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A WORK PERFORMANCE CONCEPTUAL FRAMEWORK FOR AIRCRAFT MAINTENANCE WORKERS

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Abstract

Many studies have found that manual task activities at the workplace impose multiple risks such as awkward body posture, forceful exertion, repetitive motion and these factors are not exhaustive. Such risks give implications to the workers' health as work-related musculoskeletal disorder (WMSD) begins to develop which can impair not only their quality of life, but also in work performance. The aircraft maintenance workers are equally affected to some extent, as their main tasks still involve manual activities since human skills and judgments are indispensable in this line of industry. Therefore, a study on WMSD and its association with work performance among aircraft maintenance personnel is needed since very limited research was performed in the past. Hence, this paper discusses work-related musculoskeletal disorder (WMSD) and its influence on aviation maintenance personnel, especially on work performance and productivity. The existing models on the relationship between WMSD and work performance are discussed and a new conceptual framework is proposed for the workers in the aviation maintenance industry.

Keywords: work performance, aircraft maintenance, manual task.

1. Introduction

The subject of work-related musculoskeletal disorder (WMSD) has been discussed in many industries due to its significant effect on work performance. Basically, WMSD is a condition that affects a worker who has been involved with manual tasks at the workplace. Such manual activities may engage actions and movements which deviate from a neutral position and this implicates awkward posture. The manual activity could also mean having to carry or push an object with a certain exertion of force. A motion that requires recurring actions to be done by a certain cycle within a certain time, is another common activity for manual tasks. All these activities have been found to contribute to health issues, if it prolongs for a certain period of time. Nevertheless, if such tasks are unavoidable due to pre-design arrangements at the workplace, health issues start to affect the workers. The pain, discomfort and injuries in the area associated with muscles, tissue, ligaments or nerves will eventually influence the work performance of the personnel affected (Nestorova & Mircheva, 2018). In fact, work productivity was found to deteriorate with the impact of WMSD (Jagadish et al., 2018; Luger, 2016; Tee et al., 2017).

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Researchers in many industries have been studying this health issue. Its significant effect not only in terms of work productivity of the workers, but also on the organization as cost for medical claims will increase. Other than that, it also affects the presenteeism and absenteeism of the workers which is also considered as productivity loss to be borne by the affected organization (Brunner et al., 2019; Kirsten, 2010). Hence, studies associated with the relationship between WMSD and work performance have been found especially in the industries such as construction, manufacturing, nursing, and many more.

However, in the aviation maintenance industry which still uses manual activities as its main job nature, such WMSD study is very much limited (Asadi et al., 2019). The fact that the focus of aviation has always been to ensure minimum incidents and accidents from occurring, instead of studying the WMSD effect on work performance, reveals a knowledge gap to be further explored (Yusof et al., 2020).

2. Aviation Maintenance Industry

The aviation industry in general is a highly regulated industry due to the safety factors associated with it. In addition, aviation maintenance activities are considered as expensive for the aeronautical industry, as it reaches between 12% and 15% of an airline's total costs per year (Olja, 2011). Besides, the duration of each maintenance task gives an impact on the turn-around time for the aircraft operations and be reflected in cost and revenue (Salvendy, 2012). Additionally, regulatory requirements stated that continuing airworthiness is one of the critical factors for the approval of the aircraft to be operated. Hence, aircraft maintenance activities are critical for any commercial aircraft operation. Its manual tasks such as inspection, troubleshooting, modification and replacements require the workers to be in the position of awkward posture, repetitive motion as well as susceptible to force exertion due to the complexity of the aircraft system and its wide-body structure (Asadi et al., 2019). Such elements indicate that the WMSD risk factors are inevitable.

Previous studies have shown that WMSD does occur amongst aviation maintenance workers, yet very limited studies were performed in order to mitigate this problem (Zungu & Nigatu, 2015). The following Table 1 shows the previous WMSD studies on the aircraft maintenance scope, converging specifically on commercial aviation. Such studies are categorized into three main perspectives namely psychological, physiological and physical risk factors (Nestorova & Mircheva, 2018) together with their respective variables engaged in the research.

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Table 1 also shows that low back pain has been the main complaint from the aircraft maintenance workers which involved 58.3 % of the studies. Apparently, low back pain is profoundly indicator as one of the WMSD symptoms (Fung et al., 2008; Yilmaz & Dedeli, 2012). Hence, the WMSD glitch has to be tackled before the work performance of the workers could have been affected. It is also important to highlight here that based on Table 1, none of the researchers incorporate all three risk factors (psychological, physiological and physical) concurrently in their studies.

