Implementation Of Smart Headband Technology As A Solution To Handling Work Accidents In The Construction Sector In Real-Time To Support The Pillars Of The Vision Of Human Development and Mastery Of Science and Technology In Indonesia Golden 2045

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Abstract

Construction is an industrial field that has a high rate of work accidents, the construction sector is the largest contributor to cases of work accidents. Not only in Indonesia, based on data from the International Labor Organization (ILO) reports that at least 60,000 fatal accidents occur each year. Work accidents occur due to human error which can result in injury, loss and even death. At height workers in the construction sector are very vulnerable to the risk of impaired concentration, loss of focus so that they are very at risk of work accidents. In the development of technology in the era of society 5.0, it is able to become one of the main solutions that is used as a means of innovation to increase effectiveness and efficiency at work. Therefore, the smart head band comes as a solution in overcoming cases of work accidents so that it is expected to achieve zero accidents. This supports the golden Indonesia 2045 program in the first pillar, namely increasing education and development technology. smart head band uses EEG (electroencephalograph) technology to measure concentration and fatigue of the human brain. The writing method carried out is a literature study which then the data obtained is analyzed comprehensively. thus the use of smart head bands is a solution to achieve zero accidents. The results of this study indicate that experiencing conditions that experience a good level of focus with an average Beta brain wave value that is at a frequency of 14 - 26 Hz where the value is in medium conditions or 60 dB - 75 dB. While working at 13.00-17.00 WITA workers experience between consciousness and falling asleep or drowsy with a large increase in Theta brain waves with a range of 75 dB - 100 dB which will indicate many abnormalities and cause pathological problems, problems where a person cannot control his body. This can potentially lead to work accidents or more fatally falling from heights and causing fatal accidents.

Keywords: Construction, Work Accident, Smart Head Band

1. INTRODUCTION

The International Labor Organization (ILO) estimates that 2.9 million employees experience workplace accidents with more than 4 days of absence from work each year [1]. Studies show that the incidence of occupational accidents is higher in those in developing countries than in developed countries [1].

Changes in improving process/business performance through digitization and integration as a form of industry 4.0 [2]. According to many studies, working in the construction industry has a high risk of accidents compared to other fields. One of the jobs that contributes to the number of fatal accidents in construction activities is working at heights [3]. because 50% of fatal accidents occur in the construction sector due to falls from height. as for the increase in data obtained in Indonesia in the last 5 years regarding the incidence of falls in the construction sector [4]. Meanwhile, data from the Canadian Center for Occupational Health and Safety in 2021, more than 42,000 workers are injured each year due to falls. About 67% of falls occur at the same level as slips and trips. The remaining 33% fall from heights [5]

So the purpose of this study is to determine the percentage of causes of accidents and handling or solutions if there is a work accident in a building construction project, especially at an altitude [6]. The factors that cause accidents falling from a height such as rushing while working, not having vigilance, making wrong decisions, feeling lazy while working [7]. As well as the occurrence of fatigue and loss of concentration and lack of monitoring resulting in the occurrence of accidents at very high atitudes.

The main change in this industrial era occurs in the connectivity of manufacturing systems due to the integration of information and communication technology, and the Internet of Things (IoT) [8]. Digital apps and tools offer significant opportunities for advancement and productivity in the workplace [9]. Identify most of the construction hazards in the workplace by analyzing the physical and physiological signals [10]. Diagnosing human brainwaves can be done with the Smart Head Band using electroencephalography (EEG) technology [11]. EEG signals involve biopotential information related to human perception and cognition [12]. The level of fatigue and concentration in high-altitude workers can be detected easily, so as to reduce the level of work accidents. Then the Smart Head band tool with Portable EEG technology can be owned by every company[13]. Recent advances in EEG technology make it possible to collect EEG signals without disturbing workers [14].

2. METHODS

This paper is descriptive with a case study of occupational safety and health in the construction sector by applying Smart headband technology that is sensor-based and can be monitored in real-time through a monitor.

