Cognitive Differences between Senior and Younger Worker: A Mental State Examination

Kristiana Asih Damayanti, Ari Widyanti, and Yassierli
Industrial Engineering and Management Department
Institut Teknologi Bandung
Bandung, Indonesia
kristiana_damayanti@students.itb.ac.id, widyanti@ti.itb.ac.id, yassierli@ti.itb.ac.id

Abstract

The need for more competencies in information and communication technology has raised the issue of the roles of senior workers at the workplace while their population has increased. Senior workers are associated with declines in cognitive ability, which is defined as the ability to think logically, analyze and solve novel problems. The purpose of this study is to compare the cognitive ability between young and senior workers using the Saint Louis University Mental State Examination (SLUMS), which measures the ability of attention, visuospatial, memory and calculation, and language. Thirty-one younger worker participants who are fresh graduates (age range 22-24 years old) and sixty-two senior workers who are classified into two groups (52-56 and 57-61 years old) are involved voluntarily in this study by filling out the SLUMS questionnaire. The result of this study shows that there are significant cognitive differences between younger and senior workers, especially in language and visuospatial ability. This study also found no correlation between the type of work and cognitive ability in younger workers, but the correlations exist for the senior workers. As predicted, education also correlates with the cognitive ability of senior workers. The implications of these results from an ergonomics point of view are discussed.

Keywords
Cognitive ability, senior workers, ergonomics, and SLUMS.

1. Introduction

The Indonesian population is undergoing changes not only in its increasing number but also in its structure. Based on the projection of the Indonesian population in 2035 by the Central Bureau of Statistics (Badan Pusat Statistik 2013), the number of Indonesians aged 15 years and over will increase, while the population under 15 years will decrease. Thus, if depicted into the population pyramid, it will not be sharp upwards but will tend to widen in adulthood. The change in population structure resulted in a lower dependency ratio since the number of productive people (aged 15 years and above) increased more than the number of non-productive people (Heryanah 2015).

According to BPS data, the dependency ratio of the Indonesian population reached 51,3% in 2010, began to fall below 50% in 2015, and is predicted to decline every year until 2045 (Maylasari et al. 2019). Therefore, Indonesia is currently entering the demographic bonus period marked by a higher number of productive people than non-productive people. The population with this productive age is known as the labor force. The demographic bonus period will change in 2045, where the population with productive age will be aging, thus turning the dependency ratio to rise above 50% again (Maylasari et al. 2019).

The projection of the demographic period that ends in 2045 is predicted since people who fall into the productive age category will be aging. Moreover, the addition of elderly people per year has been happening. In 2019, the number of elderly people in Indonesia had reached 9,6% (25,64 million people) of the total population and was predicted to be more than 10% in 2025 (Badan Pusat Statistik 2019). This change needs to be anticipated from now on by taking advantage of the demographic bonus and preparing for the aging society (Heryanah 2015).

The increasing number of productive and aging societies mentioned above are by the BPS data of the labor force. Based on the data plotting results from 2016 to 2019 by the BPS, the population that is actively working in the labor

force within the age of 45-59 years and elderly (60+) experienced a higher increase compared to the young labor force (age 15-44 years) and is expressed as the percentage of participation in Figure 1.

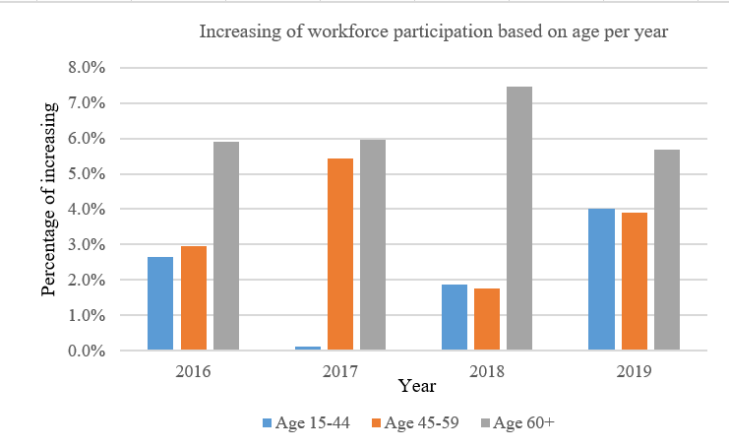


Figure 1. Increase in the number of active workers within each age group of the workforce per year (summarized from www.bps.go.id)

On average, the highest increase in work participation is by the elderly, the age group 55-59 years, and the age group 50-54 years respectively, as shown in Figure 2.