Table 1. Summary of MSD Risk Factors in Aviation Maintenance Studies

No	Researchers	Scope of Risk Factors & associated variable(s)			Main Issue
		Psychological	Physiological	Physical	
1	Asadi et. al (2019)	X (perceived workload)		X (awkward posture)	Low back pain
2	Santos & Melicio (2019)	X (perceived stress/ pressure/ fatigue*)*			Stress, fatigue, pressure
3	Landau, et. al (2017).		X (energy turnover)	X (posture)	Stress & strains
4	Ghazali & Mohammad (2016*)*			X (awkward posture, lifting, forceful movement, heavy physical work)	Low back pain
5	Rodriguez & Mayorga (2016)	X (mental load)		X (posture/ load exertion)	Low back pain
6	Zungu and Nigatu (2015)			X (load exertion & posture)	Low back pain
7	Wang and Chuang (2014)	X (mental fatigue)	X (subjective physical fatigue)		Fatigue
8	Stader (2013)			X (body posture/ task repetition/ tool vibration)	Low back pain
9	Nogueira et al. (2012)	X (work engagement & work demand)		X (posture)	Low back pain
10	Oliveira et al. (2012)	X (work engagement & work demand)		X (force exertion)	Low MSD risk with high work engagement
11	Park et. al. (2012)	X (individual morale & psychological health)			Fatigue & stress
12	Chae & Kim (2005)	X (perceived load & psychosocial)		X (MSD symptoms)	Low back pain

3. Work Performance

Work performance is commonly discussed in the perspective of human resources which relates to salary, manpower, productivity, occupational health to name a few. The topic of work performance of the workers is important as it impacted the organizational cost, and its definition might vary depending on types of organizational business nature. Similarly, the terms of efficiency and effectiveness also vary accordingly. Work performance is interrelated with productivity. Park et al., (2012) described that in the aircraft maintenance industry, productivity is associated with efficiency which refers to output per unit input meanwhile effectiveness is described as the extent of the value of outputs or outcomes produced, meeting the pre-set standard or expectations. Meanwhile, Bozkurt (2013) associates the term of productivity as a term to be measured based upon total hours spent by workers, materials or time spent divided by a number of aircraft maintenance checks. However, in the perspective of work performance, productivity should also be associated with issues related to workers' well-being conditions.

3.1 Work Productivity

Work productivity in relation to WMSD is an area that requires further attention. Such study has been established in many other industries, especially in manufacturing (Kamat et al., 2017; Luger, 2016; Srinivasan et al., 2016), construction ((Lop et al., 2019; Palikhe et al., 2020; R. & Xavier, 2020) nursing (Beyan et al., 2020; Li et al., 2020; Yang et al., 2019) and others.

Even though a similar study in aircraft maintenance is very limited, but since working environment factors are relatively similar in some of the workplaces, further investigation can be accomplished in the aviation maintenance scope. Having the physiological measurements using proper equipment will enable such investigation to go deeper, which enables researchers to determine the relationship between workplace physical risk factors, towards human physiological responses and their implications to work productivity.

Such clear evidence was determined from investigations of the previous studies on the association between workplace physical risk factors and physiological responses. For example, Nur et al., (2015) discussed energy expenditure, Srinivasan et al., (2016) discussed the heart rate and muscles fatigue, Tapley & Riley (2005) discussed physical load activities, Gallagher (2005) associated work with awkward posture and Haapalainen et al., (2010) discussed on the cognitive load.

It can be concluded that multiple variables need to be studied in order to develop a work performance model for aircraft maintenance personnel, which commonly involves work productivity elements. Occupational physical risk factors associated with WMSD such as repetitive tasks, awkward posture and force exertion (Nordander et al., 2016), together with a psychological risk factor such as mental fatigue, are necessary to be evaluated. Physiological responses such as muscle activity, energy expenditure and heart rate are some of the variables needed to be

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measured to analyze the relationship between the physical, psychological and physiological factors with their influence on work performance.

3.2 Existing Work Performance Models

Generally, work performance commonly engages appraisal matters in human resource scope (Wu et al., 2012). Nevertheless, many work performance models were found to be deficient in examining the actual performance of the individual, but focusing more on the organizational global characteristics (Campbell & Wiernik, 2015). The same researchers of Campbell & Wiernik (2015) argued that without effectively considering and assessing the individual performance, the goals of the organization may not able be met.

In the view of occupational safety and health, individual performance is an asset that requires much more attention as an organization will not be able to survive without the support of its employees. Hence, the individual performance of employee-related studies is critical, especially when safety and wellbeing are involved. Therefore, the existing research studies involving work performance as well as work productivity, together with WMSD are profoundly needed to be examined so that further improvements can be continuously proposed if a certain knowledge gap arises. Consequently, after scrutinizing the literature published by researchers, there were roughly twenty work performance models have been published. Attention was given to those models which suitably fit the environment of a worker in aviation maintenance which involves labor work, safety, task engagement and demand, psychosocial elements, WMSD factors as well as productivity.As a result, the following work performance models were found to be suitable and comparably applicable to be employed as well as adopted in the scope of the aviation maintenance industry. The models are arranged based on the chronological order, and within the researchers’ field of expertise.

