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Compliance with the Use of Personal Protective Equipment (PPE) on Construction Sites in Johor, Malaysia

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Abstract

The construction environment is one of the most dangerous workplaces where several fatal accidents have been recorded. Personal protective equipment (PPE) has therefore been used as a vital protection in ensuring the health and safety of workers on construction sites. A few findings reveal that PPE is usually not worn by construction workers in Malaysia. The purpose of this research was to investigate the awareness and compliance with PPE usage on construction sites in Johor, Malaysia. A mixed-method research approach was adopted for the study. A total of 95 questionnaires were distributed to workers on nine (9) construction sites in Johor with a response rate of 72%. The data analysis method utilised quantitative analysis using mean values, and qualitative analysis using coding of real-time observations. Both quantitative and qualitative methods reveal head, foot, body, and hand PPE as the most commonly used PPE among construction workers on sites in Johor. The findings also reveal a considerable level of awareness but a low level of compliance with the use of PPE by construction workers in Johor as only three (3) PPE out of eight (8) had a compliance level above the average mean of 2.5. Hence, approaches such as provision of safety training and penalties to workers who fail to comply with PPE usage should be implemented to enhance compliance with the use of PPE on construction sites.

Keywords: Awareness and compliance, construction health and safety, PPE, Johor

1.0 INTRODUCTION

The construction sector is one of the fundamental drivers of the economic development of any country as evident by the rapid development of construction activities. In Malaysia, the Department of Statistic Malaysia (DOSM, 2019) advanced that the value of construction work done in the third quarter of 2019 is RM36.1 billion. This could depict the contribution of the construction industry to the economic growth of the country. Considering the states in Malaysia, Johor contributed 13.2% value of work done, which is the third-highest contributing state (DOSM, 2019). Johor is in the south of Peninsular Malaysia with latitude 1.4854°N and longitude 103.7618°E. It is the second largest state in Peninsular Malaysia which possesses a land area of 19,166 km2 with a population of 3.76 million (DOSM, 2020). Thus, numerous construction projects such as Forest City, R&F Princess Cove, Greenland Jade Palace, Singapore-Johor Bahru Rapid Transit System (RTS Link), to name a few, are on-going in Johor.

Occupational Health and Safety (OHS) problems in the construction industry are worldwide issues (Zhang et al., 2020) and are not exclusive to any country or state. Heinrich (1931) proposed the Domino Theory which explained the occurrence of accidents and likened accidents to linear outcomes of unsafe conditions and human errors. Thus, the likelihood of fatality and acquiring injuries in the construction environment is three times and two times more than the average in all other sectors at the global level (Sousa et al., 2014). In 2015, the highest part of fatal occupational accidents in Europe was in the construction industry with more than 1 in 5 accidents (Eurostat, 2020). In mainland China, from 2011 to 2017, there were 4766 deaths in the construction industry, with an average of 1.87 deaths per day according to Ministry of Housing and Urban-Rural Development of the People's Republic of China - MOHURD (Zhang et al., 2020).

Therefore, with the rising construction developments in Johor, it is also evident that Johor would have a great number of construction sites where possible hazards may lurk on. Some researchers (Tadesse & Israel, 2016; Zerguine et al., 2017) have referred 'construction sites' to the most dangerous working place over other sectors of the economy. Vitharana et al. (2015) defined 'hazard' as a potential source of harm or adverse health effect on a person. Since the construction workers are generally exposed to hazards and risks, it the responsibility of employers to provide construction workers with safety training and the necessary PPE. Conversely, many studies had revealed that most of the accidents on construction sites were caused by non-compliance with the use of PPE (Al-Khaburi & Amoudi, 2018; Berhanu et al., 2019; Ghuzdewan & Damanik, 2019; Hashim & Ee, 2018; Tadesse & Israel, 2016; Zerguine et al., 2017). Hence, the development and

implementation of policies and regulations with respect to PPE is paramount. A finding in Figure 1 on the total number of occupational accidents in different sectors by DOSH (2019b) revealed the number of victims from the construction sector from January to June 2019. This clearly shows the occurrence of accidents and hazards on construction sites.

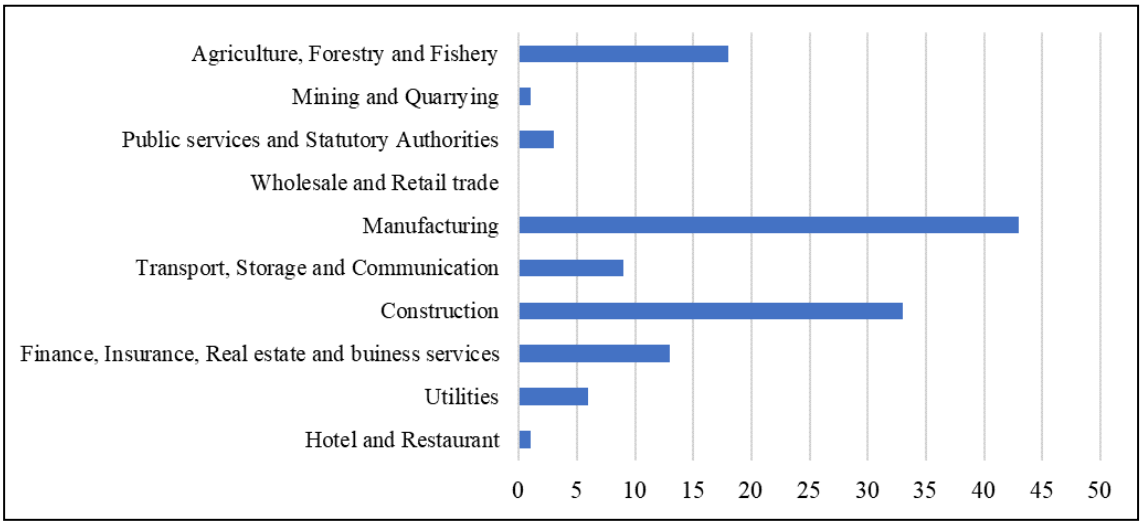

Figure 1 Total number of occupational accidents by sector 2019
(Source: DOSH, 2019b)

The Malaysian government has initiated several platforms (i.e. National Institute of Occupational Safety and Health [NIOSH]; Construction Industry Development Board [CIDB]; and Department of Occupational Safety and Health [DOSH]) that would improve the overall safety of construction workers on site. The main purpose for establishing these institutions is to promote, improve and govern the construction industry in order to achieve global competitiveness. Under the initiatives, the use of PPE is regulated as a mandatory protection for all workers where they are required to wear the relevant PPE whenever they are working on sites. A study by Tadesse and Israel (2016) revealed that the possibility of a worker who wears PPE to get injured is 60% less than those who fail to comply with the use of PPE. Similarly, the OSHA (1994) legislation in Malaysia stipulates the protection of workers against risk to safety and health due to activities at work, thereby ensuring the use of PPE for all persons who enter a construction site. Hence, with proper adherence to the use of PPE, most workers who have access to construction sites would be protected. In an event where the risks could neither be eliminated nor substituted, the PPE would serve as an essential protection to all construction workers.

