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ERGONOMIC FACTORS IN CONSTRUCTION INDUSTRY: A LITERATURE REVIEW

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ABSTRACT:- Construction Productivity largely depends upon human performance. Labor productivity is also a key concept of construction planning efforts and thus construction productivity is primarily dependent on human effort and performance. Ergonomic is the significant factor to maintaining high level of workers' productivity and eliminate the risk factors in construction sector. To improve labor productivity by applying the ergonomic principles in the workplace is important to consider. The aim of ergonomics is to decrease injuries at the workplace and to improve productivity. Ergonomics is known as a science of designing the job to fit the worker which makes the job easier, safe and more pleasant for them and also leads to save money. Development of establishing ergonomics program can be achieved by focusing on all essential principles of ergonomics.In a workstation the labor productivity gets affected due to discomforts and several other factors such as awkward and static posture, repetition, vibration, force, contact stress, time period, work related factors, environmental risk factors, individual factors, health factors, employee motivation, organization support, productivity improvement. The study aims to identify and evaluate the main factors affecting the labor productivity and also give possible recommendations to improve ergonomics of construction projects.

***KEY WORDS**: Ergonomics, Labour Productivity, Ergonomics program, Risk factors, Construction.*

1. INTRODUCTION

Construction industry is an ancient human activity. Construction activities are considered to be dangerous and risky job. Construction industry faces lots of challenges variety of injuries can occur in the construction industry. Productivity is one of the most important factors affecting the overall performance of any organization, whether large or small and the problems are usually associated with performance of labor. The performance of labor is affected by many factors and is usually connected to the performance of time, cost and quality. Construction performance and productivity improvement are the key focus areas in construction industry. Work is still physically straining, work organization and working methods are traditional. Quality of the construction largely depends upon the quality of work done by labor.

The Labor productivity directly affects construction productivity. Ergonomics principles can be applied at many stages of work design. They can be used in tool and equipment design, workplace layout, and the planning of work processes. Ergonomic focuses on the work environment and items such as design and function of workstations, controls, displays, safety devices, tools and lighting to fit the employee's physical requirements, capabilities and limitation to ensure his/her health and wellbeing.It may include changing the workplace conditions to reduce stressors that may cause musculoskeletal disorders.It also useful to increases the productivity of construction projects.

2. FOCUS OF ERGONOMICS

2.1. ERGONOMIC PRINCIPLES

Ergonomic term, that has been derived from the Greek ergon and nomos, means that thought of laws into the work. It is the strategy of designing the work in a way to make the job easier for involved workers (MojtabaValinejadShoubi, AzinShakibaBarough, Amin Rasoulijavaheri 2013); Ergonomics (or human factors) is the subject involved with the understanding of interactions among humans and alternative parts of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. (Maura Mengoni, Marco Matteucci, DamianoRaponi 2017); Ergonomics programs tend to be reactive when considering employees' complaints, absence from work, quantity of work accidents and occupational diseases (Priscila Rodrigues Fernandes, Ana Lucia Berretta Hurtado, Eduardo Concepcion Batiz 2015);Injuries and illness not only force workers to stay away from work but also pose the risk of chronic problems (Soumitry J. Ray, JochenTeizer 2012); MSDs is a disease that needs to be avoided, because it is very harmful to workers and the company.

MSDs cause workers become ill, job quality is lowered, and even not able to continue the work. Furthermore, the productivity of the company may be down (WiyonoSutaria et al. 2015);MSDs are responsible for pain, difficulty performing work-related tasks, and long periods of absence from work and disability in the workforce (Yves Roquelaure 2016); Manual material handling (MMH) is the most common reason for contractor disorders (MSDs) and low back pain (LBP). It involves manual lifting, lowering, carrying, pushing and pulling loads (Baba MdDerosa, Dian Darina Indah Daruisb, Ishak Mohamed Basir 2015); Many ergonomics simulation systems have been introduced to improve the productivity, comfort, and safety of workers in manufacturing workplaces and numerous assessment tools have been suggested to assess and analyse the risk factors associated with prolonged standing (Isa Halim et al. 2014);