The following Figure 1 is an adaptation from an intervention ergonomics study by Westgaard & Winkel (1997). The intervention study was carried out in order to improve the worker’s work performance in terms of productivity in the association of WMSD. In this model, mechanical exposure represents the biomechanical forces of human exposure. Such exposure in the workplace would affect the worker’s job demand and task actions either directly or indirectly (eg. externally or internally). This exposure to the staff eventually gives an impact not only on WMSD but also on the psychosocial (eg. cognitive, emotional stress linked to repetitive tasks) and physical factors (eg. working environment) related to those who are affected. Hence this model possesses some details in the work productivity improvement. In this model, the work productivity term is used instead of work performance. However, in this model, the criteria to assess work productivity are not specifically laid down.

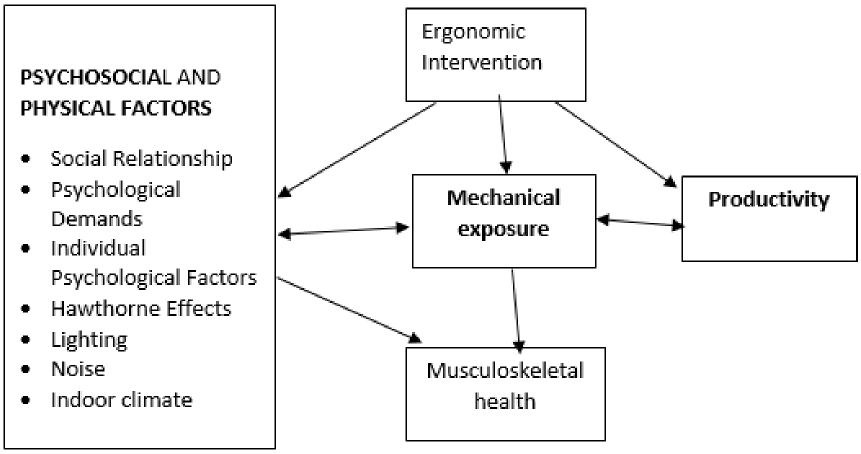

Figure 1. Model Proposed by Westgaard & Winkel (1997)

A work productivity model within the context of WMSD is proposed by Escorpizo (2008). The author pointed out three elements that directly affect employee productivity at the workplace; which consist of the health conditions associated with risks including pain due to WMSD, worker's capability to perform the job (eg. training/ knowledge/ skills) and their life balance after working hours. These three main clusters may influence the workers' productivity to be positive or otherwise. Meanwhile, to examine work productivity, the "observed" and "perceived" productivity is discussed. Observed work productivity is measurable, based on the output from the completed job eg. the number of units per day. Meanwhile, the perceived work productivity represents the worker's perception of their ability and capability to perform tasks through the self-report mechanism. Hence the researcher believes the work productivity should take into consideration both elements of observed and perceived work productivity in order to have a better performance of a worker. In addition to this, the individual work productivity also reflected by the workers' absenteeism (off-duty due to sickness) and presenteeism (on-duty but unable to perform the job efficiently due to sickness) as health effect inevitably does give big impact to the work performed. Hence the 'true' work productivity must look into these two components. Nevertheless, the details on absenteeism & presenteeism are not properly addressed in this model.

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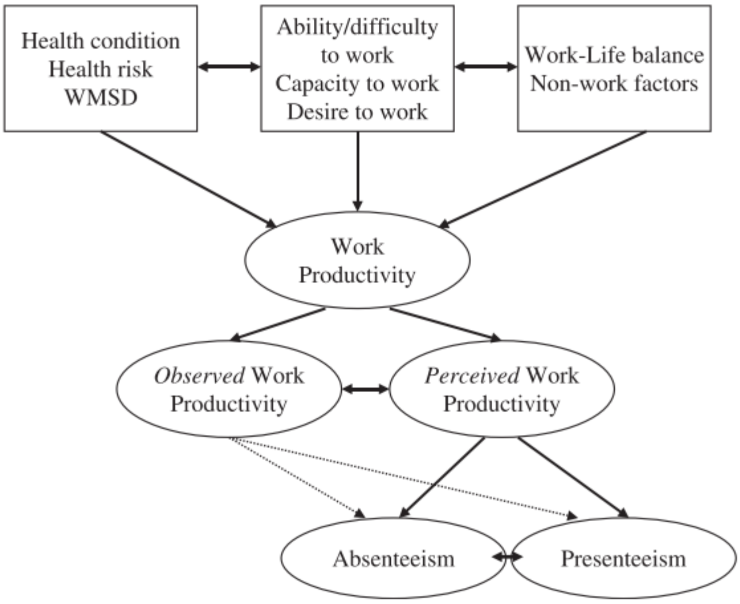

