

ISSN 1742-1897

# **IOP** Conference Series

## Earth and Environmental Science

1st Workshop on Metrology for Agriculture  
and Forestry (METROAGRIFOR)

# 275

VOLUME 275 – 2019

3–2 October 2018  
Arezzo, Italy

EDITOR  
Enrico Pitta Tomassini

The open access journal for conference proceedings  
[iopscience.org/jpcs](http://iopscience.org/jpcs)

**IOP** Publishing

## Table of contents

## Volume 419

2020

[◀ Previous issue](#) [Next issue ▶](#)

The 3rd International Conference on Civil and Environmental Engineering (ICCEE 2019) 29–30 August 2019, Bali, Indonesia

Published online: 08 February 2020

[Open all abstracts](#)

## Published online: 8 February 2020 Preface

**OPEN ACCESS** 011001

Preface

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 011002

Peer review statement

[+ Open abstract](#) [View article](#) [PDF](#)

## Papers

## Infrastructure Development

**OPEN ACCESS** 012001

Earthquake Vulnerability of Port Structures in Indonesia

H Widayastuti, E Lumantarna, M Soft, M I Ramli, Y Oktavianus and A Rajabifard

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 012002

Effectiveness of sediment flushing by using under sluice flush canal

A Safanjo, Suripin and I K Hadihardaja

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 012003

Evaluation of factors contributing to wave-in-deck using pushover analysis for fixed jacket structures

N C Yoo, A Johan, A E Kadjuputra and L A Pangestu

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 012004

Individuals' activity space in Seri Iskandar Malaysia

M A Z Khalif and D B E Dharmowijoyo

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 012005

Lock-brick system technology is an ecological building material innovation

C L Sullawati, P K Yulus Sumi and E Tjandra

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 012006

Numerical analysis of water temperature difference on baroclinic flow in the region of freshwater influence (ROFI)

A N Arifin, S Yano and A T Londo

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS** 012007

Provision of community based clean water in Tonggo village, Nangaroro District, Nagekeo Regency

## JOURNAL LINKS

[Journal home](#)[Journal scope](#)[Information for organizers](#)[Information for authors](#)[Contact us](#)[Reprint services from Curran Associates](#)physicsworld  
WEBINAR

Optimize manufacturing and enhance battery performance via multi-technique materials analysis

Live at 3.30 p.m. BST/  
10.30 a.m. EDT on  
4 April 2023

Sponsors

Waters | CTA

OXFORD  
INSTRUMENTSCLICK TO  
REGISTER

- OPEN ACCESS** 012007  
Provision of community based clean water in Tonggo village, Nangaroro District, Nagekeo Regency  
Y Meo and I W Tyas  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012008  
The flatness levels of flexible road based on roadroid software in Perintis Kemerdekaan Street Makassar  
M Lukman, H Halim and Z Saing  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012009  
The role of the *Titian* path as accessibility in the marginal housing on the water at Kampung Karabba and Marboe, Buloa-Tallo  
N Amri, I Asmal and S Amin  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012011  
Assessment of tsunami risk to offshore platforms in Indonesia archipelago  
A Y Baeda and G P Carayannis  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012012  
Conceptual framework of knowledge sharing and project team performance relationship in design and build project  
M N Indriani, I N A Tharaya, N Y Astana and A A G A Yana  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012013  
Experimental investigation on strength improvement of lateritic Halmahera soil using quicklime stabilization  
Z Saing, M H Ibrahim and Kianto  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012014  
Construction labor's physiological workload based on labor's perspective  
B Anondho and M Y Superman  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012015  
An easy method for barchan dunes automatic extraction from multispectral satellite data  
A Aydda, O F Althwaynee and B Pokharel  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012016  
Application of pavement condition index (PCI) on the assessment of the Kalumata highway section of the City of South Ternate  
Sabaruddin and A Deni  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012017  
Dynamics urban development to the carrying capacity of agricultural land Maros Region Province South Sulawesi  
Ihsan, A R Rasyid, L O M Astfan and S A Yanti  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012018  
Identification of economic activity in coastal community (Case study: Bulu Cindea village, Bungoro district, Pangkep region of South Sulawesi)  
M Ali, M Rusli and S A Ekawati  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012019  
A GIS analysis approach for flood vulnerability and risk assessment index models at sub-district scale  
I Djamiluddin, P Indrayani and M A Caronge  
[+](#) Open abstract [View article](#) [PDF](#)
- 
- OPEN ACCESS** 012020  
Identification of water origin model in the West Tompaso Minahasa, North Sulawesi, Indonesia