This contributes to enterprises reducing costs of accidents and occupational injuries, absenteeism, turnover, designing a more comfortable place to work that permits to increase productivity and quality on products (Karla Gabriela Gomez-Bulla, Juan Luis Hernandez-Arellanob, Gabriel Ibarra-Mejiac 2015); Ergonomics Research Division, carries out teaching activities in theoretical-practical undergraduate and postgraduate courses, and research activities through the ergo research seedbed, degree work and applied project research (Luz M. Saenza, Gustavo Sevillaa, Ever Patinoa 2015).

2.2. ERGONOMIC DESIGN

In applied science style, one can use anthropometric data in three different ways. The first is designing for a range, The second is designing for the extremes, The third is designing for an average (Jeffrey E. Fernandez, Michael Goodman); High risk tasks will be targeted in order that automation, robotics, and ergonomic principles can be applied to modify the task or work environment to accommodate human capabilities and limitations (John G. Everett 1994); Design is a central preoccupation for ergonomists. From designing a new system, process, machine or product to the effective implementation of the projects, ergonomists track all the aspects that may affect humans. On the one hand, ergonomics studies design as a process, that is how a system is conceptualized, what are the factors considered as determinant in the proper functioning of the system and influence the decisions made (Maria – Elena Boatca, Bianca Cirjaliu 2015);A cross-sectional workplace study was conducted in 2011at twelve different blue collar companies across Denmark.

Muscular load was measured throughout an entire working day among employees exposed to a high number of lifting tasks (Markus Due Jakobsen et al. 2018); Ergonomics produces and integrates data from the human sciences to match jobs, systems, products, and environments to the physical and mental abilities and limitations of people. In doing thus it seeks to safeguard safety, health and well being while optimizing potency and performance. Therefore, considering ergonomics will lead to improving safety of workplaces and organization productivity promotion (MortezaOostakhan, ShahramVosoughi, Mohammad Khandan 2012); Participative engineering is rumored to own a variety of benefits additionally to reduction in system injury risks, such as improved flow of useful information within an organisation, an improvement in the meaningfulness of work, more rapid technological and organisational change, and enhanced performance (Robin Burgess-Limerick, 2018); The obstacles to designing for ergonomics is the narrow specialisation of design and construction practice limited preconstruction collaboration between the designer and constructor due to the traditional construction procurement system the limited availability of ergonomicsin design tools, guidelines and procedures, and the limited education architects and engineers receive regarding construction ergonomics (Smallwood, J.J. 2015); The purpose of associate degree intervention is to undertake to manage the assorted system disorders within the work atmosphere.

There square measure a good sort of things which will be tried within the work atmosphere so as to undertake to scale back or eliminate the existence of system disorders. These include engineering redesign, work method changes, administrative control, worker training, work hardening, and management organizational work rules to reduce exposures (Dennis R. Jones 2015). If workplace design does not guarantee a certain ergo-quality level, the loop back to system configuration design phase is necessary in order to select a system configuration that impact less on psychosocial conditions (D.Battini 2011); Workplace design is considered to be allencompassing, including job rotation and the way in which workers carry out their day to day tasks as well as physical design of the workplace (S. Eaves 2016).

2.3. ERGONOMICS IN THE CONSTRUCTION INDUSTRY FOR IMPROVING PRODUCTIVITY

Construction industries have focused more on improving productivity over ensuring safety and health issues of the construction workers such as conducting ergonomic analysis (In-Ju Kim 2017); Productivity translates directly into cost savings and profitability (Mohammed SallehHammad 2011); The idea of labour productivity is significantly connected to the input, output and method. Loss of productivity occurs at the crew level.