The research was conducted at the APK & Ergonomics Laboratory of Industrial Engineering, Faculty of Industrial Technology, Muslim Indonesia University. The research object in this study is mental workload, fatigue and brain concentration in employees. Sampling of respondents was carried out on the mental workload of employees who carried out Building Repair construction work at the Faculty of Industrial Technology as many as 6 respondents by comparing working hours between 08.00-12.00 WITA and 13.00-17.00 WITA. Requiring workers to perform work at heights to collect data, involves attaching headbands to construction workers to capture EEG data. Furthermore, the data obtained from multiple sensors were analyzed using the HJORTH method used in electroencephalogram (EEG) signal analysis for mental workload monitoring and human brain fatigue by observing HJORTH parameters over time.

The data obtained was organized and reviewed at source in order to obtain results that were relevant to the problem. The data is processed by comparing and linking the results of the literature review with each other. The results of data processing are then systematically organized according to the framework that forms the basis for solutions in overcoming related problems.

3. RESULTS AND DISCUSSION

3.1 Data Collection

I In collecting research data, researchers took samples from workers who were doing building repair construction work at the Faculty of Industrial Technology. The results of the measurements will be processed and can be estimated how much brain wave value is generated from the construction activities of 6 workers.

The use of this tool is on the helmet used by workers, where the network is used to connect between the monitor and smart headband technology.

3.2 Introduction

Work accidents are one of the serious problems that need attention in the industrial sector in Indonesia, especially in the construction industry. Work accidents can cause various problems that arise both individually and in groups that can result in injury, loss and even death, the study of work accidents is important to understand, especially on the factors and impacts that cause work accidents.

3.3. Data processing

Furthermore, it enters the data processing stage. The data analysis conducted in this study uses the HJORTH method which is used in the analysis of electroencephalogram (EEG) signals for monitoring mental workload and human brain fatigue by observing HJORTH parameters over time. In addition, this method can evaluate changes in the human condition under different conditions. Thus, researchers can determine differences in brain complexity activity associated with observed variables, such as stimulus response or changes in a person's condition. In addition, descriptive analysis was also carried out by looking at the graph of brain performance results using the muse headband tool on the mind monitor application for each respondent.

3.4. Respondent Profile

Table 1. Respondent

Participant	Age	Gender	Working at the height of the Construction sector	Physical and Spiritual Health
Participant 1	39	Man	Yes	Yes
Participant 2	41	Man	Yes	Yes
Participant 3	38	Man	Yes	Yes
Participant 4	37	Man	Yes	Yes
Participant 5	39	Man	Yes	Yes
Participant 6	19	Man	Yes	Yes

Based on the table above, participants have met the qualifications in the participant requirements, namely in physical and spiritual health, so that respondents can work at altitude effectively.

In the process of collecting data using the Muse handband, it was carried out in the morning before noon and in the afternoon before the afternoon, namely at (08.00 - 12.00 WITA) and at (13.00 - 17.00 WITA), this refers to a study that this time has the largest percentage of accidents compared to other time ranges. One of the other factors that can affect the smoothness of work is having a healthy physical body. An unhealthy physical body when doing work can cause lack of concentration on the work being done and trigger work accidents.

Table 2. Observation of Brainwave Values

Responden	**Brain Waves**	**Treatment 1 Working at 08.00-12.00 WITA (dB)**	**Tingkat**	**Treatment 2 Working at 13.00-17.00 WITA (dB)**	**Level**
1	Delta	66,78	Medium	70,57	High
	Alpha	64,77	Medium	90,55	High
	Beta	57,88	Medium	88,88	High
	Theta	56,88	Medium	80,90	High
	Gamma	34,88	Low	80,88	High
2	Delta	44,55	Low	90,89	High
	Alpha	57,80	Medium	78,66	High
	Beta	67,88	Medium	78,99	Medium
	Theta	56,80	High	86,98	High
	Gamma	74,77	High	88,90	High
3	Delta	58.64	Medium	91,23	High
	Alpha	78,46	High	74,55	Medium
	Beta	62,77	Medium	78,90	Medium
	Theta	57,88	Medium	90,55	High
	Gamma	80,72	High	76,66	Medium
4	Delta	77,89	High	85,80	High
	Alpha	69,87	Medium	70,90	Medium
	Beta	78,44	High	75,70	Medium
	Theta	55,80	Medium	80,88	High
	Gamma	86,44	High	95,80	High
5	Delta	56,37	Medium	76,89	Medium
	Alpha	87,56	High	76,99	Medium
	Beta	67,85	High	87,90	High
	Theta	56,90	Medium	68,99	Medium
	Gamma	78,55	High	75,88	Medium
6	Delta	78,88	High	77,90	Medium
	Alpha	85,80	High	74,88	Medium