Figure 2. Work Productivity Model by Escorpizo (2008)

In order to determine the essences of absenteeism and presenteeism with worker productivity, Beaton et al. (2009) proposed a model as shown in Figure 3, in the perspective of work productivity loss. This model was introduced with the idea that the worker's illness reflects the organization's productivity loss as their wage rates are related to the number of working days or hours on duty. Absenteeism (off-duty due to illness) and presenteeism (on-duty but inefficient due to sickness) are also considered as latent factors, which can be a descriptor of productivity loss as proposed by earlier researchers (Allen, 2008). Presenteeism refers to the presence of a worker at the workplace but unable to fully committed to tasks at hand due to health issues meanwhile absenteeism represents the absence of an employee due to health matters. Hence, the organization can quantify the generated productivity by calculating the number of days such as employees attending the workplace and give contributions effectively. As such, these quantifiable parameters are suitable to be used for any proposed model of work productivity. Allen (2008) also describes eight categories of the predictor in work production loss which are work-life balance, personal life impact, financial concerns, health, stress, job characteristics, employee characteristics, and company characteristics. Therefore, it is significant to point out that worker productivity must take into account the elements of absenteeism and presenteeism issues as they directly influence performance at work.

Perspective→ Component	Outcome state	Cost indicator
Absenteeism	No. of days/hours off work	Cost of time away from job
At-work productivity loss or Presenteeism	Difficulties at work	Worker productivity loss expressed in hours and translated to dollars

Figure 3. Model Proposed by Beaton et.al (2009)

A model proposed by Mitropoulos et. al (2009) as depicted in Figure 4, discusses the cognitive aspect of humans while working and the importance of taking into consideration the task demands while completing the job, specifically from the construction workers' perspective. This is vital because the construction industry involves physical activities and is associated with a high rate of accidents (Asl et al., 2014; Inyang, 2013). One of the elements in the model specifies speed and efficiency, which are commonly associated with productivity (Azadeh & Zarrin, 2016). The speed and efficiency may jeopardize the work performance as workers tend to complete tasks in a shorter time (by creating shortcuts/ omitting steps/ overlapping tasks) and this may increase the task demands (psychological factor). Hence, the workload and work pressures in the workplace are factors influencing the workers' behavior. Nevertheless, workload and work pressures directly affect the increase of the task demands (psychological factor) of these workers. The impact from this psychological influence may be positive or negative, either making the worker being obedient and observe safety actions as necessary or reluctantly comply with specified procedures which can lead to unsafe conditions. Since the construction industry mainly represents physical works, this model may be applicable in aviation maintenance scenario since similar intrinsic factors are involved. Its intrinsic factors which inter-related with human error based on cognitive approach and discuss on the effect towards safety performance of employees, very much harmonizes with aviation maintenance stance.

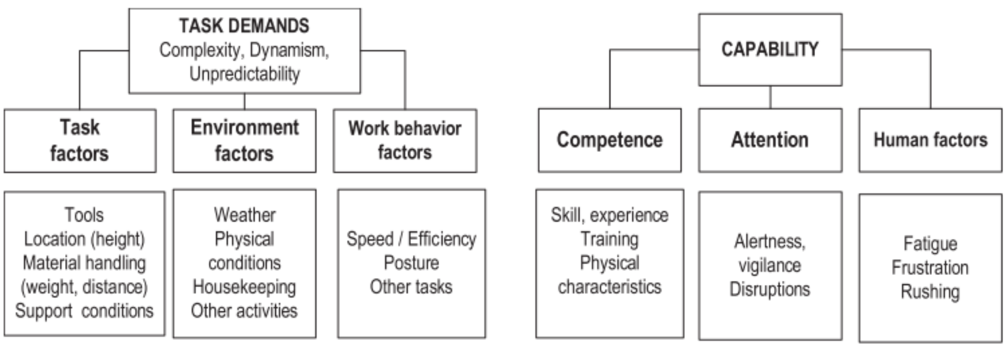

Figure 4. Model on Task Demands and Applied Capability (Mitropoulos et al., 2009)

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Another work productivity model is suggested by Nur et al., (2015), in which the relationship between production standard time and acute responses was analyzed with respect to the prevalence of WMSD. The study specifically focused on the study of repetitive tasks based on industrial-simulated activity in a manufacturing environment. As can be seen from Figure 5, the human muscles can experience fatigue when exposed to repetitive tasks and may affect work productivity undesirably (Bosch, 2011; Luger, 2016; Metwali, 2019), either in the long term or in shorter-term of exposure based on production standard time. However this effect can be minimized with mitigation parameters, This model specifically studied human responses on repetitive task influence, and does not consider other WMSD risk factors such as awkward postures and force exertion.