However, since the relevant knowledge about the awareness and compliance of PPE usage on construction sites in Johor is lacking, the purpose of this study is to investigate the awareness and compliance of PPE usage on construction sites in Johor in order to reduce the incidence of accidents. The objectives of the study are: to identify the availability of PPE on construction sites; to determine the level of awareness of PPE usage among construction workers; and to examine their compliance with the use of PPE on construction sites. Hence, this study uniquely delved into analysing the awareness and compliance with the use of PPE using both quantitative and qualitative methods. The findings of this study will be significant to policy makers, construction stakeholders, contractors, and construction workers by identifying and recognizing the gap that exists between PPE's compliance and non-compliance to strengthen overall health and safety in the construction sector.

■2.0 LITERATURE REVIEW

2.1 Personal Protective Equipment (PPE)

Personal protective equipment, which is abbreviated as PPE refers to the equipment which provides the protection to the workers against any hazards or risks to health and safety in their working place (DOSH, 2019a). The hazards and risks that are common on construction sites include falling objects, dust, poisonous fumes, noise, and sharp objects. According to Gomeseria (2019), PPE acts as an important protection which helps to reduce workers' exposure to hazards when the risks could not be reduced to acceptable levels through engineering and administrative controls.

The regulations of PPE are designed to meet the requirements of the Occupational Health and Safety Act (OSHA) of 1994. The main purpose of this act is to secure the safety, health and welfare of persons against the risk to safety or health arising from the activities of persons at work. Besides, it also promotes an occupational environment with physiological and psychological needs of persons at work. By referring to a reprinted document published by The Commissioner of Law Revision, Malaysia (2006, p. 21), the Occupational Safety & Health Act 1994: Section 24(1) put forward that:

It shall be the duty of every employee while at work - (a) to take reasonable care for the safety and health of himself and of other persons who may be affected by his acts or omissions at work; (b) to co-operate with his employer or any other person in the discharge of any duty or requirement imposed on the employer or that other person by this Act or any regulation made thereunder; (c) to wear or use at all times any protective equipment or clothing provided by the employer for the purpose of preventing risks to his safety and health; and (d) to comply with any instruction or measure on occupational safety and health instituted by his employer or any other person by or under this Act or any regulation made there under.

In addition, the issuance of all PPE should be properly documented, recorded, stored and maintained. Similarly, Tanko and Anigbogu (2012) revealed that supervision, checking, maintaining, and replacement of PPE will go a long way in enhancing the use of PPE on construction sites. This is buttressed by the findings of Goh et al. (2016) who specified that once PPE is not properly used, stored or maintained, workers will be put at risk when working in unsafe working platforms. Therefore, it is imperative to be aware of the effective use of relevant and suitable PPE to ensure the overall health and safety of workers (Muema, 2016).

A research work by Wong et al. (2020) highlighted eight (8) uses and types of PPE in Table 1. These include safety helmet, eye protectors, ear protectors, respirators, protective gloves, safety belts, safety footwear, and protective clothing. Thus, eight types of PPE (respiratory, hearing, eye, hand, foot, body, head and falling protection) are categorized according to the risk and parts of the body being protected. DOSH (2019a) put forward that respirators ought to be used where hazardous fumes are presented on sites. Therefore, it is imperative to provide respirators to construction workers who are exposed to debris, fumes, vapour and dusty environment. Most construction sites produce noise pollution when operating different types of machines; injuries due to the high intensity of noise should also be prevented using ear protection.

Another type of protection is related to the eye. Sakka (2016) submitted that wearing eye protection during the course of work could prevent particles from getting into the eye during cutting, welding, nailing, chipping, grinding or dealing with harmful chemicals including concrete. Next, the hands of construction workers should be protected by different kinds of gloves to avoid being harmed by sharp objects etc. Construction sites are generally full of construction materials all over the place. Also, the foot of workers should be protected against sharp objects like nails which could puncture the soles of shoes. Kyalo (2016) advanced that workers are expected to wear waterproof safety shoes when working in wet conditions to prevent falls and slips. It is important to note that protective clothing such as safety reflector vest should be worn by workers while on construction sites. The United States Department of Labor (2004) defined the safety vest as "a brightly-colored reflective clothing which could increase the visibility of the wearer in working conditions with poor lighting".

An additional PPE to be considered is the safety helmet. Head protection is crucial as head injuries could cause fatal accidents to a worker. Wearing of safety helmet may perhaps protect the person from the impact of a falling object or accidental head contact with electrical hazards (Kyalo, 2016). Lastly, falling from a high level is one of the leading causes of injury and death on construction sites. DOSH (2019a) provided that, safety harness should be attached to the anchorage and fitted with two receptacles and a bolt bag to prevent any free fall. Having discussed the different types of PPE, the next section will discuss the awareness and compliance level with the PPE usage.

Table 1 List of the PPE commonly used in the construction industry and their functions
(Source: Wong et al., 2020)

PPE	Function
Safety helmet	Avoidance of head injury
Eye protectors	Eye protection from dust, particles, flying chips, smoke and chemical splattering
Ear protectors	Ear protection from high levels of noise
Mark and respirator	Protection from inadequate oxygen supply, presence of toxic gases, harmful particles and virus in the air
Protective gloves	Avoidance of hand injury
Safety belts	Fall protection for working at heights
Safety footwear	Avoidance of foot injury and slipping on wet floors
Protective clothing	Physical protection and increase of comfort levels

2.2 Awareness and Compliance with the Use of PPE

The awareness of PPE usage means the consciousness of both workers and employers to alert that the use of PPE as protection on construction sites is a necessity. According to Mosly (2015), all key players should be aware of the potential hazard when they are working or accessing a temporary structure to enable the construction work environment become a safer workplace. Therefore, the failure to provide and inspect PPE on regular basis, and lack of safety training are factors that could lead to the lack of contractor's awareness regarding the use of PPE (Al-Khaburi & Amoudi, 2018). While a quantitative study by Izudi et al. (2017) in Uganda revealed 15.6% low PPE usage amongst building construction workers, a qualitative study of 23 female construction workers by Onyebeke et al. (2016) revealed that the size of PPE provided by contractors was not suitable. These explain the challenge with the use of PPE. A seminal work by Wong et al. (2020) concluded that accident experience, attitude towards the use of PPE, safety knowledge, perceived ease of use, and safety consciousness as some of the reasons why construction workers avoid or use PPE.