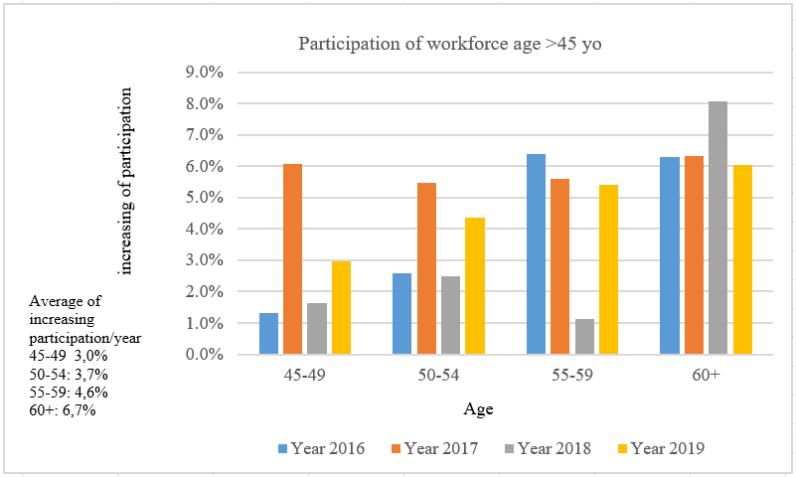


Figure 2. Increasing labor force participation aged > 45 years (summarized from www.bps.go.id)

The labor force aged 45 years and over is often referred to as senior workers. Senior workers are workers who have entered the age of 45 or 50 years and over or starting at 30 who experience a physical and mental decline (Ilmarinen 2005). Mccarthy et al. (2014) determined senior workers based on biological age, psychological age, and social age (age in the organization). Based on the results of the study, organization-wise, workers are considered as senior if they have reached 48 years old and over, meanwhile for the other age indicators (biological and psychological), workers are included in the senior category if they are 52 years old and over. The biological and psychological age will affect individuals in work (Salthouse 2012).

The International Labor Organization (ILO) predicted that in 2025 there would be a significant increase in the number of senior workers aged 50 years and above in Europe, America, and Asia compared to the young workers (Ilmarinen 2005). The projected increase can be seen in Figure 3. This occurred in line with aging in the demographic condition of the world, where the population of elderly is more than those with young age (aging society).

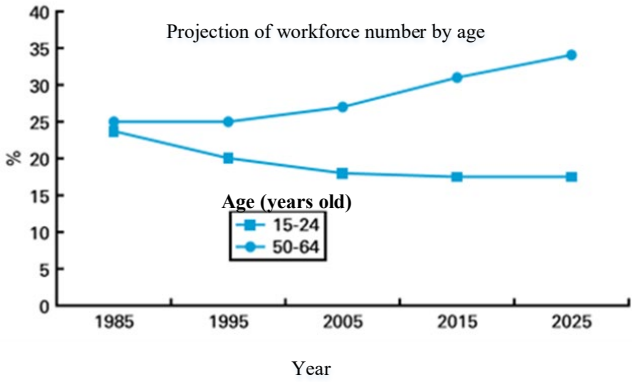


Figure 3. Projection of number of workers in 2025 (Ilmarinen 2005)

In general, senior workers still work due to economic factors, but apart from that, there are also personal reasons as well as company adjustment. Cheung (2013) and Shacklock et al. (2011) stated that those aged 55 years and over still work because of their love for the work, the desire to do activities outside their home, and good company management. Some business actors in Indonesia also widely use those factors to continue to employ their workers even though they have entered retirement age. Besides, the workers already have a specific skill (expert) compared to newly recruited employees.

The Indonesian government also provides the same rights for the elderly to improve their welfare through work as regulated in the Undang-Undang Number 13 of 1998 Article 5. This is also in line with the World Health Organization (WHO) guidelines at the end of 2020 regarding sustainable efforts to anticipate aging society as outlined in the Decade of Healthy Ageing 2020-2030. Ten plans are made to ensure the elderly remain healthy, one of which is regarding the rights to access employment for the elderly and the equality of treatment in employment (World Health Organization 2020).