# IOP Conference Series: Earth and Environmental Science

COUNTRY

SUBJECT AREA AND CATEGORY

PUBLISHER


H-INDEX

United Kingdom


Earth and Planetary Sciences

IOP Publishing Ltd.

41

 Universities and research institutions in United Kingdom

Earth and Planetary Sciences (miscellaneous)

 Media Ranking in United Kingdom

Environmental Science  
Environmental Science (miscellaneous)

Physics and Astronomy  
Physics and Astronomy (miscellaneous)

**PUBLICATION TYPE****ISSN****COVERAGE****INFORMATION**Conferences and  
Proceedings

17551315, 17551307

2010-2022

[Homepage](#)[How to publish in this journal](#)[ees@iopublishing.org](mailto:ees@iopublishing.org)**SCOPE**

The open access IOP Conference Series: Earth and Environmental Science (EES) provides a fast, versatile and cost-effective proceedings publication service.

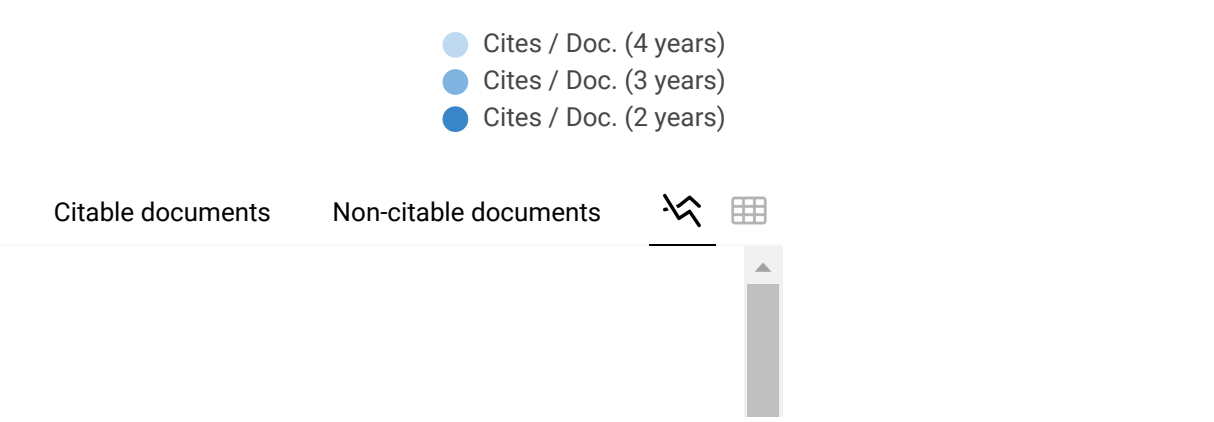
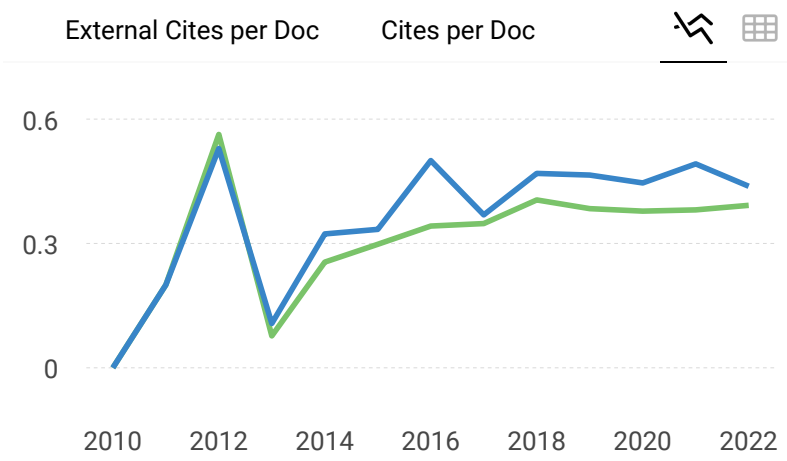
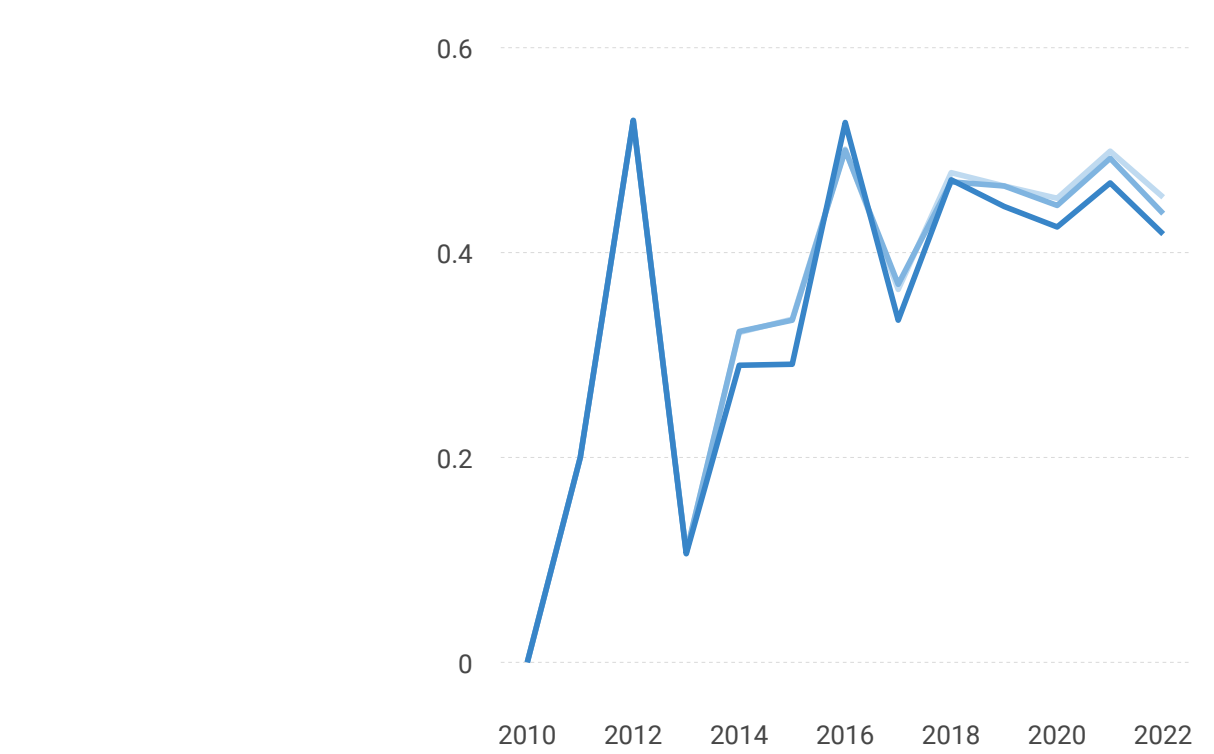
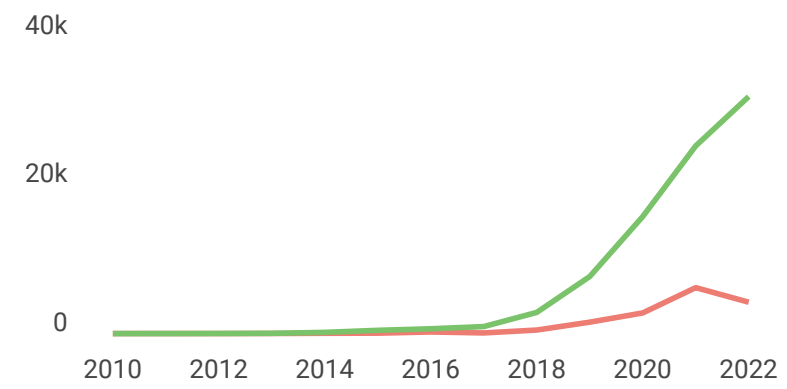
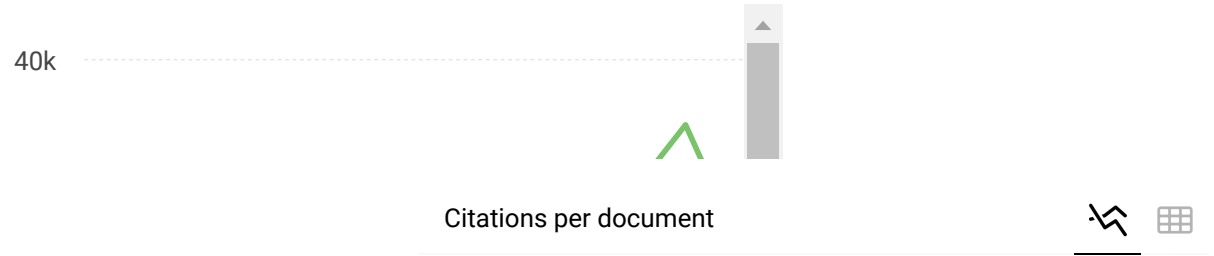
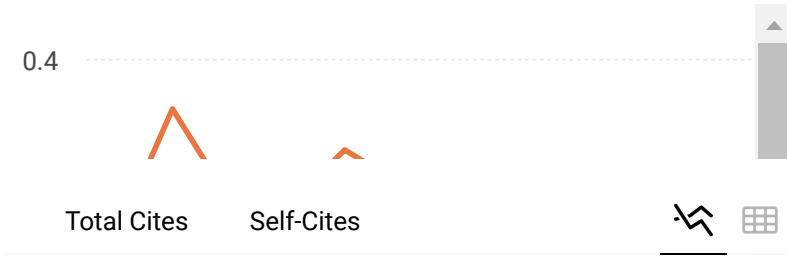
 Join the conversation about this journal