	Beta	87,90	High	75,30	Medium
	Theta	67,88	Medium	85,65	High
	Gamma	75,89	High	75,90	Medium

The results of this study are based on [15]. observation results if the delta wave has increased then in a state of relaxation, alpha wave has increased then in a state of relaxation.
Theta (4-8 Hz): An excessive increase in theta waves may indicate that a person is starting to feel stressed or mentally fatigued.
.
Alpha (8-12 Hz): An increase in alpha waves may indicate a deeper level of relaxation or deeper meditation
Beta (12-30 Hz): Increased beta waves are generally associated with high mental activity, such as high concentration or problem solving.
Gamma (30-100 Hz): An increase in gamma waves indicates that a person is engaged in complex problem solving or intense creative thinking.

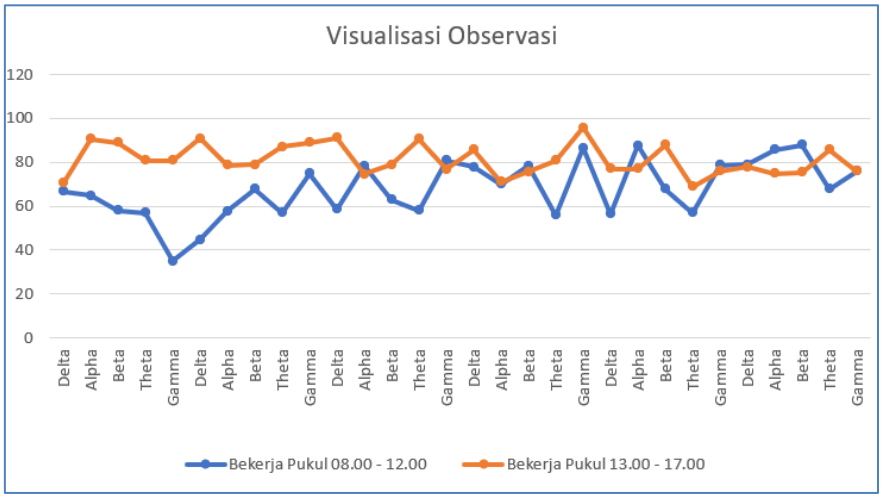

Figure 1. Visualization of Sound Waves Listening to Noise

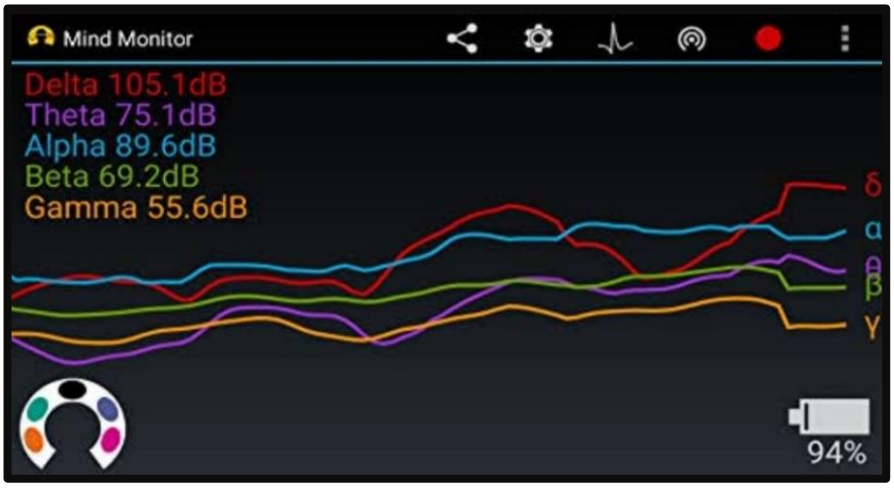

Figure 2. Respondents' Brain Waves Using the Mind Monitor Application

1. Statistical Test of the Effect of Treatment on Respondents
   Statistical tests used to determine the effect of treatment on respondents working on arithmetic problems are regression tests for residual normality, multicollinearity tests.
2. Residuak Norality Test
   The normality test is important because it is one of the requirements for conducting statistical tests, namely that the data must be normally distributed. The residual normality test is carried out to determine whether the residual value of the data is normally distributed or not. The hypothesis used in the residual normality test is as follows :
   a. H0: Data is normally distributed
      If the Significance value > 0.05, then H0 is accepted and H1 is rejected, so the data is normally distributed.
   b. H1: Data tidak berdistribusi normal
      If the Significance value is <0.05, then H1 is accepted and H0 is rejected, so the data is not normally distributed.