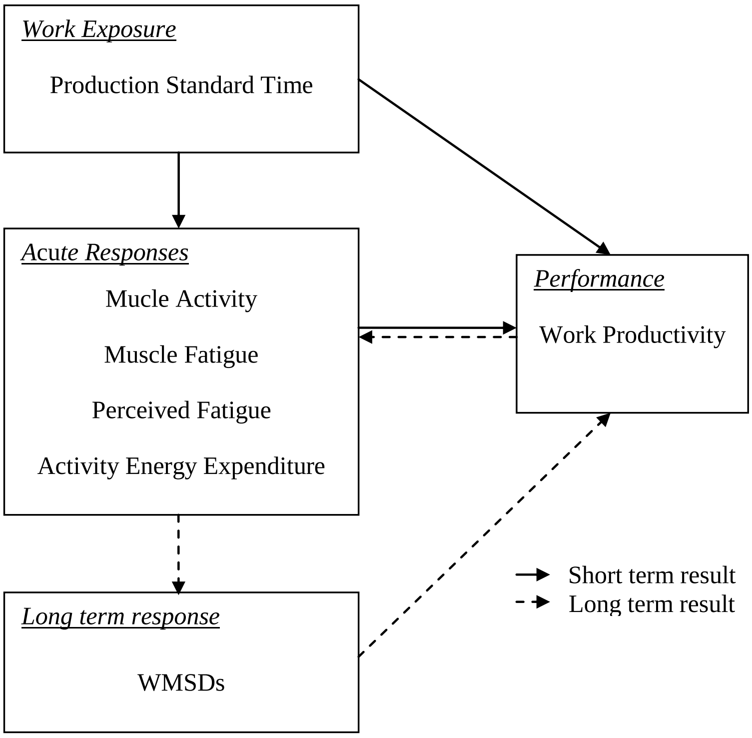

Figure 5. Conceptual Model of Work Productivity (Nur et al., 2015)

Researchers Sohail & Kashif (2016) introduced a model as shown in Figure 6. They have specified four main factors affecting the work performance of a worker, namely anthropometrical, physiological, psychological together with human engineering and environment. The model proposed was quite simple as the authors merely intend to show the factors involved between WMSD and work performance. However, the authors argued that the risk factors present in the working area do not directly contribute to the WMSD but the extent of those risk factors that lead towards WMSD.

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As such, the related risk factors mentioned need to be properly managed within the organization. One key finding in this research is that psychosocial risk factors directly affect the growth and syndrome of WMSD, such as human factors and communications. Nevertheless, the work performance features in this model are not properly detailed.

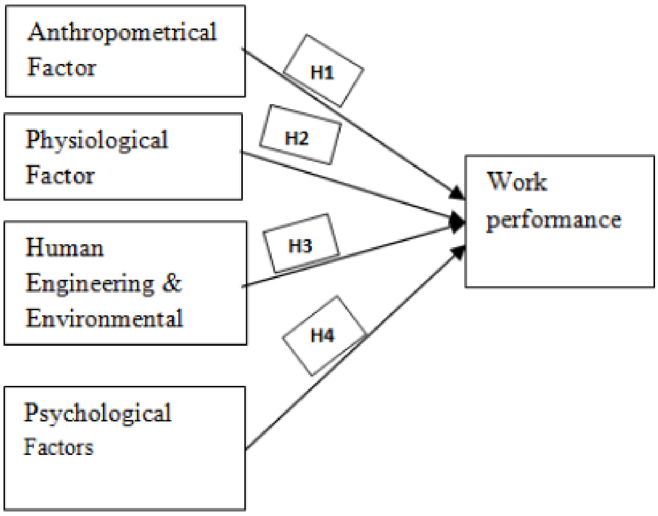

Figure 6. Work Performance Model from Sohail & Kashif (2016)

A study done by Lee et. al (2020) focuses on how individual productivity and safety performances are affected by two main elements; task/ job demands and personal resources. Even though this study was focused on an unskilled construction worker, the suggested model is applicable to reflect any worker's performance with manual task activities. This model is a modification from a job demands-resources (JD-R) burnout model of previous researchers; Nahrgang et al., (2011) on workplace safety.

As can be seen in Figure 7 below, the focus was given on two parameters which are demands of the task (which can lead to emotional exhaustion) and the individual personal resources (reflected with the physical, cognitive and emotional absence on the job) towards their ability to be productive and being safe at work. The result of the study by Lee et. al (2020), shows that there is a positive relationship between task demands and exhaustion (denoted by H1+ in the model), while exhaustion is negatively related to productivity (denoted by H5a- in the model). Hence, it is stated that fatigue is inevitable with high task demands which later contribute to lower productivity performance.