The presence of senior workers, even those above the retirement age in companies or organizations, often raises negative issues related to decreased ability. However, the presence of senior workers in the company can provide benefits for the company, not only because of the skills in the job as they are more skilled than younger workers, but also because of the sense of responsibility, stability, and experience in work that the company needs (Findsen 2015). Issues regarding the declining ability of senior workers may not be entirely true. According to the results of a study conducted by Vasconcelos (2018), most senior workers today are increasingly aware of the need to develop their abilities so that they are still eager to learn to improve their abilities. Companies that are open to help develop the abilities of senior workers benefit from increased loyalty and productivity (Vasconcelos 2018). The ability of senior workers also cannot be generalized and is influenced by many factors. Many senior workers have a good ability to interact with technology (Findsen 2015, Vasconcelos 2018).

The cognitive ability and job experience can be used to predict the workability performance of senior workers (Kolz et al. 2010). Workability is defined as the physical and intellectual resources a person has to perform tasks. This workability is closely related to individual responses emotionally, cognitively, and physically (Converso et al. 2018). The ability to work will decrease when there is an imbalance between the resources owned by a person and the job's demand. However, since there are emotional factors that affect workability, motivation is considered as one of the differences that makes senior workers have as good workability as young workers. A study conducted by Converso et al. (2018) found that senior workers are more motivated by the main job tasks (intrinsic job factors) than extrinsic job factors (such as team and work environment), which are considered to be more attractive for young workers. In addition, Galy et al. (2012) described the intrinsic and extrinsic factors of work as factors that affect workers' cognitive abilities.

Another study conducted by Salthouse (2012) found out that the average human body function, especially cognitive ability, starts to decline at the age of 45 years old, whereas cognitive abilities are essential in work performance, such as decision making and complex system operation (Kuncel et al. 2010). Based on a study conducted by the Boston

University School of Public Health (2013) regarding the decline in the cognitive ability of the elderly in the United States, it was found that the symptoms of cognitive decline in those aged over 53 years happened in problem-solving abilities, spatial orientation, speed of perception, numerical abilities, memory, and verbal. In contrast with the earlier study by Salthouse (2012), according to this study by Boston University School of Public Health (2013), the decline in all cognitive ability, especially memory, occurs from the age of 53-60 years, but then increases at the age of 67 in verbal ability.

Cognitive ability is defined as the capacity to think logically, analyze and solve novel problems, and maybe independent from background knowledge (Ogawa et al. 2020). It is an integral mental component to maintain a healthy, active, and independent lifestyle (Bixter et al. 2018). Cognitive ability involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience (Mark and Hughes 2017).

Salthouse (2015) stated that although on average, the cognitive function at the age of 45 and over begins to decline, it cannot be generalized because many factors influence it. Individuals aged 50 years and over who continue to work have better cognitive abilities than individuals of the same age who do not work (O'Regan et al. 2016). Therefore, the measurement of cognitive function for senior workers must consider factors that affect cognitive function and use more variation of cognitive function variables.

Various factors affect the cognitive abilities of individuals, especially when it comes to age. Börsch-Supan et al. (2013) stated that lifestyle affects cognitive abilities. Cognitive abilities are also influenced by daily activities (Atalay et al. 2019), including physical activity (Biazus-sehn et al. 2020) and social activity (Choi et al. 2016). The level of education also affects cognitive abilities (Banks and Mazzonna 2012). Other factors that affect cognitive abilities at work are the type of work and age at retirement (Bonsang et al. 2012, Banks and Mazzonna 2012, Mazzonna and Peracchi 2012, Hessel 2016). Job factors that affect the cognitive abilities of senior workers include the physical environment of work (Bantoft et al. 2015, Nexø et al. 2016, Torbeyns et al. 2016, MacNaughton et al. 2017, Yang et al. 2021), job demand (Grzywacz et al. 2016, Sabbath et al. 2016), the number of physical aspects involved at work, including stress caused by work (Fisher et al. 2017), work shift and working hours (Özdemir et al. 2013, Virtanen et al. 2009) and quality of sleep (Boland et al. 2015, Dijk et al. 2020). Job factors that also affect workers' cognitive abilities are work hours (Charles et al. 2020),

