonomic policy at a large newspaper. Appl. Ergon. **36**(2), 231–239 (2005)
38. Baydur, H., Ergör, A., Demiral, Y., Akalın, E.: Effects of participatory ergonomic intervention on the development of upper extremity musculoskeletal disorders and disability in office employees using a computer. J. Occup. Health **16**, 3 (2016)
39. McPhee, B.: Ergonomics in mining. Occup. Med. **54**(5), 297–303 (2004)
40. Burgess-Limerick, R., Dennis, G., Straker, L., Pollock, C., Leveritt, S., Johnson, S.: Participative ergonomics for manual tasks in coal mining. In: Proceedings of the Queensland Mining Industry Health and Safety Conference, Townsville, Australia, pp. 14–17 (2005)
41. Torma-Krajewski, J., Hipes, C., Steiner, L., Burgess-Limerick, R.: Ergonomic interventions at vulcan materials company. Mining Eng. 54–58 ((2007))
42. Apud, E.: Ergonomics in mining: the Chilean experience. Hum. Factors **54**(6), 901–907 (2012)
43. Cantley, L.F., Taiwo, O.A., Galusha, D., Barbour, R., Slade, M.D., Tessier-Sherman, B., Cullen, M.R.: Effect of systematic ergonomic hazard identification and control implementation on musculoskeletal disorder and injury risk. Scand. J. Work Environ. Health **40**(1), 57–65 (2014)
44. St-Vincent, M., Chicoine, D., Beaugrand, S.: Validation of a participatory ergonomic process in two plants in the electrical sector. Int. J. Ind. Ergon. **21**(1), 11–21 (1998)
45. St-Vincent, M., Lortie, M., Chicoine, D.: Participatory ergonomics training in the manufacturing sector and ergonomic analysis tools. Relat. Industrielles/Ind. Relat. **56**(3), 491–515 (2001)
46. Nagamachi, M.: Requisites and practices of participatory ergonomics. Int. J. Ind. Ergon. **15**(5), 371–377 (1995)
47. Halpern, C.A., Dawson, K.D.: Design and implementation of a participatory ergonomics program for machine sewing tasks. Int. J. Ind. Ergon. **20**(6), 429–440 (1997)
48. Laing, A., Frazer, M., Cole, D., Kerr, M., Wells, R., Norman, R.: Study of the effectiveness of a participatory ergonomics intervention in reducing worker pain severity through physical exposure pathways. Ergonomics **48**(2), 150–170 (2005)

49. Liker, J.K., Nagamachi, M., Lifshitz, Y.R.: A comparative analysis of participatory ergonomics programs in US and Japan manufacturing plants. Int. J. Ind. Ergon. **3**(3), 185–199 (1989)
50. Motamedzade, M., Shahnavaz, H., Kazemnejad, A., Azar, A., Karimi, H.: The impact of participatory ergonomics on working conditions, quality, and productivity. Int. J. Occup. Saf. Ergon. **9**(2), 135–147 (2003)
51. Moore, J.S., Garg, A.: Participatory ergonomics in a red meat packing plant, Part I: Evidence of long-term effectiveness. Am. Ind. Hyg. Assoc. J. **58**(2), 127–131 (1997)
52. Gjessing, C.C., Schoenborn, T.F., Cohen, A.: Participatory ergonomic interventions in meat-packing plants, US department of health and human services. Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication, pp. 94–124 (1994)
53. Fontes, A.R.M., Braatz, D., da Silva, J.E.A.R., Ferreira, R., Menegon, N.L.: The perspective of ergonomics in the design of work situations using computational tools: case in a plastic film manufacturing plant. Prod. Manag. Dev. **16**(2), 114–121 (2019)
54. Zink, K.J., Steimle, U., Schröder, D.: Comprehensive change management concepts: development of a participatory approach. Appl. Ergon. **39**(4), 527–538 (2008)
55. Haines, H., Wilson, J.R., Vink, P., Koningsveld, E.: Validating a framework for participatory ergonomics (the PEF). Ergonomics **45**(4), 309–327 (2002)
56. Rivilis, I., Van Eerd, D., Cullen, K., Cole, D.C., Irvin, E., Tyson, J., Mahood, Q.: Effectiveness of participatory ergonomic interventions on health outcomes: a systematic review. Appl. Ergon. **39**(3), 342–358 (2008)
57. Van Eerd, D., Cole, D., Irvin, E., Mahood, Q., Keown, K., Theberge, N., Cullen, K.: Process and implementation of participatory ergonomic interventions: a systematic review. Ergonomics **53**(10), 1153–1166 (2010)
58. Cuny-Guerrier, A., Savescu, A., Tappin, D.: Strategies to commit senior subcontractor managers in participatory ergonomics interventions. Appl. Ergon. **81**, 102878 (2019)
59. Mahdavi, N., Shafiee Motlagh, M., Darvishi, E.: Implementation of ergonomic interventions using participatory program method of PErforM. Iran. J. Ergon. **7**(2), 19–29 (2019)
60. Capodaglio, E.M.: Participatory ergonomics for the reduction of musculoskeletal exposure of maintenance workers. Int. J. Occup. Saf. Ergon. 1–21 (2020). (Just-Accepted)
61. Narsia, R.H., Raj, J.O.: Participatory ergonomics: work related musculoskeletal disorders among cashew nut factory workers in Karkala Taluka. Acta Sci. Orthop. **3**(6) (2020). ISSN: 2581–8635
62. Bernardes, J.M., Ruiz-Frutos, C., Moro, A. R.P., Dias, A.: A low-cost and efficient participatory ergonomic intervention to reduce the burden of work-related musculoskeletal disorders in an industrially developing country: an experience report. Int. J. Occup. Saf. Ergon. 1–8 (2020)