A good number of studies have stated that the awareness of using PPE in Malaysia is low. A study by Awang and Kamil (2014) shows that 60% of contractors provided their workers with PPE, however, the study revealed that most of the workers were not wearing the PPE during a site inspection. This finding is supported by Williams et al. (2017) who revealed that non-availability and non-usage of PPE are the second leading causes of injuries among reported accidents in every state of Malaysia. In addition, one of the studies on safety issues of high-rise construction discovered that safety training and PPE provision were insufficient due to higher cost of preparing safety training and PPE for workers (Goh et al., 2016). However, some contractors could not provide safety training and PPE in an attempt to cut the overall cost of the project. Hence, the need for safety training and the provision of PPE could be compromised. Yusof and Misnan (2019) stressed that a lack of safety practice among the contractors particularly in small-scale contractors still exist, this could lead to a possibility of high accident occurrence.

On the hand, some studies revealed that some employers strongly demand their workers to properly use and wear the required PPE. A study by Tan and Razak (2014) involving a safety officer reveals that, all personnel and workers who were physically on construction sites wore the necessary PPE. Moreover, hazard assessment was conducted on sites to assess the potential hazards and the matching PPE to keep the workers from hazards (Tan & Razak, 2014). The outcome of this study inferred that the construction site had a robust and well-organised safety practice such as the provision of PPE by the employers and compliance with PPE by the construction workers. The contractor's provision of PPE to workers is considered a common factor that would enhance safety on construction sites (Fassa & Sofia, 2019). In the same way, Hashim and Ee (2018) advanced that most contractors are aware of the threats on sites and consider PPE as an obligatory equipment for all workers.

Another influencing factor is safety training. Contractors are encouraged to provide safety training to all construction workers so as operate on sites with minimum associated risks. An excellent compliance with the use of PPE is vital in reducing the occurrence of injuries and death. The Occupational Safety & Health Act of 1994 requires all construction workers to comply with the proper use of PPE. A research contribution by Wright et al. (2019) revealed that 80% of the respondents always wear PPE whenever they are on site; with safety shoes as the most necessary PPE and respiratory protection as the least mandatory protection. In a same vein, Tan and Razak (2014) highlighted that workers that were under observation complied with the proper use of the PPE. However, many studies discovered that, compliance with the use of PPE is still a challenge (Berhanu et al., 2019; Izudi et al., 2017; Okoye et al., 2016). Hence, the compliance with PPE usage by most construction workers is still a mirage.

Several variables may be responsible for the low compliance with PPE by most construction workers. The first factor is the attitude of workers on work procedure. According to Wright et al. (2019), PPE is often ignored by workers as they do not feel wearing of PPE is necessary for their safety. Thus, workers sometimes wear PPE because of an instruction from the site safety supervisor (Ulang et al., 2014). Consequently, instructions given to workers are indiscriminately defied when a monitoring system is not put in place by the site supervisor. Furthermore, Tan and Razak (2014) put forward that behaviour such as negligence, and carelessness have resulted in the poor level of PPE usage among workers. A second factor that is related to the low level of compliance with PPE usage is the language barrier between supervisors and workers. Malaysia has documented about 1,994,100 foreign labour force (Ministry of Finance Malaysia, 2020) and the construction industry has the largest number of these labour force.

Most of the foreign construction workers who come from Indonesia, Bangladesh, Myanmar, Nepal, Bangladesh, and other neighbouring countries cannot speak nor understand the local language. Valitherm (2014) submitted that language barrier will result in communication barrier among personnel on construction sites, particularly between foreign workers and site supervisors. The third factor is discomforts while using the PPE. Comfortability is one of the major reasons which could directly influence PPE compliance by the construction workers. As specified in a study by Goh et al. (2016), the International Labour Organization revealed that the core reason why workers do not wear PPE is because of the discomfort associated with wearing the PPE as this may perhaps indirectly reduce their work efficiency.

A study by Tanko and Anigbogu (2012) in Nigeria revealed the need to address the issues of comfort associated with PPE usage to guarantee it does not interfere with worker's productivity and work environment. Hence, PPE should properly fit all workers as this could help to eliminate discomfort while wearing the equipment. Next, lack of proper instructions and knowledge could affect the compliance level of most workers. While Goh et al. (2016) stated that lack of proper instruction could lead to construction accidents, Okoye et al. (2016) concluded that construction workers would work safely, if they are equipped with the necessary safety knowledge. According to Jasani et al. (2016) and Stella and Okeoghene (2017), most workers do not have knowledge of occupational hazards and their preventative measures. Poor coordination between the supervisors and workers could lead to severe hazards and accidents on construction sites. Consequently, employers or supervisors are required to ensure proper PPE compliance and provide the required training to construction workers in order to sustain the role and importance of using PPE.

2.3 Hazard Control and Risk Reduction

According to CIDB (2018), hazard control and risk reduction could be achieved by the hierarchy of control (HOC). Construction Industry Development Board (CIDB) defines 5 levels of the hierarchy of control which are elimination, substitution, isolation, engineering control, administrative control and personal protective equipment (Shrestha, 2019). The preventive measures were arranged accordingly from the top to the bottom of the triangle as depicted in Figure 2. To begin with, elimination could be regarded as the most effective approach which reduces threats by eliminating the sources of hazards that physically appear on sites. However, this approach could be impractical as some processes involving hazardous equipment could not simply be eliminated (Kyalo, 2016).

The second control measure is via the substitution method which replaces hazardous work activities with less hazardous tasks. This happens when the hazards could neither be eliminated nor substituted. The third control measure is via isolation. Isolation separates either the hazard from the people or the people from hazard, this eliminates direct contact between people and the hazard. The next mitigatable approach is engineering control where the hazard is redesigned and removed prior to any contact with the workers (RICS, 2018). Also, administrative controls such as training and safety procedures are normally applied by numerous construction companies in managing risk. The last but not the least control measure is the use of PPE which has been extensively discussed in this paper. PPE is the most practical

and effective measure in managing and controlling risks on construction sites. It is the final barrier to hazards on sites as it protects workers by minimising the consequences of associated risk.

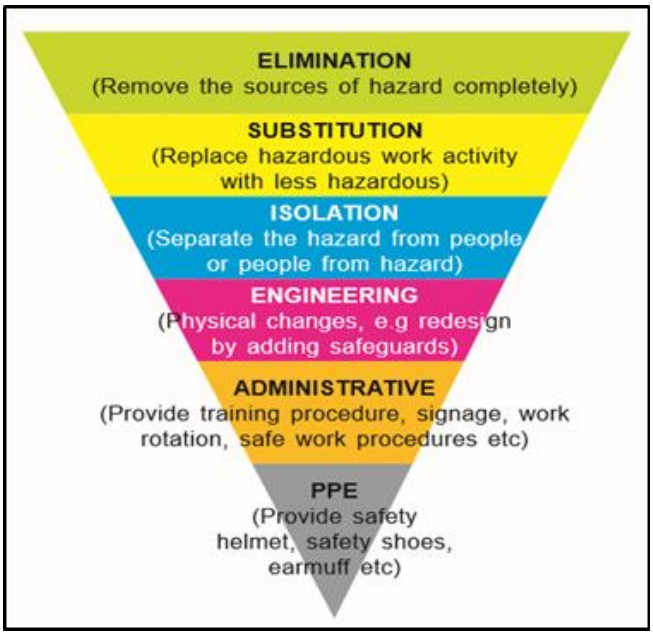

Figure 2 Hierarchy of control
(Source: CIDB, 2018)

