

Consequences of Shift Work in Industry: A Critical Review

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ABSTRACT

The goal is to determine which aspects of shift work have a negative impact on employees' health, well-being, and productivity in the workplace. Based on inclusion criteria, 27 research studies were chosen from a total of 60. Studies were chosen for review based on their unique outcome measurement, such as health, weariness, sleepiness, sleep disorders, injuries, and accidents. The impact of shift work on these specific outcomes was investigated, and the severity was addressed in order to determine whether or not intervention was necessary. The review emphasised the multiple complications that shift work research entails, which make it difficult. In order to improve shift work research, more high-quality, field-data-based preventative research in the field of shift work in industry is needed.

Keywords: Shift work; Health; Night shift; Fatigue; Sleep; Productivity

INTRODUCTION

The effect of globalization resulted in continuous improvements in technology to cater the increased market demands for goods and services. The cut throat competition emerged to maintain the market leadership. The manufacturing and service industries in developed and developing countries functioning round the clock to deliver services to their client and hence shift work became inevitable [1]. Shift work refers to all time arrangement which is outside the normal work time of 9.00 am to 5.00 PM [2]. In the process, adverse effects on health and working performance are surfacing. The working time arrangement is a key issue in work organization as it links human resources with production and service requirement. A 24 × 7 work culture now became common as production houses have to run continuously for output and profits. The sleep and wake cycle of human get disturbed due to shift work or working in non-traditional time which impact health and wellbeing. The research work highlighted the negative impact of shift work and night work across industrial and service sector in industrialized countries. There is wide scope for improvement to minimize negative effects of shift work particularly night shift and extended shift hours.

LITERATURE REVIEW

The database of Scopus and Web of Science along with Pub Med, MEDLINE, and NIOSH searched and the articles pertaining to shift work research published were selected. The keywords such

as shift work, work schedule, non-traditional work schedule, shift pattern, night shift, shift work and diseases and disorders, shift work and performance, shift work and cognitive performance used for related article search.

SHIFT WORK AND HEALTH

Akerstedt indicated that night shift work strongly influences the psychology and psychophysiology of humans that means disturb sleep wake cycle which result in severe sleepiness and reduced performance among labour force [3]. Further Harrington in his study highlighted that the most important physiological problems associated with shift work and the night shift is that working, eating, and sleeping phases are changed and sleep and wake cycle get disturbed which result in health problems [4]. The data from National Centre for Health Statistics National Survey of Personal Health Practices and Consequences United states analysed to determine the impact of variable shift schedules on health for US labour force. The results indicated higher rates of heavy drinking, job stress, and emotional problems found in labour working in variable shift when compared to non-variable shift. The study also highlighted that lot of number of people forced to work in non-traditional work schedule but relatively little is known about the physiological, medical, and psychosocial effect of night and rotating shift work [5]. Monk explored the various situations in which the performance of shift workers is critical and identified five different problem areas of shift workers which include errors, sleep, fatigue, job absence, and off-work accidents. As a remedy

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Study recommended the elimination or reduction of night work. The selection of appropriate shift workers based on their experience of shift work to avoid ill effect of shift work was recommended. Use of correct shift rotation schedules and the improvement of the working environment and conditions was one more measure recommended [6]. Giovanni Costa highlighted that in modern society, people work during 'non-standard' working hours which include shift and night work. This non-standard work schedule are recognized risk factors for health, safety and social well-being as sleep and wake cycle alter and natural rhythm of body changes which give rise to health issue. The study concluded that the preventive and protective interventions are required to mitigate the adverse effects and ensure that the worker can cope satisfactorily to shift work effect. The organization of shift schedules according to ergonomic criteria and on specific medical surveillance was recommended. The shift work cause the misalignment of circadian rhythms of body functions which is responsible for feelings of fatigue, sleepiness, insomnia, digestive troubles, irritability, poorer mental agility, and reduced performance efficiency [7]. A study performed in a petrochemical plant in Brazil investigated the consequence of shift work upon workers health and well-being. A self-reported assessment questionnaire was used to analyse health and well-being of workers. Results indicated that shift workers face worse health, social and family effects as compared to day workers. The study reported that the main physiological consequence of such shift schedules is disruption of circadian rhythm which can have a deleterious effect on performance, sleep patterns, accident rates, mental health, and cardiovascular diseases [8]. Further another study examined the effect of morning, afternoon and night shift on sleep patterns and wakefulness in shift workers and concluded that acute effects like difficulty getting to sleep shortened sleep observed. This effect may cause fatigue-related accidents and reduced productivity and cause economic and human loss [9]. The night shift work has pronounced negative effect on sleep, performance, accident risk and cardiovascular disease [10].