The issue of senior workers' ability to do jobs needs to be paid more attention as the current shift in jobs or industries, where Information and Communication Technology (ICT) is increasingly being used in jobs and industry, which is also known as industry 4.0. The Boston Consulting Group predicted that by 2025 the job demand for simple and repetitive tasks would continue to decline, as these activities can be standardized and replaced by machines. On the one hand, jobs that require cognitive abilities are increasing (Lorenz et al. 2015). This is in line with Industry 4.0, which is more dominated by cognitive activities related to increased automation, machine-to-machine, human-to-machine communication, artificial intelligence, and sustainable technology development. Therefore, to provide equal employment opportunities to senior workers, it is necessary to see whether there are differences in cognitive abilities between senior and younger workers so that interventions can later be given if gaps are found.

There are several methods to measure cognitive ability, from survey to experiment and simple to complex tools. Referring to Szulewski et al. (2017), there are generally two approaches to measuring cognitive ability: psychometric and physiologic tools. Psychometric measurements are easier to conduct than physiology due to the equipment requirements, time constraints, and ease of taking more samples. There are many psychometrical cognitive measurement methods, but only a few have been devoted to assessing age-related cognitive concerns. One of them is mental state examination methods. The first examination method was Mini-Mental State Examination (MMSE), which is the most widely used. It is a popular clinical measure that is available in many languages. In addition, the MMSE is also widely used in epidemiological studies and community surveys (Tombaugh and Mclntyre 1992). The second method is the Montreal-Cognitive Assessment (MoCA), which was developed by Montreal Cognitive Institute. The MoCA test was validated in the setting of mild cognitive impairment (MCI) and has been subsequently adopted in numerous clinical settings. The MoCA has greater sensitivity than the MMSE and readily detects mild impairment. It is useful when the only symptom is memory impairment, or physicians suspect cognitive impairment in individuals who score 25 points or better on the MMSE (Kaufman and Milstein 2013). The MoCA Assess short-term memory, visuospatial abilities, executive functions, attention, concentration, and working memory, language, and orientation to time and place. The third and newest method is Saint Louis University Mental State Examination (SLUMS).

SLUMS is a psychometrical cognitive measurement method commonly used to identify when there is a decline in cognitive function regarding aging. SLUMS is more sensitive than other methods, such as MMSE and MoCA (Szcześniak and Rymaszewska 2016, Tariq et al. 2006). SLUMS was developed to address this limitation. The SLUMS is a 30-point, 11-item, clinician-administered scale similar to the MMSE and MoCA format. Compared to others, the SLUMS enhanced tasks corresponding to attention, numeric calculation, immediate and delayed recall, animal naming, digit span, clock drawing, figure recognition/size differentiation, and immediate recall of facts from a paragraph. The maximum score for SLUMS is 30, it is the same with MMSE and MoCA, but in SLUMS, the score is divided into three categories: normal (27-30 for high school and more; 25-30 for less than high school), cognitive disorder (21-26 for high school and more; 20-24 for less than high school), and cognitive problem – dementia (1-20 for high school and more; 1-24 for less than high school).