■3.0 METHODOLOGY

3.1 Quantitative Method

A questionnaire is an instrument used in a survey research for the collection of data. According to Rowley (2014), questionnaire is one of the most extensively used means of collecting data and is typically adopted in surveys to profile a population. Therefore, considering the quantitative nature of this study, it becomes necessary for questionnaires to be used. A total of 95 questionnaires were administered to different construction workers on nine (9) construction sites in Johor with a 72% response rate. A 5-Likert scale was adopted for this survey. To consider the population of the study area, a total of 7,789 registered contractors in Johor (CIDB, 2018) was utilised. The study primarily considers construction workers who work with this population that constitutes grade 1 to grade 7 contractors.

Daniel's (1999) sample size method (Equation 1) was used to calculate the sample size of the study with a population of 7789, with a confidence level of 95% and a confidence interval of 10%. The sample size determination is shown in Figure 3. Next, mean scores were also used to calculate the mean scores of the data collected (Equation 2).

$$n = \frac{Z^2\ P(1-P)}{d^2} \quad \text{(Eqn.1)}$$

Where, n = Sample size;
Z = Confidence level;
P = Expected proportion; and
D = Confidence interval

$$Mean\ value = \sum \frac{pi}{N} \quad \text{(Eqn.2)}$$

Where, pi = 1 to 5 on a Likert scale;
N = total number of sites

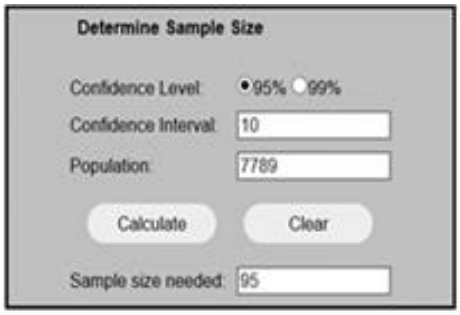

Figure 3 Sample size determination

3.2 Qualitative Method

According to Saunders et al. (2019, p. 378), "observation involves systematic viewing, description, recording, analysis and interpretation of people's behaviour". A similar study by Wong et al. (2020) adopted the qualitative to find and establish the attitude of construction workers on the use and non-use of PPE. This approach is widely accepted in construction safety (Man et al., 2017) and other fields for the collection of qualitative data. Therefore, Figure 4 shows the coding process utilised in this study.

Saunders et al. (2019) outlined the process of qualitative data analysis which constitutes four stages of the coding process. The data collected will be categorised in order to facilitate the process of coding after which the data would be analyzed. To discover the data, the behaviour of workers on construction sites in Johor was observed to establish whether they were compliance with the use of PPE or not. With the permission of the contractor, digital images were also captured on the sites (see Section 4.4). The data were categorised according to the compliance of workers with the use of PPE on nine different construction sites in Johor. Therefore, this study utilized real-time observation to observe, record, and interpret workers' level of compliance with the use PPE on construction sites. The selected sites had different contractor grades of 4, 5, 6, and 7 (Table 2) that are registered with CIDB.

A sample on how the data was coded is provided in Appendix A while the results of the observation are presented in Table 3.

Figure 4 The coding process

Table 2 Observation sites and contractor grade

PPE	Contractor Grade
Site 1	Grade 6
Site 2	Grade 6
Site 3	Grade 5
Site 4	Grade 3
Site 5	Grade 4
Site 6	Grade 7
Site 7	Grade 6
Site 8	Grade 5
Site 9	Grade 7

3.2 Reliability Test

According to Mondal and Mondal (2017), Equation 3 (Cronbach's Alpha) can be used to calculate the reliability of a research data. This method was used for the study. The reliability index for the level of awareness among the participants is 0.896, while the level of compliance is 0.937. The details of the calculation are presented in Appendices B and C.

$$\alpha = \left(\frac{k}{(k-1)}\right) * \left(1 - \left(\left(\sum s_i^2\right) / s_t^2\right)\right) \quad \text{(Eqn.3)}$$

where, k = number of items in questionnaire; S_i = Standard Deviation of i^{th} item; and S_t = Standard Deviation of sum score

Calculation of reliability index for awareness:

$$a = \left[\frac{68}{(68-1)}\right] x \left[\frac{(1-10.034)}{85.713}\right]$$

$$a = 0.896$$

Calculation of reliability index for compliance:

$$a = \left[\frac{68}{(68-1)}\right] x \left[\frac{(1-12.313)}{159.458}\right]$$

$$a = 0.937$$

4.0 RESULTS AND DISCUSSION

4.1 Contractor's Grade

Figure 5 depicts different grades (G1, G2, G3, G4, G5, G6, and G7) of contractors. It is apparent that 26% of the respondents are G5, 24% are G7, 21% G6, 16% G4, 12% G3, and 1% are G2. It could be deduced that all the respondents stem from different grades of construction companies.

These contractors are involved in several projects such as commercial development, landed housing development, and high-rise residential development. The study utilized all the grades of contractors (G1 to G7) for the quantitative survey. However, the sites selected for the observation survey had grades 4,5,6, and 7 with higher percentages. It is important to note that G1, G2, and G3 contractors constitute only 0%, 2% and 12% respectively.

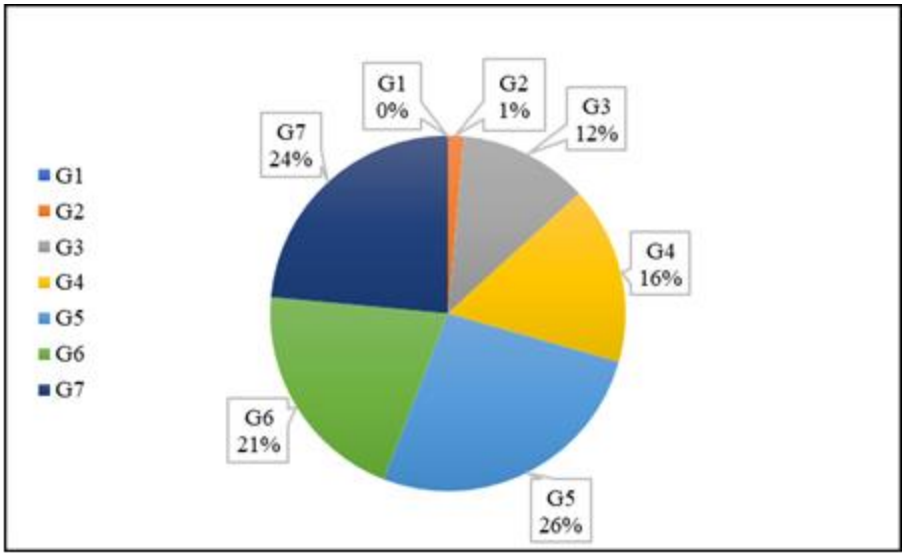

Figure 5 Contractor's grade

4.2 Types of PPE Provided on Construction Site

Figure 6 illustrates the provision of different types of PPE on construction sites. The most common PPE provided on sites are Head (100%), Foot (100%), Body (84%), Hand (81%), and fall (69%). Respiratory, eye, and hearing protection had 34%, 16%, and 7% respectively. The outcome of this finding is supported by Tan and Razak (2014) and Ulang et al. (2014) who insisted that the provision of these types of PPE on construction sites was high. Hence, head, foot, body, and hand protection have a relatively higher provision on construction sites. This indicates that other PPE (hearing, eye, respiratory, and fall) should sufficiently be provided to construction workers on sites.