A study in the staff of Division of the Indian Railways working on shift duties explored the occupational health problems among shift staff. It examined 300 individuals including Loco Pilots, Train Guards and Technicians and Office staff. The result indicated that 31.33% of total respondent reported the incidence of fatigue stress. The major finding was that among the fatigue affected employees, 88.85% were from lower age group (20-40 years) employees which indicate that age does not act as a tolerance against health effect of shift work [11]. Salma and Rao performed a similar study among Railway shift workers (Loco Pilots, Train Guards, and Technicians TTE office staff) in India. Symptoms of the health problems like sleeplessness, stress anxiety and depression were assessed. Stress and Mental health identified based on own ratings of respondents. Result indicated 49.65% of the respondents reported stress. The mean incidence of depression was at 22.64% while incidence mean of anxiety was at 13.91%. It was noted that 84.62% of the affected by anxiety and stress and 84.5% affected by depression stress were in lower age group (20-40 Yrs). Keeping in view of the high incidences of the specific health problems especially lower age groups (20 and 40 years) the study recommended that the night shift be limited to 4 hrs duration and rotation of the shifts be adopted so as to reduce the sleeplessness and fatigue among the shift workers [12]. Other study analysed the effect of shift work among workers of manufacturing, coal mining, steel industry, iron, metallurgical

industries and engineering plants. The result indicated that the risk was higher on the afternoon shift than on the morning shift and peak in risk was dominant in midnight during the night shift. The other finding reported that an increase in risk was observed over spans of four successive nights [13].

A study in cement plant in Raipur, India investigated the pulmonary function in shift workers. The peak expiratory flow rate (PEFR) was monitored in 202 day workers and 208 shift workers which is one of the measures of pulmonary function. Findings of study indicated that the shift workers (453.9) have consistently lower mean values of PEFR than the day workers (469.8). The results of the present study clearly demonstrated a decreased capacity in shift workers pulmonary function [14]. The findings among workers of United States summarized impact of extended work shifts on worker health and safety. The result indicated a decreasing performance and injuries observed while working log hour shifts particularly of 12 Hour. Findings reported that the 9th to 12th hours of work exhibit decreased alertness, increased fatigue, lower cognitive function, increased injuries among workers. The 12-hour night shifts were associated with more fatigue [15].

Deng reviewed the associations between shift work exposure and health issues like metabolic syndromes, cardiovascular disease, and gastrointestinal problem in US workforce [16]. The study highlighted that literature reviewed supports an increased risk of developing hypertension, coronary heart disease, peptic ulcer disease, and depression in shift workers. The increased risk of negative health outcomes in non-shift workers observed when compared to daytime workers. The evidence for a link between various medical conditions and working at night or on shift systems is reviewed by Knutsson [17]. He concluded there is the most evidence indicating a link between peptic ulcer illness, coronary heart disease, and a poor pregnancy outcome.