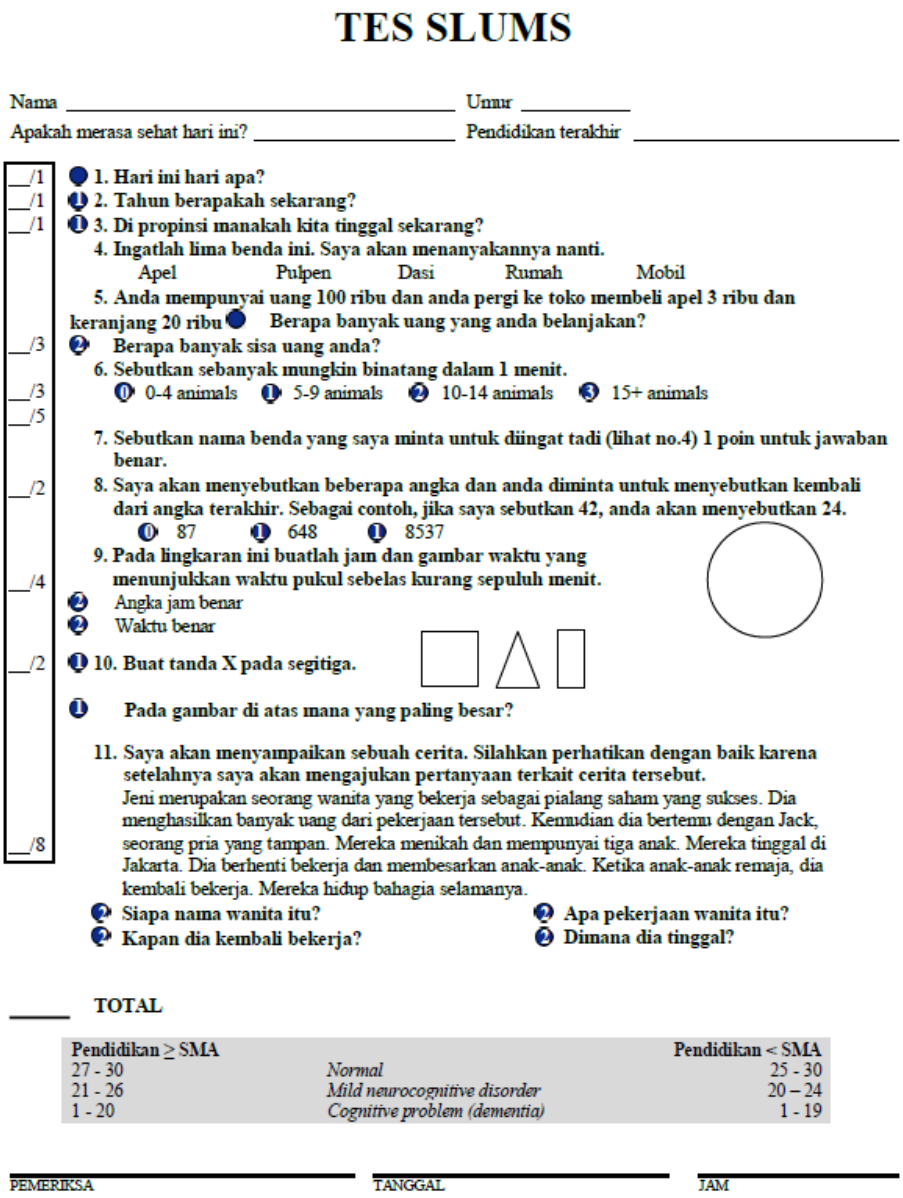
This study aims to identify whether senior workers' cognitive function is different from young workers. Suppose there are differences, what kind of cognitive aspects it is. This study is a pilot study of a plan to measure cognitive workers using psychometric and physiological methods.

From the results of previous studies, it was found that there were no significant cognitive differences between senior and younger workers (Brough et al. 2011). This is in line with a study conducted by Chung et al. (2015). Whereas in other studies regarding cognitive abilities related to increasing age, it was found that individual cognitive abilities will decrease with age (Salthouse 2012, Salthouse 2015, Salthouse 2009). Because of these differences, it is necessary to conduct a study on the cognitive abilities of these senior workers.

2. Methods

Ninety-three participants in this study are recruited from various work backgrounds. The recruitment is based on convenient sampling. Sixty-two senior workers are divided into two groups: thirty-one of them are in group 1, which is for those aged 52-56 years, and the others are in group 2, which is for those aged 57-61 years. Meanwhile, younger workers are fresh graduates who have worked for one to two years. Each participant is tested according to the questions on the SLUMS form (in the Indonesian language). The result is then processed by statistical analysis.

The SLUMS is made up of 11 tasks, which can give up to 30 points (Szcześniak and Rymaszewska 2016). The participant is asked to memorize five words. Next, the participant is asked to perform a simple mental math task, which evaluates the subject's arithmetic skills, abstract thinking, as well as his/her ability to concentrate. Categorical fluency is assessed when the subject is asked to name as many animals as possible in 1 minute. The researcher then asks the subject to recall the words he/ she had memorized earlier. This allows the assessment of delayed memory. Subsequently, the participant is asked to recall a sequence of numbers in reverse order, draw a clock (setting the hands at ten to eleven) and recognize geometric figures. The last task evaluates the subject's logical memory, whereby the researcher reads the subject a story, and he/she has to answer four questions connected to it (Szcześniak and Rymaszewska 2016). The test lasts for 10 – 20 minutes, and it takes longer for senior worker participants. The SLUMS questionnaire in Indonesia's language can be seen in Figure 4.