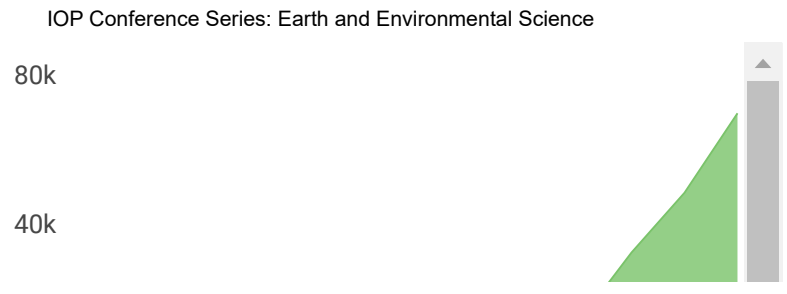
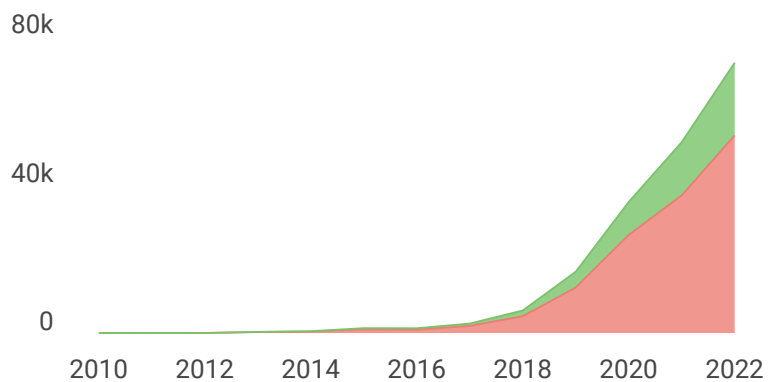
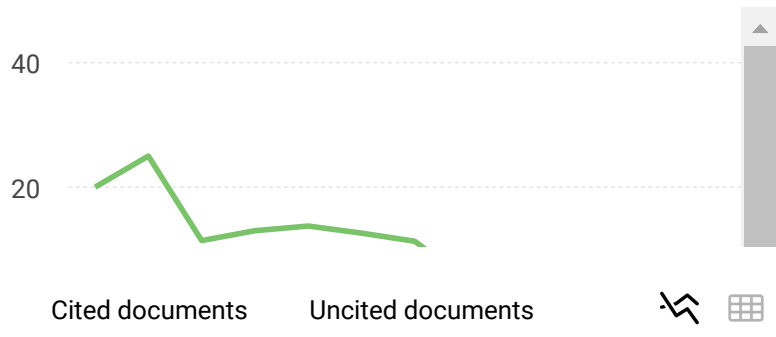
SJR