Difficult operating conditions, out of stock resources associated an unsuitable hands will every cause slowed pace of labor, absence, employee turnover, and an idle time, and fatigue, loss of motivation or poor quality work (N.T.Satheish Kumar, S.Loganathan 2016); Productivity prognostication plays a crucial role in strategic and operational designing. Site productivity is one of difficult factor for measurement because they can be determined significantly depending upon size of site and place of measurement (Shinde V. J., Hedaoo M. N. 2017); Any construction web site the contractor's gain depends, amongst different things, on completion of the add experience and at the smallest amount price, and also the productivity of labour has a direct bearing on this being achieved (Mr.C.Thiyagu, Mr.M.Dheenadhayalan 2015); Ergonomic solutions may therefore help to reduce the risk of MSDs among construction workers (JulittaS.Boschman, Monique H.W. Frings-Dresen, Henk F. Van der Molen 2015).

2.4. ERGONOMIC RISK ASSESSMENT

The draft normal engineering science certification of machinery and equipment: applied science of technologies and therefore the organization of machine operation;ergonomics of the work house in man-machine systems; applied science of knowledge and decision-making in man-machine systems; ergonomics of the physical, chemical and biological work environment (GrzegorzDahlke 2015); Based on ergonomic expertise gained through specific trainings, experts apply scientifically validated assessment methods for analyzing and evaluating work stations. (Johannes Labuttis 2015); The purpose of identifying risks associated with awkward postures,generally, postures of different body parts are measured in terms of degree of bent from the neutral posture (Nipun D, Reza Akhavian, Amir H. Behzadan 2017); The exposure time estimates for all participants were then controlled at the site by a technician from the occupational health services (Per Vihlborg 2017); Given that the prevention of injuries is one of the principal aims of H&S management, it is crucial to identify the causes of accidents and develop equivalent prevention measures in the industry (Winn-Yam Ayessaki, John Smallwood, 2017).

3. ERGONOMICS RISK FACTORS

Ergonomics Risk Factors (ERF) is that exist or created by choice or accidentally that might contribute to results contravene or against the principles or philosophy of biotechnology that could or would possibly harmful to the health and well-being of employees or users at work or when work. Understanding and aware on the negative aspects of ERF are critical and essential for countermeasures to take before solutions to the problems could be found. (N. Jaffar 2011); Factors moving on self propelled vehicle operator load square measure whole body vibration, dimensional answer of self propelled vehicle cabin, view cone and visibility, configuration of foot and hand controls, configuration of control panels and displays and fatigue (MiroslavaKramarova, LuboslavDulina, IvanaCechova 2017); Since CART selects the most important predictive variables and their interactions and generates unique collection of target variables that accurately predict low and high risk groups, this technique is again applied for individual occupations to identify the critical occupational risk factors for those occupations (Pradip Kumar Ray, RatriParida, EshaSaha 2015); Ergonomics may be wont to cut back injuries, improve productivity and reduce the costs of doing business.

The construction trade suffers from exhausting and expensive activity injuries primarily to employees. The Ergonomics Risk Factors (ERF) are Awkward Posture, Force, Repetition, Vibration, Static Loading, Contact Stress, Extreme temperature (Shabin.S, Ramesh Babu.T 2007); Many organizational factors have been linked to stress reactions and the organization can influence ergonomic factors such as posture, repetition, and movements, which have been identified as risk factors for musculoskeletal disorders. (Elvia Luz Gonzalez-Munoz, Rosalío Avila Chaurand 2015).

4. LITERATURE REVIEWS

Abdulrahman M Basahel (2015) have analysed numerous tasks in the workplace, particularly in the industrial sector (i.e., manual material handling tasks) require an individual to perform in poor working conditions to meet task demands. The purpose of the present study was to judge contractile organ disorders and establish engineering science factors associated with lower back, shoulder and lower arm pain in 2 varieties of manual tasks lifting and actuation objects in grocery warehouses. Rapid higher Limb Assessment and a pain self report chart were used. The results of the study well tried that the RULA technique was a great tool to assess the MSDs on body regions in manual lifting and actuation tasks.