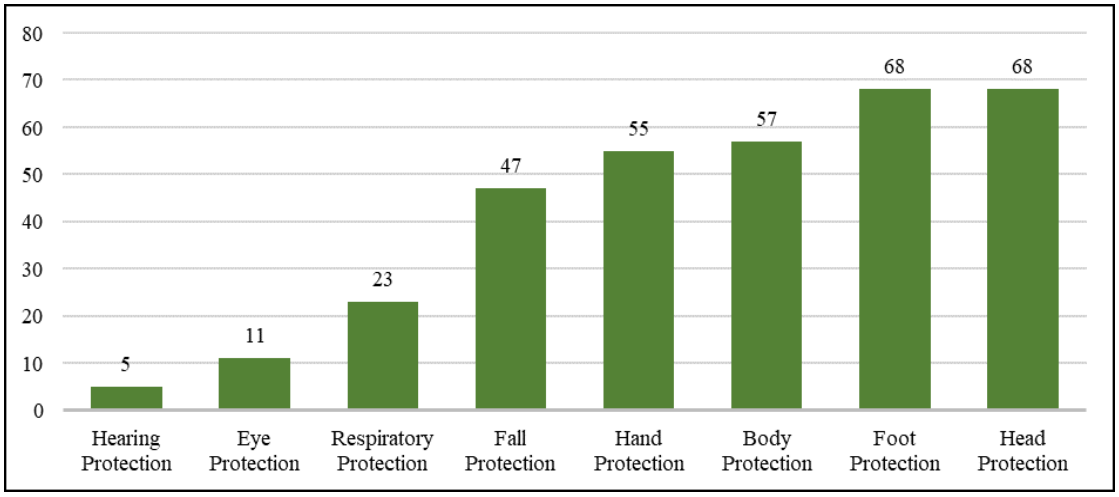

Figure 6 Provision of PPE on construction sites

4.3 Level of Awareness and Compliance with the Use of PPE

Figure 7 illustrates the level of awareness with the use of PPE among construction workers. From the Figure, it can be seen that the stacked bar for fall, head, body, and foot have more level of awareness than other types of PPE. This means that the awareness of construction workers on these PPE is higher compared to hand, eye, hearing and respiratory protection.

This finding is generally held by Tan and Razak (2014) and Hashim and Ee (2018) who stated that the level of awareness of these PPE in Malaysia is high. However, studies by Goh et al. (2016), Williams et al. (2017), and Yusof and Misnan (2019) disagreed with their submission. Tan and Razak (2014) finally inferred that in order to encourage the awareness of using PPE, safety training should be provided to all workers and contractors.