Amelvoort through the Maastricht cohort research (N=12 095) collected data from 95 forward-rotating three-shift workers and 681 backward-rotating three-shift workers with 32 months of follow-up [18]. Results when compared to a forward rotation schedule, a backward rotation schedule was associated with an increased requirement for recuperation [relative risk (RR) 2.88, 95 percent confidence interval (95 percent CI) 1.06-7.81] and poor general health (RR 3.21, 95 percent CI 1.32-7.83). To investigate the effects of shift work on the health of 482 male industrial workers, Velayudhan conducted a cross sectional study utilising self-administered questionnaires [19]. Workers on shift were found to be 2.71 times more likely than their regular work peers to have a sleep disturbance (95 percent CI=1.58-4.66). Also, those with self-reported angina were 1.07 times more likely than those without to have a sleep disorder (95 percent CI 1.08-6.13).

Kantermann, et al. summarized the current state of shift-work research in a study to find out the reasons as to why links between shift-work and health is lacking [20]. The result highlighted shift-work seriously affects the health and well-being of millions of people worldwide. The causal mechanisms of shift-work's effects on health are not understood properly and the research design and methodology of research also vary based on type of industry, type of shift design. There is no common ground for comparison of different shift work studies. The assessment of effect on shift work is not easy as there are various interacting factors [20]. Similar

work reviewed the literature on shift work to evaluate effects on sleep. The study concluded that shift workers have to balance productivity and sleep time between shifts and it results in sleep deprivation which increases fatigue and drowsiness due to this sleep deprivation [21].

Another study reviewed the literature on the effects of shift work on workers' physical health, mental health and well-being and family life. Study concluded that night shift and rotating shifts has negative effects on physical health. The gastrointestinal disorders and sleep problems are more severe than cardiovascular problems. Workers on non-standard shifts, compared to regular day time workers, report more health issues [22].

Manjunatha, et al. investigated sick leave and workplace injuries among iron and steel workers in Karnataka, India's southern state [23]. Overall, 66.9% of employees were absent due to illness (95 percent confidence interval: 0.62–0.71). Sick leave cost an average of 16.4 days per worker per year (male = 16.5 days, female = 16.2). Health issues affecting the musculoskeletal system (31.4%), gastrointestinal system (25.8%), hypertension (24.4%), respiratory system (18.1%), and other minor disorders (19.3%) were reported to be common among workers. Despite there is evidence that shift work is associated with a danger to shift workers' health, many shift workers continue to work in shift systems for years while dealing with the responsibilities that come with it. Kogi highlighted the significance of multiple approaches that address both the impacts of disturbances in circadian rhythms and the actual interferences with daily routines at work, in family and social life, in order to improve shift workers' health and tolerance [24]. Ahasan advocated there is currently insufficient material in the literature that supports the effective design of shift schedules that enable effective production levels while maintaining shift workers' health and safety further research is needed for intervention [25].

From these studies it is concluded that many research studies focused on relation between shift work and health, sleepiness, fatigue, increased diseases. There is significant evidence of shift work and particularly night shift have negative effects on employee health and wellbeing. The quantitative and mathematical relationships between shift work factors and outcome variables are lacking in various research studies which is the need for further research.

SHIFT WORK AND INJURIES

The shift work disturbs the circadian rhythm and cause sleepiness [3]. A cross-sectional study conducted in a small scale industry in India evaluated the relation of occupational injuries and rate of sleepiness. The pretested and structured questionnaires were used for data collection. The data on demographics, sleep habits, symptoms of depression, occupational injury, presence of diseases and lifestyle factors was collected from the workers. The results reported that poor nocturnal sleep is related to occupational injury. A nap for 15–20 min during lunch for reducing job stress was suggested as an intervention in preventing sleep-related injuries at work [26].

Nag and Patel conducted a similar type of study in textile industries in Ahmadabad, India which investigated the severity of risk and accident patterns among monthly rotating shift workers and night shift workers [27]. The record of only those accidents cases was used for analysis in which injured person had to be off work for

at least two days after the accident. The findings indicated 1726 accidents were noted in the morning shift, 1033 in afternoon and 711 in the night shift. The results indicated an upward trend in accident rate by the fifth and sixth hour in night shift. Almost the 60% accidents of the morning shift occurred in first half of the shift and 57% of accidents in night work happened in the second half of the night shift.