Amin Yazdani et al. (2018) identified common barriers and facilitators encountered during the implementation of changes to prevent musculoskeletal disorders (MSDs) and examined their relationship with those encountered in occupational Health and Safety (OHS) efforts. Thematic analysis of the literature identified barriers and facilitators were similar to those in general OHS processes. The integration of MSDs prevention into a general management system approach may overcome these barriers.

Enrico Del Fabbro et al. (2016) have analysed the specific case is the material handling operations, starting from the supplier delivery.The target is to known and forestall, using standard methods (NIOSH) and index (OCRA), eventual ergonomic hazards in pre-assigned movements (picking, handling, loading, etc) also comparing alternative solutions. Such associate in nursing innovative approach of study can permit anspot understanding of any work-related physical unwellness and choosing a more robust resolution for each random and mass operating operations.

Mohd Suleiman Murad et al. (2012)studied to translate the 21 item Occupational Self Assessment and to measure its psychometric properties. The results recommend that it's reliable and valid in assessing activity functioning for employee with system disorders.

Peter Vink et al. (2006)have focused on the positive aspects of ergonomics in improvement of the working environment. The model distinguishes the success factors in ‘goal’, ’involvement’ and ‘process’. It is hypothesized that the chance of success increases by empowerment and positive experiences of end user with the potential improvement.

Pradip Kumar Ray et al. (2015) explained the details of a study undertaken for biomechanical evaluation of a number of Manual Material Handling (MMH) tasks being carried out at a construction site in India. Results additionally indicate that

there's a requirement for applied science performance improvement for such MMH tasks by the known preventive and corrective measures.

Raemy Md. Zein et al. (2015) have studied with the survey of the posture practices by Malaysian industrial workers. Based on the applied mathematics analysis there are significance correlation of the physical injury with the body injury among industrial staff. Therefore, this survey will offer a preliminary knowledge for any analysis to confirm the right operating posture for employee.

SerdarDurdyev et al. (2012) identified the key factors constraining labour productivity of Turkish contractors in Turkmenistan based on the views of project manager consultants, contractors and subcontractors. Recommendations were provided for up construction labour productivity of Turkish contractors within the housing industry of Turkmen for addressing the labour productivity constraints.

Sheila Mota et al. (2015) have analysed an ecodesign strategy concerning the improvement in the production efficiency of structural ceramic using traditional kilns in the Brazilian Amazon region. This analysis is engaged in making innovative product supported the 3 basic subsystems of the synchronic style model: formal, purposeful and engineering.

TutiSumarningsih et al. (2016) explained labor productivity is influenced by the work methods, physical fatigue, work environment, capability, and complexity of the work. To improve labor productivity due to the work technique, application of the principle of engineering science is vital to contemplate. The application of engineering science principles within the masonry work, plaster work, ceramic installation, and painting work to increase productivity.

5. ERGONOMIC HAZARDS

The players within the industry particularly people who are operating directly within the construction website ought to have basic information, understanding or a minimum of awareness of the potential hazards prevalence especially while working on or around the temporary structures (HerdaBalqis Ismail and Kay Dora AbGhani 2012); Building/erecting scaffolds required lifting/carrying heavy and bulky materials, awkward postures and repetitive motions (Lu Yuan, Matthew Buvens 2015); WRMSD have an effect on the standard of lifetime of the development employee by inflicting loads of absence, increasing work restriction and incapacity so moving the economic standing of the worker (NeerjaJaiswal and VashimaVeerkumar 2016);

Therefore, so as to assess the impact of atmosphere on the performance of employee, the extent of risk associated with the manual handling of tools/equipment, details of the tools and instrumentation and connected problems whereas employees are engaged in construction jobs during this context, applicable applied science principles are needed to be applied to reduce the health hazards for guaranting safety and comfort of the workers (RatriParida, PradipKumarRay 2015).