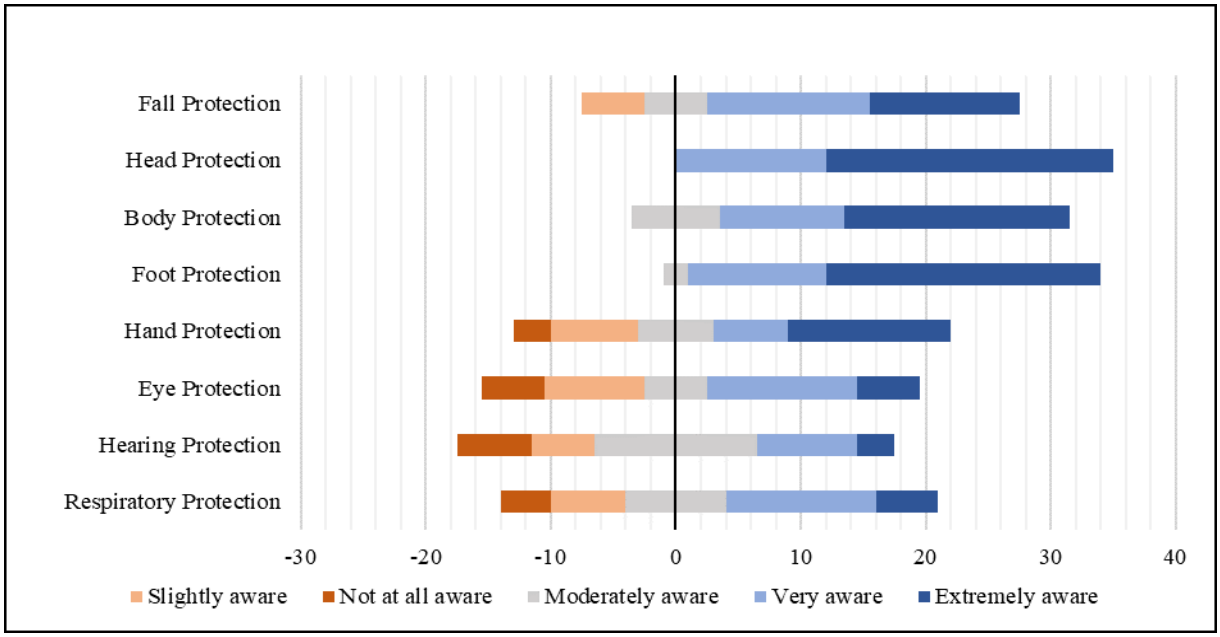

Figure 7 Level of awareness with PPE usage

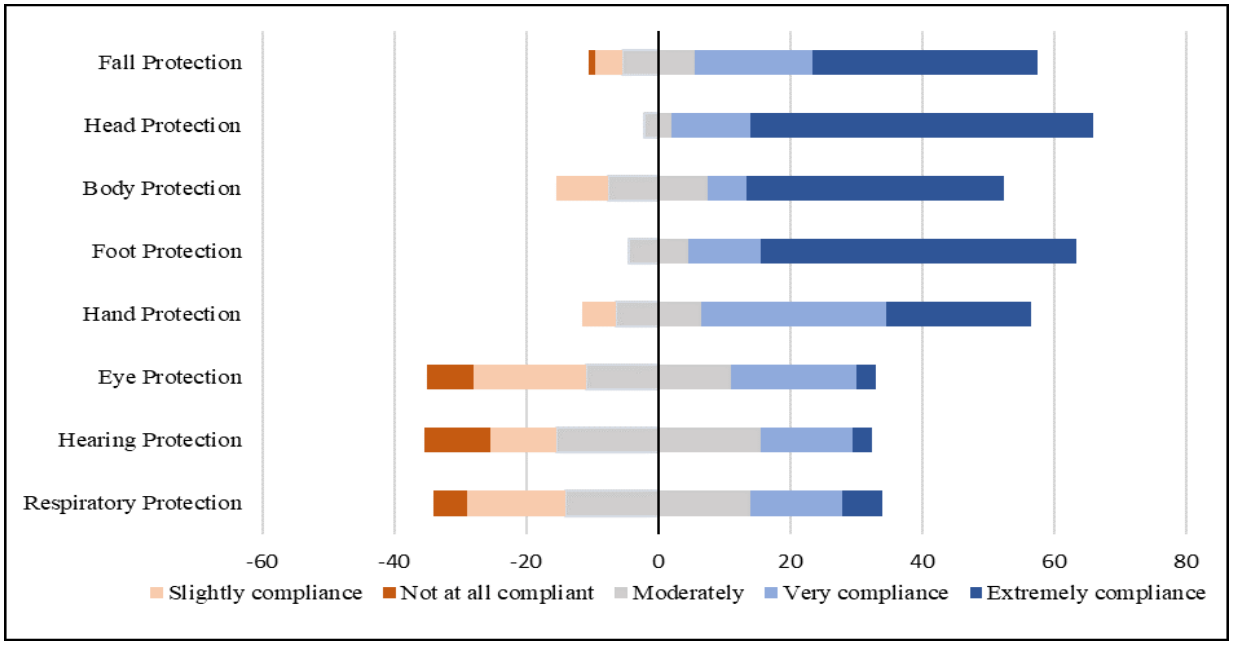

Figure 8 Level of compliance with PPE usage

On the other hand, the compliance level of PPE usage is illustrated in Figure 8. From the Figure, it can be seen that the stacked bar for fall, head, body, foot, and hand PPE have more level of compliance compared to eye, hearing and respiratory protection. This denotes that the compliance with the above-mentioned PPE is higher than eye, hearing and respiratory protection. Therefore, there is a need to implement the compliance of these PPE to improve the overall compliance of available PPE on construction sites.

4.4 Real-Time Site Observation

From the visual data of Site 1, it can clearly be seen that all construction workers are equipped with safety helmet, safety vest and safety shoes. Next, Site 2 illustrates construction workers executing some aspects of piping work. There was good compliance with the use of safety helmet, safety shoes, safety vest and hand gloves during the whole process. During the real-time observation on Site 3, it can be seen that some workers did not wear safety vest while some did. However, other safety equipment such as safety helmet and safety shoes were worn. From Site 4, it can be observed that some construction workers did not wear safety helmet at all while some wore a straw hat in place of safety helmets.

Afterward, Site 5 shows a good compliance with the use of safety helmets by some workers while some failed to wear safety shoes and inappropriately wore straw hats as safety helmet. From Site 6, it be seen that PPE such as safety helmet, safety vest, safety shoes and gloves were properly complied with by the workers. In addition, the use of safety masks was utilised by some workers as respiratory protection. From the real-time observation, Site 7 shows a full compliance with safety helmet, safety shoes and hand gloves. However, neither the safety vest nor the safety harness was worn by the workers. Subsequently, Site 8 shows construction workers carrying bricks without neither hand gloves nor safety vest. The only PPE worn by the workers is the safety helmet. Finally, the personnel and workers on Site 9 properly wore the safety helmet, vest and safety shoes but without hand gloves.

Site 1

Site 2

Site 3

Site 4

Site 5

Site 6

Site 7

Site 8

Site 9

4.5 Coding of the Observation Data

Table 3 shows the observation and coding of the use of different types of PPE on construction sites. Using a similar decision rule by Majid and McCaffer (1997), the decision rule utilised for a 5-Likert scale analysis, and the acceptance region is calculated thus: **(1+2+3+4+5)/5 = 3.0.**

In order to use a standard analysis, this research adopts 3.0 as the average of a 5-point Likert scale. Jacoby and Matell (1971) in support of Likert assertion upholds the conversion of any universal scale to three scale point in order to enhance decision-making. The lower limit for 3.0 is 2.5 and the upper limit for class 3.0 is 3.5. Consequently, instead of using 3.0 as a criterion for making decision, 2.5 is used. Thus, the PPE usage can be rated as "extremely compliant" ($4.5 \leq$ mean < 5.0), "very compliant" ($3.5 \leq$ mean < 4.5), "moderately compliant" ($2.5 \leq$ mean < 3.5), and "low compliant" ($1.5 \leq$ mean < 2.5) depending on their mean values. Hence, the compliance level of the PPE usage was established. The mean value of an item > 2.5 is considered, while mean values less than ≤ 2.5 are not considered.

Based on the decision rule and summary of results in Table 4, it could be seen that head protection is ranked 1st as the most "extremely compliant" PPE followed by the foot PPE. Body, hand, respiratory, eye, hearing, and fall protection ranked 3rd, 4th, 5th, 6th, 7th, and 8th respectively. It can be deduced from the findings that during the observation, almost all the construction workers wore safety helmets (HD) on construction sites. This finding is maintained by Hashim and Ee (2018) who inferred that safety helmet has the highest usage amongst other PPE. However, from the real-time observation of the study, some workers were found to have worn straw hats in place of safety helmets.

Next, the PPE that were commonly worn by the workers are foot protection (FT) and body protection (BD). From the observation, the overall compliance level of safety shoes is satisfying although it was observed that some workers wore ordinary covered shoes during their work procedure. It is revealed that the 3rd ranked PPE (body protection-BD) was moderately worn by the construction workers as some of them did not wear the reflective safety vest on construction site.

In addition, it was observed that the construction workers had low compliance with the use of hand, respiratory, and eye PPE. This outcome is upheld by most researchers (Berhanu et al., 2019; Izudi et al, 2017; Okoye et al., 2016) who advanced that the compliance of PPE usage by the construction workers is low. Moreover, it is important to note that masks were not be worn by the workers as some workers inappropriately used a piece of cloth to cover their nose and mouths. Finally, hearing (HE) and fall (HL) protection which ranked 7th and 8th were not complied by most of the construction workers. According to DOSH (2007), "the guidelines for the prevention of falls at workplaces stated that fall protection should be provided and applied in any workplace with a height of 2 metres or above". This should be adhered to by all construction workers. Awang and Kamil (2014) and Tan and Razak (2014) highlighted that the deduction of wages is a most common penalty that is usually imposed on workers to ensure compliance. The findings of the qualitative method are clearly similar

with that of the quantitative approach which identified head, foot, body, and hand PPE as the most commonly used PPE on construction sites.