On the other hand, personal resources which are reflected by the worker's physical capabilities may influence the feeling of task/ job disengagement. The term 'disengagement' in this model represents the individual sense of being apart from work due to the absence of physical as well as psychological touch. Based on their study, Lee et. al (2020) found personal resources and task disengagement are

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negatively related (denoted by H3- in the model) while disengagement is also negatively related to safety performance (denoted by H6b- in the model). In a simpler form, it is stated that a worker with enough necessary capabilities and abilities to perform a job, may reduce the feeling of being demotivated on the tasks assigned. This eventually may create a safer working setting. In addition, task disengagement is also negatively related to work productivity (denoted by H6a- in the model). In the nutshell, the positive work productivity of an individual is closely related to less exhaustion and reduction of feeling task disengagement at the workplace. Having staff with a sense of engagement with their job, coupled with the influence of less fatigue or exhaustion will create progressive productivity at the workplace.

An organization that can assist its employees on their task/ job demands may reduce fatigue symptoms and soon promote better productivity (Smith et al., 2019). Similarly, organizational support on the worker's resources may reduce the sense of being disengaged with the job, and this motivates them to be safe and productive at work (Sonnentag, 2017). Even though the focus of Lee et. al (2020) was to assess the psychosocial aspect of a worker, the said researchers carried out objective measurements in concluding those results.

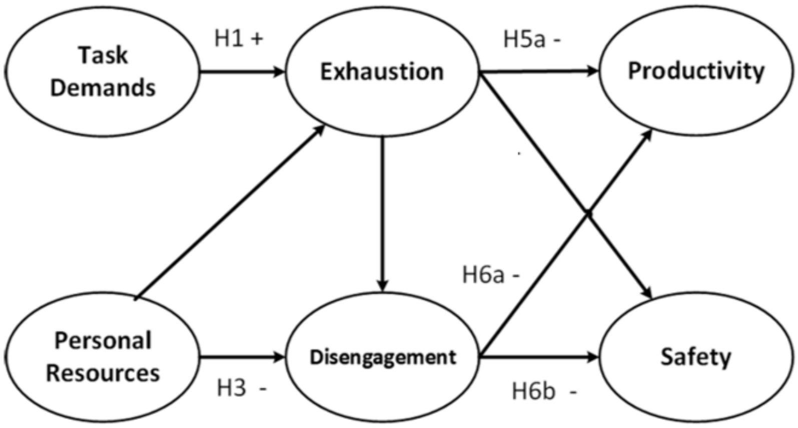

Figure 7. Proposed model of productivity by Lee et. al (2020)

3.3. Summary of the Related Work Performance Models

Based on the models mentioned earlier, the following Table 2 represents the summary of the said models specifically on individual work performance and work productivity concept.

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Table 2. Summary of the existing work productivity models

	MODELS	FOCUS AREA	REMARKS	METHODS APPLIED
1	Westgaard & Winkel, (1997)	Individual work productivity is affected by multiple factors such as biomechanical exposures, psychosocial and physical factors. Ergonomics intervention at the workplace can improve work productivity.	Items to be assessed for work productivity are not specified.	Conceptual model
2	Escorpizo (2008)	Individual work productivity should consider the absenteeism and presenteeism concept	How to assess absenteeism and presenteeism are not elaborated	Conceptual model
3	Beaton et al. (2009)	The productivity loss concept is introduced, by looking into absenteeism and presenteeism of the employees	Proposed that an organization can quantify their productivity generated by calculating the number of days' employee attending workplace and how they are being effective.	Conceptual work based on discussions in workshops with expertise
4	Mitropoulos et. al (2009)	The non-conformance of employees to safety is due to factors associated with their task demands and capabilities (cognitive load), which the organization should improve.	Applying a cognitive approach to relate human capabilities and productivity towards safety. Methods to evaluate productivity are not specified.	Conceptual model
5	Nur et al. (2015)	The effect of repetitive tasks on human muscles' fatigue in the short and long terms.	The study is specifically on repetitive tasks alone. Awkward	Questionnaires: Nordic Musculoskeletal Questionnaire (NMQ)

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			posture & force exertion were not considered	Work Productivity and Activity Impairment – Specific Health Problem (WPAI-SHP) Borg Rating scale Objective measurement: energy expenditure heart rate
6	Sohail & Kashif (2016)	The model is too general, where the work performance items are not appropriately laid out.	Psychosocial directly affect the growth towards MSD	Questionnaires and statistical analysis. The type of questionnaires was not specified
7	Lee et. al (2020)	Individual productivity and safety performance are affected by multiple psychosocial influences. Job Demand-Resources and Burnout models were incorporated, as a continuous process of improving control over related risk factors and causes of musculoskeletal disorders.	This study focused on unskilled construction workers, however, the model can be adapted and applied in aircraft maintenance environments due to similar external and internal factors at the workplace.	Questionnaires: Nordic Musculoskeletal Questionnaire (NMQ) Work Productivity and Activity Impairment – Specific Health Problem (WPAI-SHP) Objective measurement: energy expenditure heart rate, sleep quality/ quantity

By taking into consideration of all the related influencers to an employee associated with MSD and safety, a new conceptual framework is proposed to study the work performance of an employee specifically in the aviation maintenance industry.