6. CONCLUSION

Productivity is a serious issue in the construction industry. There are various method of study to improve the productivity that consists of material tracking, healthy and safe working condition to the workers and effective management systems in the construction industry. Conducting an appropriate ergonomic program in the construction industry can be effective to preventing the work related MSDs. Many studies shows that occupational ergonomics should provide changes of design in the workplace and the organisation of work to match the workers and to decrease injuries at the workplace and increase the productivity. The result of this research prove that labor productivity achieved by the application of ergonomic work method and physical capability of the workers. Finally, in a broader context, by increasing the knowledge and awareness of ergonomics programs this will lead to increasing of the productivity, health and safety of employees in the construction industries.

REFERENCES

1) Abdulrahman M Basahel (2015) “Investigation of work-related Musculoskeletal Disorders (MSDs) in warehouse workers in Saudi Arabia” Procedia Manufacturing, Vol. 3, PP. 4643–4649.
2) Amin Yazdania, Richard Wells (2018) “Barriers for implementation of successful change to prevent musculoskeletal disorders and how to systematically address them” Applied Ergonomics, Vol. 73, PP. 122–140.
3) Baba MdDerosa, Dian Darina Indah Daruisb, Ishak Mohamed Basirc (2015) “A Study on Ergonomic Awareness among Workers Performing Manual Material Handling Activities”Procedia - Social and Behavioral Sciences, Vol 195, PP. 1666-1673.
4) D. Battini, M. Faccio, A. Persona, F. Sgarbossa (2011) “New methodological framework to improve productivity and ergonomics in assembly system design”International Journal of Industrial Ergonomics, Vol. 41, PP. 30-42.
5) Dennis R. Jones (2015) “The relationship between working conditions and musculoskeletal/ergonomic disorders in a manufacturing facility – a longitudinal research study” ProcediaManufacturing , Vol. 3, PP. 4480-4484.
6) S. Eaves, D.E. Gyi, A.G.F. Gibb (2016) “Building healthy construction workers: Their views on health, wellbeing and better workplace design” Applied Ergonomics, Vol 54, PP. 10-18.