TES SLUMS

Nama _____ Umur _____

Apakah merasa sehat hari ini? _____ Pendidikan terakhir _____

__/1 1. Hari ini hari apa?

__/1 2. Tahun berapakah sekarang?

__/1 3. Di propinsi manakah kita tinggal sekarang?

4. Ingatlah lima benda ini. Saya akan menanyakannya nanti.
Apel Pulpen Dasi Rumah Mobil

5. Anda mempunyai uang 100 ribu dan anda pergi ke toko membeli apel 3 ribu dan keranjang 20 ribu. Berapa banyak uang yang anda belanjakan?

__/3 Berapa banyak sisa uang anda?

6. Sebutkan sebanyak mungkin binatang dalam 1 menit.

__/3 0 0-4 animals 1 5-9 animals 2 10-14 animals 3 15+ animals

__/5

7. Sebutkan nama benda yang saya minta untuk diingat tadi (lihat no.4) 1 poin untuk jawaban benar.

__/2 8. Saya akan menyebutkan beberapa angka dan anda diminta untuk menyebutkan kembali dari angka terakhir. Sebagai contoh, jika saya sebutkan 42, anda akan menyebutkan 24.
0 87 1 648 1 8537

9. Pada lingkaran ini buatlah jam dan gambar waktu yang menunjukkan waktu pukul sebelas kurang sepuluh menit.

__/4
2 Angka jam benar
2 Waktu benar

__/2 1 10. Buat tanda X pada segitiga.

1 Pada gambar di atas mana yang paling besar?

11. Saya akan menyampaikan sebuah cerita. Silahkan perhatikan dengan baik karena setelahnya saya akan mengajukan pertanyaan terkait cerita tersebut.
Jeni merupakan seorang wanita yang bekerja sebagai pialang saham yang sukses. Dia menghasilkan banyak uang dari pekerjaan tersebut. Kemudian dia bertemu dengan Jack, seorang pria yang tampan. Mereka menikah dan mempunyai tiga anak. Mereka tinggal di Jakarta. Dia berhenti bekerja dan membesarkan anak-anak. Ketika anak-anak remaja, dia kembali bekerja. Mereka hidup bahagia selamanya.

__/8
1 Siapa nama wanita itu? 1 Apa pekerjaan wanita itu?
1 Kapan dia kembali bekerja? 1 Dimana dia tinggal?

_____ TOTAL

Pendidikan ≥ SMA		Pendidikan < SMA
27 - 30	*Normal*	25 - 30
21 - 26	*Mild neurocognitive disorder*	20 – 24
1 - 20	*Cognitive problem (dementia)*	1 - 19

PEMERIKSA TANGGAL JAM

Figure 4. SLUMS Questionnaire in Indonesia language (adapted from SLUMS questionnaire in Tariq et al. (2006) and www.slu.edu/medicine)

3. Results and Discussion

Demographic data were summarized using descriptive analysis as in Table 1. This table shows that most of the participants aged 52 years old and more work out of the analysis and administration task, and vice versa with younger workers who mostly work in analysis and use of ICT area. The seniors with less than High School Education have no normal score for SLUMS. The average SLUMS score of seniors is also lower than the younger, it is by the study of Salthouse (2012, 2009) the decline of cognitive related to aging.