It is important to note that only three (3) PPE had mean values > the average mean of 2.5. The other five (5) PPE had mean values < 2.5. From the mean calculation in Table 3, the overall average compliance level is derived by finding the average mean of all the PPE.

Overall Compliance Level = (1.56+1.33+1.44+2.00+4.33+3.44+4.67+1.22) / (8 (Total number of PPE) = 2.5.

Hence, the compliance level with the use of PPE on construction sites in Johor is low. Perhaps, the low provision of safety training due to financial capabilities of some companies could be the cause of low compliance with the use of PPE (Goh et al., 2016). However, Sites 6, 9, and 2 ranked 1st, 2nd and 3rd with the highest provision of PPE. Lastly, employers and supervisors should ensure that PPE must be provided and properly worn by all construction workers.

Table 3 Coding of the observation data

Site	RE	HE	EY	HA	FT	BD	HD	FL	Total Number of PPE
1	1	1	1	1	5	5	5	1	**20**
2	1	1	1	3	5	5	5	1	**22**
3	1	1	1	1	5	4	5	1	**19**
4	1	1	1	1	4	3	3	1	**12**
5	1	1	1	1	2	1	4	1	**12**
6	4	4	3	4	5	5	5	2	**32**
7	1	1	1	3	5	2	5	2	**20**
8	1	1	1	1	3	1	5	1	**14**
9	3	1	3	3	5	5	5	1	**26**
Mean	1.56	1.33	1.44	2.00	4.33	3.44	4.67	1.22	
Average	2.50								
Rank	5	7	6	4	2	3	1	8	

where, RE = Respiratory Protection; HE = Hearing Protection; EY = Eye Protection; HA = Hand Protection; FT = Foot Protection; BD = Body Protection; HD=Head Protection; and FL=Fall Protection

where, 1=not at all compliant; 2=slightly compliant; 3=moderately compliant; 4=very compliant; 5=extremely compliant

■5.0 CONCLUSION AND RECOMMENDATION

The study investigated the awareness and compliance with the use of PPE on construction sites in Johor, Malaysia. From the findings of real-time observation and quantitative analysis, the study revealed that the construction workers have a considerable level of awareness of PPE usage in Johor. The compliance level of the PPE usage was also investigated. It was revealed that the compliance level depends on the type of PPE available on different construction sites. The findings revealed that head protection (safety helmet), foot protection (safety boots), and body protection (safety vests) had the highest usage and compliance among the eight (8) PPE considered in this study. Overall, the findings revealed that the compliance level with PPE usage on construction sites in Johor is low as only three (3) PPE out of eight (8) had at least moderate compliance. The poor compliance of PPE by these workers could be due to other several reasons. In addition, the outcome of the study reveals the need to sensitize construction workers on the importance of wearing PPE particularly hand, eye, hearing and respiratory protection to improve the overall health and safety of workers.

The following are the limitations of the study: small sample size and observed sites; the methods employed in the study; language barrier with the construction workers as they come from different countries; difficulties to obtain permission to have access to some sites; and lack of literature that focused on the awareness and compliance of using specific types of PPE in the construction industry. Hence, the outcome of the study is specific and cannot be generalized. The study finally recommends the need for more investigation into the use of each PPE type and approaches that could tackle non-compliance of PPE usage among construction workers.

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APPENDIX A
Coding of Observation Data

Type of PPE	Code	Level of compliance	Code
Respiratory Protection	RE	**Not at all compliant**	1
Hearing Protection	HE	**Slightly compliant**	2
Eye Protection	EY	**Moderately compliant**	3
Hand Protection	HA	**Very compliant**	4
Foot Protection	FT	**Extremely compliant**	5
Body Protection	BD		
Head Protection	HD		
Fall Protection	FL		

APPENDIX B
Reliability Test Using Cronbach's Alpha for Awareness of PPE Usage

Iterms	Frequency of training	Importance of PPE	Awareness								Total
			Respiratory	Hearing	Eye	Hand	Foot	Body	Head	Fall	
1	1	2	1	1	1	1	3	2	3	2	17
2	2	2	1	1	1	1	3	2	4	2	19
3	2	3	1	1	1	1	3	3	4	2	21
4	2	3	1	1	1	2	4	3	4	2	23
5	2	3	1	1	1	2	4	3	4	2	23
6	2	3	1	1	1	2	4	3	4	2	23
7	3	3	2	1	1	2	4	3	4	2	25
8	3	3	2	1	1	2	4	3	4	2	25
9	3	3	2	1	2	2	4	3	4	2	26
10	3	3	2	1	2	2	4	3	4	3	27
11	3	3	2	2	2	2	4	3	4	3	28
12	3	3	2	2	2	3	4	3	4	3	29
13	3	3	2	2	2	3	4	3	4	3	29
14	3	4	2	2	2	3	4	3	4	3	30
15	3	4	2	2	2	3	4	3	4	3	30
16	3	4	2	2	2	3	4	3	4	3	30
17	3	4	2	2	2	3	4	4	4	3	31
18	3	4	2	2	2	3	4	4	4	3	31
19	3	4	3	2	2	3	4	4	4	3	32
20	3	4	3	2	2	3	4	4	5	3	33
21	3	4	3	3	2	3	4	4	5	4	35
22	4	4	3	3	3	3	4	4	5	4	37
23	4	4	3	3	3	4	5	4	5	4	39
24	4	4	3	3	3	4	5	4	5	4	39
25	4	4	3	3	3	4	5	4	5	4	39
26	4	4	3	3	3	4	5	4	5	4	39
27	4	4	3	3	3	4	5	4	5	4	39
28	4	4	3	3	3	4	5	4	5	4	39
29	4	4	3	3	3	4	5	4	5	4	39
30	4	4	3	3	3	4	5	4	5	4	39
31	4	4	3	3	3	4	5	4	5	4	39
32	4	4	3	3	3	4	5	4	5	4	39
33	4	4	3	3	3	4	5	5	5	4	40
34	4	4	3	3	3	4	5	5	5	4	40
35	4	4	3	3	3	4	5	5	5	4	40
36	4	4	3	3	3	4	5	5	5	4	40
37	4	4	4	3	4	4	5	5	5	4	42
38	4	5	4	3	4	4	5	5	5	4	43
39	4	5	4	3	4	4	5	5	5	4	43
40	4	5	4	3	4	4	5	5	5	4	43
41	4	5	4	3	4	4	5	5	5	4	43
42	4	5	4	3	4	4	5	5	5	5	44
43	5	5	4	4	4	4	5	5	5	5	46
44	5	5	4	4	4	5	5	5	5	5	47
45	5	5	4	4	4	5	5	5	5	5	47
46	5	5	4	4	4	5	5	5	5	5	47
47	5	5	4	4	4	5	5	5	5	5	47
48	5	5	4	4	4	5	5	5	5	5	47
49	5	5	4	4	4	5	5	5	5	5	47
50	5	5	4	4	4	5	5	5	5	5	47
51	5	5	4	4	4	5	5	5	5	5	47
52	5	5	4	4	4	5	5	5	5	5	47
53	5	5	4	4	4	5	5	5	5	5	47
54	5	5	4	4	4	5	5	5	5	5	47
55	5	5	4	4	4	5	5	5	5	5	47
56	5	5	4	4	4	5	5	5	5	5	47
57	5	5	5	4	4	5	5	5	5	5	48
58	5	5	5	4	5	5	5	5	5	5	49
59	5	5	5	4	5	5	5	5	5	5	49
60	5	5	5	5	5	5	5	5	5	5	50
61	5	5	5	5	5	5	5	5	5	5	50
62	5	5	5	5	5	5	5	5	5	5	50
63	5	5	5	5	5	5	5	5	5	5	50
64	5	5	5	5	5	5	5	5	5	5	50
65	5	5	5	5	5	5	5	5	5	5	50
66	5	5	5	5	5	5	5	5	5	5	50
67	5	5	5	5	5	5	5	5	5	5	50
68	5	5	5	5	5	5	5	5	5	5	50
Variance	1.028547	0.679931	1.4429066	1.509299	1.57526	1.370891	0.320718	0.782872	0.237024	1.08737	