7) Elvia Luz Gonzalez-Munoz, Rosalío Ávila Chaurand (2015) "Analysis of the role of job stress in the presence of musculoskeletal symptoms, related with ergonomic factors" Procedia Manufacturing, Vol 3, PP. 4964-4970.
8) Enrico Del Fabbro, DariaSantarossa (2016) "Ergonomic analysis in manufacturing process" Procedia CIRP, Vol. 41, PP. 957–962.
9) GrzegorzDahlke (2015) "Ergonomic criteria in the investigation of indirect causes of accidents" Procedia Manufacturing, Vol. 3, PP. 4868-4875.
10) HerdaBalqis Ismail and Kay Dora AbGhani (2012) "Potential Hazards at the Construction Workplace due to Temporary Structures" Procedia - Social and Behavioral Sciences, Vol. 49, PP. 168-174.
11) In-Ju Kim (2017) "The Role of Ergonomics for Construction Industry Safety and Health Improvements"Journal of Ergonomics.
12) Isa Halim, HambaliArep, Seri RahayuKamat, RohanaAbudllah, Abdul Rahman Omar, Ahmad Rasdan Ismail (2014) "Development of a Decision Support System for Analysis and Solutions of Prolonged Standing in the Workplace" Safety and Health at Work, Vol. 5, PP. 97-105.
13) N. Jaffar, A. H. Abdul-Tharim, I. F. Mohd-Kamar, N. S. Lop (2011) "A Literature Review of Ergonomics Risk Factors in Construction Industry" Procedia Engineering, Vol. 20, PP. 89-97.
14) Jeffrey E. Fernandez, Michael Goodman (1991) "Ergonomics in the Workplace" Vol. 34, PP. 229-235.
15) Johannes Labuttis (2015)"Ergonomics as element of process and production optimization" Procedia Manufacturing, Vol. 3, PP. 4168-4172.
16) John G. Everett (1994) "Ergonomics , Health and Safety in Construction: Opportunities for Automation and Robotics"Automation and Robotics in Construction , PP.19-26.
17) Julitta S. Boshman, Monique H.W. Frings-Dresen, Henk F. Van der Molen (2015) "Use of Ergonomic measures Related to Musculoskeletal Complaints among Construction Workers" Safety and Health at Work, Vol. 6, PP. 90-96.
18) Karla Gabriela Gomez-Bulla, Juan Luis Hernández-Arellanob, Gabriel Ibarra-Mejíac (2015) "A proposed methodology for task analysis in ergonomic evaluations" Procedia Manufacturing, Vol. 3, PP. 4756-4760.
19) Lu Yuana, Matthew Buvens (2015) "Ergonomic Evaluation of Scaffold Building" Procedia Manufacturing, Vol. 3, PP. 4338-4341.
20) Luz M. Saenz, Gustavo Sevilla, Ever Patino (2015) "Ergonomics / Human Factors Applied in Formative Research at the Faculty of Industrial Design, Universidad PontificiaBolivariana" Procedia Manufacturing, Vol. 3, PP. 5792-5799.
21) Maria – Elena Boatca, Bianca Cirjaliu (2015) "A Proposed Approach for an Efficient Ergonomics Intervention in Organizations" Procedia Economics and Finance, Vol. 23, PP. 54-62.
22) Markus DueJakobsen, Emil Sundstrup, Mikkel Brandt, Roger Persson, Lars L. Andersen (2018) "Estimation of physical workload of the low-back based on exposure variation analysis during a full working day among male blue-collar workers. Cross-sectional workplace study" Applied Ergonomics, Vol. 70, PP. 127-133.
23) Maura Mengoni, Marco Matteucci, DamianoRaponi(2017) "A multipath methodology to link ergonomics, safety and efficiency in factories" Procedia Manufacturing, Vol. 11, PP. 1311-1318.
24) MiroslavaKramarova, ĽuboslavDulina, IvanaCechova, (2017) "Forklift workers strain of spine at industrial logistics in depending on human work posture" Procedia Manufacturing, Vol.192, PP. 486-491.
25) Mohammed SallehHammad, AbdelnaserOmran, Abdul Hamid KadirPakir (2011) "Identifying ways to improve productivity at the construction industry" ActaTechnicaCorviniensis.
26) Mohd Suleiman Murad, Louise Farnworth& Lisa O'Brien (2012) "Psychometric Properties of Occupational Self-Assessment for Injured Workers with Musculoskeletal Disorders" Procedia - Social and Behavioral Sciences Vol.42, PP. 507-517.
27) MojtabaValinejadShoubi, AzinShakibaBarough, Amin Rasoulijavaheri(2013) "Ergonomics principles and utilizing it as a remedy for probable work related injuries in construction projects" International Journal of Advances in Engineering & Technology, PP. 232-245.
28) MortezaOostakhan, ShahramVosoughi, Mohammad Khandan(2012) "Ergonomics Issues in The Construction Safety" Iranian Rehabilitation Journal, Vol. 10, PP. 47-51.
29) NeerjaJaiswal and VashimaVeerkumar (2016) "Work related Musculoskeletal Disorders among Construction Workers of India" Research Journal of Family, Community and Consumer Sciences, Vol. 4(2), PP. 1-5.
30) Nipun D. Nath, Reza Akhavian, Amir H. Behzadan (2017) "Ergonomic analysis of construction worker's body postures usingwearable mobile sensors" Applied Ergonomics, Vol. 62, PP. 107-117.
31) Per Vihlborg, Ing-LissBryngelsson, Bernt Lindgren, Lars Gunnar Gunnarsson (2017) "Association between vibration exposure and hand-arm vibration symptoms in a Swedish mechanical industry" International Journal of Industrial Ergonomics, Vol. 62, PP. 77-81.
32) Peter Vink, Ernst A.P. Koningsveld, Johan F. Molenbroek(2006) "Positive outcomes of paticipatoryergonomics in terms of greater comfort and higher productivity" Applied Ergonomics, Vol. 37, PP. 537-546.
33) Pradip Kumar Ray, RatriParida, EshaSaha (2015) "Status survey of occupational risk factors of manual material handling tasks at a construction site in India" Procedia Manufacturing, Vol. 3, PP. 6579-6586.