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3.4. Proposed Work Performance Conceptual Framework

Many studies have identified that three factors (physical, psychological and physiological) to be interrelated and contribute towards MSD (Nunes & Bush, 2012). Therefore, this study should also consider all these three factors as shown in Figure 8.

Work-related physical risk factors associated with aircraft maintenance activities such as awkward posture (eg. engine change/ carpet replacement in the cabin/ electrical wires inspection in electronic bay tasks), repetitive tasks (eg. riveting panels of aircraft structure tasks) and load/ force exertion (eg. aircraft tires change/ detaching aircraft generator from the engine) are meant to be the independent variables for this study. These risk factors are to be coupled with dependent variables of physiological responses such as muscle activity, energy expenditure and heart rate; to identify how they are interrelated while aircraft maintenance personnel performing their job or tasks.

Since aviation is a highly regulated industry with safety always become the priority, the element of employee's psychological factor has to be included in the work performance framework. This is consistent with the models mentioned earlier as specified by Westgaard & Winkel (1997), Mitropoulos et al., (2009), Sohail & Kashif (2016) and Lee et al., (2020) with regards to psychosocial features. Those models embrace psychological elements as part of work performance or productivity as a psychological element such as mental fatigue, do influence quality of work and eventually, it influences the prevalence of MSD (Lanfranchi & Duveau, 2008; Macdonald & Oakman, 2015; Wilson, 2014).

The complexity of the aircraft system requires aircraft maintenance employees to be agile and possess full comprehension of the required tasks assigned as well as competent to perform work using approved methods in accordance with the regulatory requirements. As such, a burdened cognitive load may lead to mental fatigue and influences the work to succumb to human error and consequently jeopardizing flight safety (Ayse, 2019; Dias et al., 2019; Wang et al., 2016). Therefore, the assessment on the cognitive load could be realized, using electroencephalogram (EEG) to identify the human brain wave/ signal if a worker is experiencing mental fatigue due to cognitive load tasks. A similar study was done by many researchers such as Huang et al., (2020), Nuamah & Mehta (2020) and Smith et al. (2019) to name a few.

It is proposed that the physiological responses are to be assessed objectively as well as subjectively using appropriate validated ergonomic methods. Identifying the relation as well as the correlation between these factors (physical and psychological risk factors with physiological responses) concurrently will enable the Work Performance Model for aviation maintenance tasks to be established. This notion is supported by the integrated model of WMSD by Karsh (2006) which specified that all

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factors concerning physical, psychological, and physiological responses are all interrelated towards MSD.

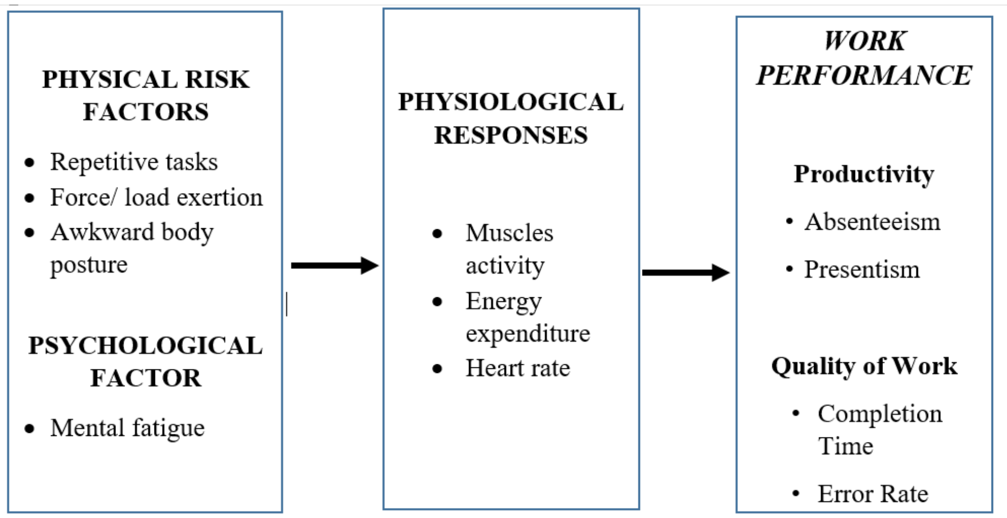

Figure 8. Proposed Work Performance Conceptual Framework for Aircraft Maintenance Workers