APPENDIX C
Reliability Test Using Cronbach's Alpha for Compliance with the Use of PPE

Items	Compliance								Agreement					Total
	Respiratory	Hearing	Eye	Hand	Foot	body	head	fall	Instruction	Discomfort	Knowledge	Language	Ignorance	
1	1	1	1	2	3	2	3	1	1	1	1	1	1	19
2	1	1	1	2	3	2	3	2	1	1	1	1	1	20
3	1	1	1	2	3	2	3	2	1	1	1	1	1	20
4	1	1	1	2	3	2	3	2	1	2	1	1	1	21
5	1	1	1	2	3	2	4	2	1	3	1	1	1	23
6	2	1	1	3	3	2	4	3	1	3	1	2	1	27
7	2	1	1	3	3	2	4	3	1	3	1	2	1	27
8	2	1	2	3	3	2	4	3	1	3	2	2	1	29
9	2	1	2	3	3	3	4	3	1	3	2	2	2	31
10	2	1	2	3	4	3	4	3	1	3	2	2	2	32
11	2	2	2	3	4	3	4	3	1	3	2	2	2	33
12	2	2	2	3	4	3	4	3	1	3	2	2	2	33
13	2	2	2	3	4	3	4	3	1	3	2	2	2	33
14	2	2	2	3	4	3	4	3	1	4	2	2	2	34
15	2	2	2	3	4	3	4	3	1	4	2	2	2	34
16	2	2	2	3	4	3	4	3	1	4	2	2	2	34
17	2	2	2	3	4	3	5	4	1	4	2	3	3	38
18	2	2	2	3	4	3	5	4	1	4	2	3	3	38
19	2	2	2	4	4	3	5	4	1	4	2	3	3	39
20	2	2	2	4	4	3	5	4	2	4	2	3	3	40
21	3	3	2	4	5	3	5	4	2	4	2	3	3	43
22	3	3	2	4	5	3	5	4	2	4	2	3	3	43
23	3	3	2	4	5	3	5	4	2	4	3	3	3	44
24	3	3	2	4	5	4	5	4	2	4	3	3	3	45
25	3	3	3	4	5	4	5	4	2	4	3	3	3	46
26	3	3	3	4	5	4	5	4	2	4	3	3	3	46
27	3	3	3	4	5	4	5	4	2	4	3	4	3	47
28	3	3	3	4	5	4	5	4	2	4	3	4	3	47
29	3	3	3	4	5	4	5	4	2	4	3	4	3	47
30	3	3	3	4	5	5	5	4	2	4	3	4	3	48
31	3	3	3	4	5	5	5	4	2	4	3	4	3	48
32	3	3	3	4	5	5	5	4	2	4	4	4	3	49
33	3	3	3	4	5	5	5	4	2	4	4	4	4	50
34	3	3	3	4	5	5	5	4	2	4	4	4	4	50
35	3	3	3	4	5	5	5	5	2	4	4	4	4	51
36	3	3	3	4	5	5	5	5	2	4	4	4	4	51
37	3	3	3	4	5	5	5	5	3	4	4	4	4	52
38	3	3	3	4	5	5	5	5	3	5	4	4	4	53
39	3	3	3	4	5	5	5	5	3	5	4	4	4	53
40	3	3	3	4	5	5	5	5	3	5	4	4	4	53
41	3	3	3	4	5	5	5	5	3	5	4	4	4	53
42	3	3	3	4	5	5	5	5	3	5	4	4	4	53
43	3	3	3	4	5	5	5	5	3	5	4	4	4	53
44	3	3	3	4	5	5	5	5	3	5	4	4	4	53
45	3	3	3	4	5	5	5	5	3	5	4	4	4	53
46	3	3	3	4	5	5	5	5	3	5	4	4	4	53
47	3	3	4	5	5	5	5	5	3	5	4	4	4	55
48	3	3	4	5	5	5	5	5	3	5	4	5	4	56
49	4	3	4	5	5	5	5	5	3	5	4	5	4	57
50	4	3	4	5	5	5	5	5	3	5	4	5	4	57
51	4	3	4	5	5	5	5	5	3	5	4	5	4	57
52	4	4	4	5	5	5	5	5	3	5	4	5	4	58
53	4	4	4	5	5	5	5	5	3	5	4	5	4	58
54	4	4	4	5	5	5	5	5	3	5	4	5	4	58
55	4	4	4	5	5	5	5	5	3	5	4	5	5	59
56	4	4	4	5	5	5	5	5	4	5	4	5	5	60
57	4	4	4	5	5	5	5	5	4	5	4	5	5	60
58	4	4	4	5	5	5	5	5	4	5	4	5	5	60
59	4	4	4	5	5	5	5	5	4	5	4	5	5	60
60	4	4	4	5	5	5	5	5	4	5	5	5	5	61
61	4	4	4	5	5	5	5	5	4	5	5	5	5	61
62	4	4	4	5	5	5	5	5	4	5	5	5	5	61
63	5	4	4	5	5	5	5	5	4	5	5	5	5	62
64	5	4	4	5	5	5	5	5	5	5	5	5	5	63
65	5	4	4	5	5	5	5	5	5	5	5	5	5	63
66	5	5	5	5	5	5	5	5	5	5	5	5	5	65
67	5	5	5	5	5	5	5	5	5	5	5	5	5	65
68	5	5	5	5	5	5	5	5	5	5	5	5	5	65
Variance	0.7089774	0.825505	0.875446	0.682099	0.560345	1.309156	0.363853	1.033294	0.851367	1.0514269	1.2057075	1.511296	1.334126	