Total Documents







**IOP Conference Series:  
Earth and Environmental...**

Not yet assigned  
quartile

**SJR 2022**  
0.2

powered by scimagojr.com

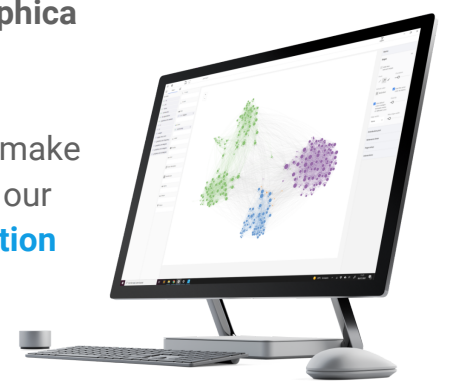
← Show this widget in your own website

Just copy the code below and paste within your html code:

```
<a href="https://www.scimaç
```

**SCImago Graphica**

Explore, visually communicate and make sense of data with our **new data visualization tool.**



PAPER • OPEN ACCESS

## Construction labor's physiological workload based on labor's perspective

To cite this article: B Anondho and M Y Suparman 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **419** 012014

View the [article online](#) for updates and enhancements.



# Construction labor's physiological workload based on labor's perspective

**B Anondho<sup>1</sup> and M Y Suparman<sup>2</sup>**

<sup>1</sup> Civil Engineering Department, Universitas Tarumanagara, Jakarta, 11450 Indonesia

<sup>2</sup> Psychology Department, Universitas Tarumanagara, Jakarta, 11450 Indonesia

E-mail: basukia@ft.untar.ac.id

**Abstract.** Construction craftwork is a physically strenuous and demanding occupation. Physically demanding work leads to physical fatigue which is associated with decreased productivity. This paper investigates the feasibility of measuring in situ physical demands based on a labor perspective. In that case, physiological measures of energy expenditure data were collected from 110 construction workers performing typical construction work, in this case, is an ironworker. The measurement of energy expenditure during physical work activities is considered a measure of the physiological workload experienced by construction workers. The measured data were evaluated against published guidelines for acceptable levels of physical performance. The result shows that the working load of ironworkers in Jakarta is very heavy on 3.0925 Kcal/minute energy expenditure by labor perspective. This paper developed for further applied research regarding the physical demands of construction work.

## 1. Introduction

Construction craftwork is a physically demanding occupation that leads to physical fatigue which is associated with productivity decrease. This condition gives influence on time management as one important variable in construction management. The nature of the construction services industry has evolved where contractors rely on labor [1]. The more time the workers do their jobs, it decreases the ability to convert chemical energy into mechanics [2]. In general, physical fatigue leads to productivity and motivation decreased, disorganization, poor judgment, poor quality of work, job dissatisfaction, accidents, and injuries [3-4].

Basically, productivity is influenced by 3 factors namely workload, work capacity and an additional burden due to the work environment. Labor productivity is a fundamental part of the information for estimating and scheduling construction projects [5]. The workload itself is related to the physical, mental and social burdens that affect the workforce. Several previous studies have suggested that workers who feel fatigued have difficulty with their physical and/ or cognitive functions [6]. Labor has a very important role in improving construction performance [7-8].

Further studies of the physical demands of labor had been conducted since the 1950s and 1960s up to now. Abdelhamid and Everett conducted research based on occupational physiology, energy expenditure, oxygen consumption, and pulse rate. Understanding the physical needs of construction work is essential to protecting safety and health while increasing labor productivity [9].

Based on the previous research above, this paper was describing preliminary research conducted in Jakarta to identify the workload of construction workers from labors perspective with the ironworkers as specific labor classification.