A study among German working population carried out to find out whether the accident risk is function of work schedule, time of day or an interaction of both 1.2 million accidents for the year 1994 were analysed for the investigation. The results indicated an exponentially increasing trend in accident risk beyond the 9th hour at work. The data analysis indicated that for evening shift starting at (1800 to 2000) or night shift or in the early morning (2000 to 0700), the percentage of accidents beyond the 8th hour at work increased as compared to the people starting their work in the afternoon. The relationship of accident frequencies and interaction for hour at work with time of day was found statistically significant ($\chi^2=71484.9$; $df=264$; $P<0.0001$). The results clearly indicate that there are time-related effects on occupational accident risk [28].

Jaiswal carried out a study among the workers of the Indian weaving textile industry group were studied in a cross-sectional study [29]. The case group consisted of 150 shift workers, while the control group consisted of 141 non-shift workers. Shift workers who had been in an accident had a greater fatigue score than shift workers who had not been in an accident ($p<0.001$), despite the fact that the number of accidents in the two groups was not substantially associated to the rate of sleepiness. Shift employees had a higher rate of fatigue or exhaustion, as well as a higher number of workplace accidents.

From these studies it is concluded that disturbed circadian rhythm due to shift work and prominently night shift may cause accidents at workplace and shift schedule and time of day interact which increases chances of accidents.

SHIFT WORK AND PERFORMANCE

Awad Hanna quantified the effects of shift work on construction labour productivity through developing a model of relationship between shift work and productivity of labours [30]. The study concluded that through the quantification model developed contractors have the ability to determine the impact of shift work on labour productivity and practically can calculate productivity loss and labour cost due to shift work. The results of the research shown that shift work have the potential to be both beneficial and detrimental to the productivity of manufacturing labour [30].

A study in nuclear and heat power plant examined the changes in mental performance parameters of operators during work shifts. The result identified that the mental performance of operators is changing under the influence of circadian rhythms. Study concluded that under unfavourable working conditions for shift workers general functional state may deteriorate [31].

A study evaluated the sleep, fatigue and alertness and performance in 20 male smelter workers in Australia working in 12 hour regular rotating shift. A general health questionnaire used for data collection of sleep disorders and health problems. The results indicated that the shift fatigue levels after shift were significantly higher than before shift ratings ($t=11.056$; $df=67$; $P<0.001$). The

fatigue levels measured using Samn-Perelli scale was mild to moderate during day shifts and higher in the night shifts. The response speed measured by visual Psychomotor Vigilance Task (PVT192 - Dinges and Powell, 1985) shown a significant effect of shift number ($F=7.966$; $P=0.001$) with performance being decreased during the night shifts. They carried out a study to determine the prevalence of weariness among employees with various work schedules [32,33]. The study concluded fatigue was prevalent in 18.1 percent of day employees, 28.6 percent of three-shift workers, 23.7 percent of five-shift workers, and 19.1 percent of irregular shift workers.

Scheroder, et al. studies implications of 8-hour against 10-hour work schedules on air traffic control professionals' (ATC) test performance and alertness [34]. The study highlighted when comparing the first four days of the work week, ATCSs on the 10 h shift performed no better than those on the 8 h shift for any of the parameters. On the final (fifth) day of the 2-2-1 8-hour schedule, test performance was noticeably worse on the night shift. Ognianova, et al. explored the stress levels of thermoelectric operators working in a fast rotating 12-hour shift arrangement [35]. The study highlighted increased feelings of distractibility and tiredness, as well as low irritability, characterise the reported stress levels. After 03 a.m. on the night shift, distractibility rose and alertness dropped rapidly. Throughout the shifts, there was a moderate amount of occurrence of stress state symptoms and few psychosomatic complaints.