Table 3. Normality Test

Residual Normality Test	**Significance**	**Critical Value**	**Description**
In Noisy Conditions	0,150		Data is normally
Dalam Kondisi Tenang	0,150	0,05	distributed
		0,05	Data is normally distributed

Based on the table above, it can be seen that the results of the significance value of the residual normality test in the 2 treatments are 0.150. So it can be stated that all data are normally distributed because the significance value obtained is> 0.05, which means that H0 is accepted or the data is normally distributed.

3. Multikolinearitas Test
   The multicollinearity test is a test that aims to test whether there is a correlation between the independent variables in the regression model to be tested. The hypothesis that will be used in the multicollinearity test is as follows :
   a. H0: No Multicollinearity
      If the Tolerance value> 0.10 or VIF value < 10 then the data does not occur multicollinearity.
   b. H1: Multicollinearity occurs
      If the Tolerance value <0.10 or the VIF value> 10 then the data occurs multicollinearity.Jika nilai Toleransi < 0,10 atau nilai VIF > 10 maka data terjadi multikolinearitas.

Table 4. Multicollinearity Test

Working hours 08.00-12.00 WITA					
Waves Theta	0,063	14,812	< 0,1	> 10	Multicollinearity occurs
Waves Alpha	0,112	7,827	< 0,1	> 10	No Multicollinearity
Waves Beta	0,068	13,552	< 0,1	> 10	Multicollinearity occurs
Waves Gamma	0,095	9,362	< 0,1	> 10	Multicollinearity occurs
Working hours 13.00-17.00 WITA					

Waves Delta	0,287	2,378	< 0,1	> 1	Multicollinearity occurs
Waves Theta	0,172	4,719	< 0,1	> 1	Multicollinearity occurs
Waves Alpha	0,294	2,287	< 0,1	> 1	Multicollinearity occurs
Waves Beta	0,355	1,704	< 0,1	> 1	Multicollinearity occurs
Waves Gamma	0,274	2,534	< 0,1	> 1	Multicollinearity occurs

From the table above, it can be seen that in the treatment with work at 08.00-12.00 WITA the results obtained are that there is no multicollinearity in the delta wave, and alpha wave because the Tolerance value> 0.1 and the VIF value < 10. While in the theta wave, beta wave, and gamma wave there is multicollinearity because the Tolerance value < 0.1 and the VIF value> 10. In workers who work at 13.00-17.00 WITA, the results obtained are all not multicollinearity because the Tolerance value> 0.1 and the VIF value < 10. A good regression test is one that does not occur multicollinearity. However, if multicollinearity occurs, it can be left alone because variables containing multicollinearity must be present in the regression calculations performed. It is also stated by Latuconsina, (2017) that if multicollinearity occurs, it can be overcome by leaving the model alone because the estimator can still be BLUE (Best Linear Unbiased Estimator).

4. CONCLUSION

Based on the results of research, delta waves are associated with unconsciousness or deep sleep, but it is also possible to be found in a conscious state. Theta waves will appear in a state of consciousness and sleep or drowsiness, where if these waves are in large numbers when someone is in a conscious state, it indicates an abnormality. So that the worker cannot control his body. Alpha waves indicate a relaxed state with a level of consciousness without concentration. Beta waves are associated with a conscious state with active thinking, focus and good attention. Gamma waves represent more activity and complexity with visual, audio and motor processes at work. The wave conditions experienced by workers who work at 08.00-12.00 WITA experience conditions that experience a good level of focus with an average Beta brain wave value at a frequency of 14-26 Hz where the value is in medium conditions or 60 dB - 75 dB. While working at 13.00-17.00 WITA workers experience between consciousness and falling asleep or drowsy with a large increase in Theta brain waves with a range of 75 dB - 100 dB which will indicate many abnormalities and cause pathological problems, problems where a person cannot control his body. This can potentially lead to work accidents or more fatally falling from heights and causing fatal accidents.

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