## 2. Methodology

### 2.1 Data gathering

This preliminary research used the questionnaire as a research instrument for gathering data. The questionnaire consists of 4 main variables which are: Level of ability, working expense, working weight, and level of fatigue tiredness. These 4 variables are measured by several physiological indicators each of which are obtained from the literature of previous research. The questionnaire addressed to the ironworkers at a construction project as object goals in this research. Likert scale is used to measure perceptions, attitudes or opinions of a person about an event or a social phenomenon, based on the operational definition set by the researcher. In this research, the Likert scale with the value of 1 (one) is the minimum value (not agree) up to the value of 5 (five) the maximum value (strongly agree).

### 2.2 Data processing

The process of data analysis is done by calculating the value of the RII (Relative Importance Index) method of each indicator on the questionnaire, which is based on workload, ability, fatigue level, and psychological influence. The value of RII calculated by the formula:

$$RII_i = \frac{\sum_{l=1}^Q l n_l}{Q \sum n_l} \quad (1)$$

- i* = Question/ statement item  
*n<sub>l</sub>* = Number of the respondent with *l* score answer  
*l* = Number of Likert scale  
*Q* = Likert range

Each question RII value will be ranked from the largest RII value to the smallest. The workload of each worker determined based on table physiological demands by construction trade (Abdelhamid, 2002) with the value of energy expenditure. Workload conversion is done by multiplying the value of RII from each item of the question with the value of energy expenditure as in the following equation:

$$WL_n = P_n \times EE_n \quad (2)$$

- WL<sub>n</sub>* = Workload indicator *n*  
*P<sub>n</sub>* = RII value of indicator *n*  
*EE<sub>n</sub>* = Energy expenditure indicator *n* as table physiological demands

Then the next step is to calculate the value of the workload of ironworkers by sum up the value of the first rank of workload for each independent variable which is the workload, ability, fatigue level, and psychological influence.

$$WL \text{ Ironworker Total} = \frac{WLvar1 + WLvar2 + WLvar3 + WLvar4}{4} \quad (3)$$

Energy expenditure calculation was done also with the same thing method, where each variable was determine based on the top ranking of sub-variable, then the sum of it divided by 4 type variables.

## 3. Result and discussion

### 3.1 Result

The questionnaire consists of 4 variables and 21 indicators where variable workload had 4 indicators which are respondents' opinions about their workload. The variable ability had 6 indicators consist of how the ironworker doing their job. Variable fatigue consists of 8 indicators of working conditions

that influence their physiological performance and variable psychology had 3 indicators of emotion and environment influence. The research started by distributes the questionnaire to 60 ironworker respondents where 51 gave back the responses.

RII analysis tabulated as seen on table 1 for ironworker perspective about working load they have to bear, table 2 for their ability or competence, table 3 shows the level of fatigue on their perspective and table 4 describes environment influence on their performance. This tabulation is the result of the analysis.

**Table 1.** Working load for an ironworker.

Question number	RII	Ranking	Energy expenditure	Working load value
(Q)	(P)		(EE) (Kcal/min)	Wl
3	0.82	1	5.65	<b>4.63</b>
4	0.75	2	5.6	4.22
1	0.70	3	3.53	2.48
2	0.67	4	2.61	1.74

**Table 2.** Working load for ironworker competencies.

Question number	RII	Ranking	Energy expenditure	Working load value
(Q)	(P)		(EE) (Kcal/min)	Wl
1	0.82	1	5.65	<b>4.61</b>
2	0.80	2	5.6	4.50
5	0.76	3	5.31	4.06
4	0.72	4	3.53	2.53
3	0.69	5	3.53	2.45
6	0.66	6	2.61	1.73

**Table 3.** Fatigue level of an ironworker.

Question number	RII	Ranking	Energy expenditure	Working load value
(Q)	(P)		(EE) (Kcal/min)	Wl
2	0.94	1	5.65	<b>5.32</b>
4	0.84	2	5.60	4.72
1	0.78	3	5.31	4.16
3	0.74	4	5.31	3.96
5	0.67	5	3.86	2.60
6	0.67	6	3.53	2.38
7	0.66	7	3.53	2.34
8	0.62	8	2.61	1.62

**Table 4.** Psychology impact.

Question number	RII	Ranking	Energy expenditure	Working load value
(Q)	(P)		(EE) (Kcal/min)	Wl
1	0.79	1	3.53	<b>2.78</b>
2	0.75	2	3.53	2.63
3	0.69	3	2.61	1.79

The RII analysis gave 4 sub-variables which are: continuously works for physically load variable, type of tools for competencies, the power requirement for fatigue and rest time for psychology impact, as top-ranking answered by the ironworkers.