Table 1. Descriptive data by age, occupation, and education

Participants		Type of work; mean SLUMS score			Less than High School			High School and More		
					Normal	Cognitive Disorder	Cognitive problem	Normal	Cognitive Disorder	Cognitive problem
Group (N)	Age mean (SD)	Analysis & use of ICT	Administration & Clerical	Others	Mean (SD); N			Mean (SD); N		
Fresh Graduate	23.2 (0.9)	51%; 27.3	19.40%; 27.3	29%; 26.3	-	-	-	28.4 (0.8); N=21	24.2 (1.5); N=10	-
Senior 1 (52-56 yo)	53.2 (1.4)	12.90 %; 26.1	16.10%; 22.8	71%; 20.0	-	21.3 (0.6); N=3	15.3 (2.1); N=3	27.1 (1.2); N=8	22.6 (1.7); N-12	17 (4.1); N=5
Senior 2 (57-61 yo)	58.9 (1.6)	16.10 %; 23.4	22.60%; 22.8	61.30 %; 19.8	-	21 (4.5) N=5	16.1 (4.2) N=7	24, N=1	23 (2.9) N=14	22.5 (5.2) N=4

The breakdown of the score in Table 1 for each item of SLUMS is shown in Table 2. SLUMS item breakdown to related cognitive aspects which is used in MMSE and MoCA.

Table 2. SLUMS item discriminations as a function of age group

Cognitive Aspect	SLUMS Items	SLUMS Score (Max)	Fresh Graduate (Mean, SD)	Senior 1 (Mean, SD)	Senior 2 (Mean, SD)
Orientation	Day of the week	1	1 (0)	0.9 (0.2)	1 (0)
	Year	1	1 (0)	1 (0)	0.9 (1.2)
	State	1	1 (0)	1 (0)	1 (0)
Attention & Calculation	Calculation story problem Money spent *Money spent *Money left	3	2.8 (0.5)	2.5 (0.9)	2.5 (0.9)
Language	Animal naming	3	2.6 (0.4)	2.2 (0.7)	2 (0.6)
Memory	Delayed recall—five objects	5	4.2 (1.1)	3.3 (1.2)	3.1 (1.2)
Attention & Calculation	Digit span	2	1.9 (0.7)	1.5 (0.7)	1.2 (0.6)
Visuospatial	Clock drawing—numbers *Number *Time	4	3.6 (0.8)	2.7 (1.3)	2.3 (1.5)
Visuospatial	Identification—triangle Differentiation—figure size	2	2.1 (0.4)	1.9 (0.2)	1.9 (0.3)
Language	Immediate paragraph recall *Who (name) *What (work/job) *When (returned to work) *Where (state lived in)	8	6.6 (1.4)	4.7 (1.8)	5.1 (1.8)

Based on statistical analysis with Mann-Whitney test, there is significant difference of SLUMS score of fresh graduate with senior group 1 (p-value: 0.014 <0.05; confident level 95%) and with senior group 2 (p-value: 0.024 <0.05; confident level 95%), but there is no significant difference of SLUMS score of senior group 1 and senior group 2 (p-

value: 0.486 >0.05; confident level 95%). Simply, this means that there are cognitive differences between the young and the seniors, but there are no cognitive differences between the seniors in group 1 and group 2. This contrasts with what was found by Salthouse (2012, 2009), where the older the participant is, the lower his/her cognitive abilities. It can also be considered related to the average retirement age in Indonesia at 56 years old and may use an older cut-off.

A significant difference in visuospatial ability was found between fresh graduates and participants aged 52-56 years (p-value: 0.038 <0.05; confident level 95%), as shown in Table 3. There are no differences in other cognitive aspects. Visuospatial is the ability to understand, place, and direct forms, objects, or images. This ability allows individuals to analyze the shape and relationships between objects, their placement, and their components (Drag et al. 2010, Heinrichs 2020, Weintraub et al. 2018). In the work context, visuospatial skills are needed for jobs that require shape analysis, moving and shaping objects, and currently for jobs related to technology operations (Heinrichs 2020).

Table 3. Statistical test of SLUMS scores of fresh graduate and senior worker Group 1

	Orientation	Memory	Attention	Language	Visuospatial
Mann-Whitney U	18.000	8.000	15.500	8.500	6.000
Wilcoxon W	39.000	29.000	36.500	29.500	27.000
Z	.000	-1.648	-.527	-1.549	-2.072
Asymp. Sig. (2-tailed)	1.000	.099	.598	.121	.038
Exact Sig. [2*(1-tailed Sig.)]	1.000[b]	.132[b]	.699[b]	.132[b]	.065[b]
a. Grouping Variable: Age group: fresh grad vs senior 1					

Another significant difference in cognitive abilities was observed between fresh graduates and participants aged 57-61 years, specifically in language skills (p-value: 0.044 < 0.05; confident level 95%), as shown in Table 4. Meanwhile, the senior workers in Group 2 did not have significant differences in visuospatial with the fresh graduates, like the seniors in Group 1. Language ability in cognitive function is an individual's ability to digest words and sentences and use them comprehensively. This language ability is closely related to controlling cognitive ability in general, performing multitasking activities, and even affecting decision-making abilities (Li et al. 2014). In the context of work, this ability is needed to understand work quickly, especially in new types of tasks and demands to do multitasking work.