34) Pradip Kumar Ray, RatriParida, SagarSarkar (2015) "Ergonomic analysis of construction jobs in India: A biomechanical modelling approach" Procedia Manufacturing, Vol. 3, PP. 4606-4612.
35) Priscila Rodrigues Fernandes, Ana Lúcia Berretta Hurtado, Eduardo Concepcion Batiz(2015) "Ergonomics management with a proactive focus", Procedia Manufacturing, Vol. 3, PP. 4509-4516.
36) Raemy Md. Zein, Isa Halim, NoorulAzreenAzis, AdiSaptari and Seri RahayuKamat(2015) "A Survey on Working Postures among Malaysian Industrial Workers" Procedia Manufacturing, Vol. 2, PP. 450 – 459.
37) RatriParida, PradipKumarRay (2015) "Factors influencing construction ergonomic performance in India"Procedia Manufacturing, Vol. 3, PP. 6587-6592.
38) Robin Burgess-Limerick (2018) "Participatory ergonomics: Evidence and implementation lessons" Applied Ergonomics, Vol. 68, PP. 289-293.
39) N.T.Satheish Kumar, S.Loganathan (2016) "Study on Ergonomics in Improving Labour Productivity" International Journal of Current Trends in Engineering & Research, Vol.2, PP. 107-117.
40) SerdarDurdyev, Syuhaida Ismail and Nooh Abu Bakar (2012) "Factors Constraining Labour Productivity: Case Study of Turkmenistan", Vol. 55.
41) Shabin.S, Ramesh Babu.T (2010) "A Study of Human Factors and Risk Related To the Construction Industry" IOSR Journal of Mechanical and Civil Engineering, PP. 67-73.
42) Sheila Mota, BernabeHernandis, Karla Mazarelo, VaniaBatalha, LizandraVergara(2015) "Ecoeficiency and Enviroment Ergonomics to the production of ceramic bricks in the Brazilian Amazon" Procedia Manufacturing, Vol. 3, PP. 5579-5586.
43) Shinde V. J, Hedaoo M. N, (2017) "A Review on productivity improvement in construction industry" International Research Journal of Engineering and Technology, Vol. 4, PP. 210-215.
44) Smallwood, J.J. (2015) "Designing for Construction Ergonomics" Procedia Manufacturing, Vol.3, PP. 6400-6407.
45) Soumitry J. Ray, JochenTeizer (2012) "Real time construction worker posture analysis for ergonomics training" Advanced Engineering Informatics, Vol. 26, PP. 439-455.
46) Mr.C.Thiyagu, Mr.M.Dheenadhayalan (2015) "Construction Labor Productivity and its Improvement" International Research Journal of Engineering and Technology, Vol. 2, PP. 824-832.
47) TutiSumarningsih, MochammadAgungWibowo, Sri PrabandiyaniRetnoWardani(2016) "Ergonomics in Work Method to Improve Construction Labor Productivity" International Journal of Science and Engineering, Vol.10(1), PP. 30-34.
48) Winn-Yam Ayessaki, John Smallwood (2017) "Influencing Workers' Performance through Health and Safety Interventions"Procedia Engineering, Vol. 182, PP.42-49.
49) WiyonoSutari, Yusuf NugrohoDoyoYekti, MurniDwiAstuti, YuvieMutiara sari (2015) "Analysis of working posture on muscular skeleton disorders of operator in stamp scraping in 'batik cap' industry" Procedia Manufacturing, Vol.4, PP. 133-138.
50) Yves Roquelaure (2016) "Promoting a Shared Representation of Worker's Activities to Improve Integrated Prevention of Work Related Musculoskeletal Disorders" Safety and Health at Work, Vol.7, PP. 171-174.