The total amount of ironworker working load by summing the amount of each variable divided by 4 to get average, gives 4.31 Kcal/minute based on the ironworker perspective. The above results are based on energy expenditure relative to the perspective of the construction workforce (ironworker).

### 3.2 Discussion

Ironworkers have a workload based on energy expenditure of 4.31 Kcal/min. Energy expenditure values obtained from the physiological demands by construction trade table. This result classified ironworker jobs at a very heavy level. This is a suitable result with some previous research which states that the work of the smith or ironworker classified as heavy work [10].

It is clear that ironworkers work beyond the generally accepted reasonable threshold for energy expenditure. Not surprisingly the workers were exhausted at the end of their working day. If the worker cannot get around or find alternative work, then the worker can face the dilemma of continuing his work caused by fatigue.

### 4. Conclusions

This paper reports the physiological workload from the perspective of its specific workers. The workload of ironworkers is 4.31 Kcal/min. The findings of this research reveal that based on the energy expenditure; the ironworker workload is classified as level very heavy work [11]. This may cause experience physical fatigue, leading to a decrease in productivity and motivation, lack of attention and decision making, poor quality of work, accidents, and work-related injuries.

The main purpose of this study is to address the need to change the policy philosophy of safety in the field of construction. This can be done by applying physiological work to the workplace. This study is only limited to the calculation of the workload of construction workers from the perspective of the workers itself and it is associated with the value of energy expenditure. Further research should investigate not only the value of energy expenditure but also other factors that can show more accurate results.

Additional research is also needed for other types of workers and shows how the workload will affect the changes in the workforce. This will assist workers and managers in identifying opportunities to reduce workload or work fatigue and introduce work procedures that accommodate the capabilities of all workers while increasing productivity.

### References

- [1] Abdelhamid T S and Everett J G 2002 Physical demands during construction work *J. Constr. Eng. Manage.* **128**(5) 427-437
- [2] Singleton W T, Fox J G and Whitfield D 1971 *Measurement of Man at Work, and Appraisal of Psychological and Psychological Criteria in Man-Machine System* (London: Taylor and Francis)
- [3] Brouha L 1967 *Physiology in Industry* (New York: Pergamon Press)
- [4] Janaro R E 1982 *Diss. The Development and Implementation of Optimal Multi-Rest Break Scheduling Model* (Florida: Florida State University)
- [5] Song J, Haas C T and Caldas C H 2008 Tracking the location of materials on construction job sites *J. Constr. Eng. Manage.* **132**(9) 911-918
- [6] Zhang M, Murphy L A, Fang D and Caban-Martinez A J 2015 Influence of fatigue on construction workers' physical and cognitive function *The Society of Occup. Med.* **65** 245-250
- [7] Jergeas G 2010 *Proc. Cons. Research Project 2010: Innovation for Reshaping Construction Practice (Banff)* (USA: ASCE) 1030-1038
- [8] Castaneda J A, Tucker R L and Haas C T 2005 Worker's skill and receptiveness to operate under the tier II strategy management strategy *J. Constr. Eng. Manage.* **131**(7) 709-807
- [9] Abdelhamid T S and Everett J G 1999 Physiological demands of concrete slab placing and finishing work *J. Constr. Eng. Manage.* **125**(1) 47-52
- [10] Abdelhamid T S and Everett J. G. 2000 *Proc. Constr. Congress VI: Building Together for a Better Tomorrow in an Increasingly Complex World (Orlando)* (USA: ASCE) 631-639
- [11] Abdelhamid T S 1999 *Diss Measuring and Evaluating Physiological Demands of Construction Work* (Michigan: University of Michigan)