In order to verify this framework, the elements of work productivity and quality of the work done have to be taken into account and evaluated as necessary. Specifically, in the work productivity domain, the absenteeism and presenteeism of the employees are commonly examined as explained earlier from the studies conducted by Beaton et al., (2009) and Allen (2008). Meanwhile, in the perspective of work quality, the evaluation of work performance should focus on the quality of the tasks done and the time taken for job completion. Hence the completion time and error rate are to be assessed in order to verify the proposed conceptual model. This is consistent with Nunes & Bush (2012) which stated that the accuracy or number of errors or error rate in the task execution has to be assessed in ensuring the safety of any operation.

In many circumstances, maintenance works could be completed in time as demanded by the flight schedule, however, the quality of work could be jeopardized due to the overwhelming cognitive loads (eg. stress, fatigue, personal issues, time pressure) by the affected individual mechanic/ technician/licensed engineer. Hence the standard of the work output or the competency skill on carrying out tasks has to be included in the framework as it is crucial to evaluate the quality of work done, in association with the time of tasks completion.

Several aviation investigations have prevailed that cognitive or task demand element has a direct contribution to the aircraft accident (Staal, 2004). As an example, in the accident of BAC 1-11 in the year 1990, the maintenance worker accidentally installed the windshield bolts in the opposite direction. To make it worse, smaller diameter bolts' size was used and consequently triggered flight safety concerns on

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performance-related issues. The fact that the affected worker had years of experience did not prevent him to make such an error. Hence, the overwhelming tasks or cognitive load as much as mental fatigue contributed to such error (Shappell et al., 2007).

For this reason, the work performance model in aviation maintenance must inclusively involve WMSD factors and symptoms as well as safety practices. This is supported by many studies which have identified work stress experienced by aviation maintenance personnel (Longo, 2018; Wang et al., 2016; Yazgan & Kavsaoğlu, 2017). Besides, Wu et al., (2012) also specified that the performance of aircraft maintenance personnel must consider task demands and role demands (cognitive load) as complexity in the workload environment require the "quality" of work to outweigh the "quantity" as it has a greater impact towards safety.

Looking into the psychological perspective, Galy et al., (2012) stated that the cognitive load represents the ability of the brain to learn new things or grasp new information. Having a chart, diagram or 3D images may assist the process of comprehension rather than having verbal instructions alone. In addition, with the complexity of the information, any distractions may expose the brain to lose the information. Therefore, the psychological factor has to be involved particularly when engrossment with cognitive load is present, such as during troubleshooting tasks.

In aviation maintenance, working practice, troubleshooting or defect searching is very much critical to ensure the serviceability of an aircraft. The working environment which has the risk of noise, stress and time pressure may influence the decision-making as well as work being done. Human error is the result of many unmanageable issues of these risks (Signal et al., 2019). Hence, cognitive load is part of the human psychological feature that must be taken into consideration in the performance model as it gives direct influence on task performance.

3.4.1. The Significance of the Proposed Conceptual Framework

It is important to highlight that the proposed conceptual framework includes all three factors associated with WMSD; physical, psychological and physiological features. This would represent that all related aspects have been taken into consideration when it comes to human work performance attributes. As shown in Table 1 earlier, none of the previous researchers were comprehensive in their work performance or productivity models by incorporating all the three main features of risk factors in their specific studies. Hence, it gives an advantage for this study to be distinct from other studies in a similar field.

Furthermore, this research provides knowledge in predicting a worker's performance, under the influence of work environment exposures. Applying the knowledge, may prevent any damages or errors within the aircraft maintenance capacity, gives a safer atmosphere in the overall aviation industry. Besides, the limited WMSD studies in this field give an opportunity for several techniques to be applied in assessing human work performance within the scope of aircraft maintenance tasks. Consequently, this framework may influence a betterment workplace setting in minimizing WMSD amongst workers not only in aircraft maintenance scenarios but also in the related industries with similar workplace settings and task activities.

4.0. Conclusion

In conclusion, WMSD does influence the workers in the aviation maintenance industry towards their well-being. Due to limited WMSD studies focusing on the aircraft maintenance field, there is a need for such an investigation to be carried out. Based on the previous researchers' existing models on work performance and work productivity in association with WMSD, a new conceptual framework is proposed. Ultimately, it is an aspiration of the authors that the new framework may promote new knowledge contribution in improving the work performance and quality of life, not only to the aircraft maintenance personnel but also to those in the maintenance industry in general.

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