From these summarized studies it is concluded that there is evidence of the association of night work and reduced performance when night work include rotating shift schedule. To analyse the consequences of shift work on performance and productivity a scope for more focused research is available in industrialized countries

SHIFT WORK AND INTERVENTIONS

Hornberger performed longitudinal study in a chemical industry to investigate the effects of the change in shift system among shift workers. The results highlighted that shift workers appreciated the fast shift rotation. The 98% of shift workers preferred the new shift system. The short-term improvements were observed after 1 yr. of application of the new shift rota in fatigue, sleep disorders, family and social life on morning shift days. The positive attitude of the shift workers toward the fast shift rotation observed. The acceptance of the new shift rota was also remarkable. The 98% of the subjects voted in favour of this shift schedule after the pilot phase. It supports the ergonomic recommendation that shifts should rotate in a clockwise direction [36].

A similar type of study in a steel industry among shift workers assessed the impact of shift work on health and well-being of employee due to change in shift system as an intervention. The findings highlighted that there were significant improvements in satisfaction level with the new shift system. The intervention was not found significant as no differences were observed with regard to health effects, sleep duration. The only improvement after the pilot period of ten month was that most of workers preferred new shift system over old shift system. The study recommended that the change in shift system should be done with ergonomic recommendations and the design of shift systems should reduce

the negative effects of shift work on well-being, sleep, health and performance [36]. A review conducted to identify effect of various shift systems characteristics such as length of shift, duration of shift, starting time of shift, shift combination, speed of rotation and direction of rotation on neurobehavioral and physiological functioning. The result indicated the direction of shift rotation and extended shift length (mainly 12-h shifts) as critical areas. The use of naps during night shifts, the starting time of shifts identified as other areas. The analysis of concern factors supported the use of forward rotating shift systems in preference to backward rotating shift system for 8 hour shifts [37].

A similar study investigated the impact of the direction of shift rotation on the need for recovery, fatigue, sleep quality, work-family conflict, and leisure time among three-shift workers. A 32 month follow up of 95 workers in forward rotating three shift work system and 681 workers in backward-rotating three shift work system was taken. The results highlighted a backward rotation schedule was related for recovery from fatigue (RR2.88; 95% CI 1.06-7.81 and poor general health (RR 3.21, 95% CI 1.32-7.83) as compared with a forward rotation schedule. The forward rotation schedule was associated with less work-family conflict and better sleep quality over the 32 months of follow-up. The study recommended optimization of shift work schedules in terms of shift rotation direction for possible decrease in the negative effect of shift work. The 29.6% fatigue cases among backward rotating three shift system found which was 7.4% higher than forward rotating shift system [38].

From these summarized studies it is concluded that interventions help to reduce negative effect of shift work if ergonomically designed shift system are implemented. The interventions like increased light, decreased temperature, and increased physical and mental activity, social interaction have to be systematically investigated as countermeasures against night work fatigue as a scope for further research.

CONCLUSION

This review identified complexities in shift work research as there is a wide variation involved in shift work research studies. The shift system design, research design, data collection tools and methods, work culture, work methods vary in shift work research which is a hindrance in concrete results and decision making and possible interventions.

Research studies compared different types of shift system, shift pattern, schedules but no optimal shift system is available which can be recommended for all kinds of shift work in industry. All shift systems and pattern have their positive and negative effects. The effect of shift work on health, well-being, and performance is of vital importance further quantitative evidence based research studies is required. Optimized shift work to minimize negative effect and improve performance is need of future research work.

Many studies have concentrated on describing the effects of certain characteristics of shift systems on the workers exposed to these working conditions. On the other hand the fact is that little attention has been paid to meeting ergonomic requirements for design of shift system. Foundry is major industry while there are limited research studies found highlighting impact of shift work in this sector.

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