Table 4. Statistical test of SLUMS scores of fresh graduate and senior worker Group 2

	Orientation	Memory	Attention	Language	Visuospatial
Mann-Whitney U	15.000	11.500	13.000	5.500	10.500
Wilcoxon W	36.000	32.500	34.000	26.500	31.500
Z	-1.000	-1.065	-.962	-2.016	-1.369
Asymp. Sig. (2-tailed)	.317	.287	.336	.044	.171
Exact Sig. [2*(1-tailed Sig.)]	.699[b]	.310[b]	.485[b]	.041[b]	.240[b]
a. Grouping Variable: Age group: fresh grad vs senior 2					

Madonna et al. (2019) found that language and visuospatial are needed in work that uses ICT and automatization. Thus, it may be a challenge for a senior worker to do such work.

Referring to Salthouse (2015) regarding the relationship of work and activities on cognitive abilities, a statistical test was conducted to see if there was a significant relationship between the type of work and cognitive abilities. The result of the test in Table 5 shows that there is no correlation between the type of work and the SLUMS score in younger workers (p-value: 0.669 > 0.05; confident level 95%). Meanwhile, correlations were found in senior workers, both in Group 1 and Group 2. Based on the Pearson value in Table 5, the correlation between the SLUMS scores and the type of work is higher in senior workers in Group 1 (52-57 years old) than in Group 2 (57-61 years old).

Table 5. Correlation test between SLUMS score and type of work

	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals (2-tailed)[a]	
			Lower	Upper
Worktypefg - SLUMSFG	.080	.669	-.282	.422
Worktypes1 - SLUMSS1	.596	.000	.306	.784
Worktypes2 - SLUMSS2	.380	.035	.030	.647
a. Estimation is based on Fisher's r-to-z transformation.				

Education also correlated with the cognitive ability of senior workers. Table 6 shows the correlation test of education background (less or more than High School) with the SLUMS score in both groups of senior workers (52-56 and 57-61 years old). This result is aligned with the study by Banks and Mazzonna (2012), which found that the opportunity to extend higher education has a positive and significant causal effect on the old age memory of less-educated people.

Table 6. Correlation test between SLUMS score and education of senior workers

	Pearson Correlation	Sig. (2-tailed)	95% Confidence Intervals (2-tailed)[a]	
			Lower	Upper
EducationS1 – SLUMSS1	-.414	.021	-.670	-.069
EducationS2 – SLUMSS2	.508	.004	.187	.731
a. Estimation is based on Fisher's r-to-z transformation.				

Findings from this study imply that some effort is needed to improve the cognitive ability of senior workers, especially in language and visuospatial aspects. Enhancing senior workers' cognitive ability can help them adapt to the work related to analysis tasks and when technology (ICT) is used at work. Then, regarding no cognitive differences between senior workers aged 52-56 years and those aged 57-61 years, the cut-off age retirement could then be considered to be more than 56 years old, which is also recommended by the ILO (International Labor Organization 2015). Lastly, regarding the type of work and education that correlates with senior workers' cognitive ability, it implies that involving senior workers in an analysis task and extending the education could improve their cognitive ability.

4. Conclusion

This study shows significant cognitive differences between senior workers and younger workers, especially in language and visuospatial aspects. However, there are no cognitive differences in all cognitive aspects between senior workers aged 52-56 years and those aged 57-61years, which can be concluded that the cognitive ability of senior workers aged 52-61 years is the same. This study also found that the type of work does not correlate with the cognitive ability in the younger worker, while for senior workers, there are correlations between the type of work and cognitive ability. Moreover, Senior workers who interact with analysis tasks and ICT jobs have higher cognitive ability than those who do not do the analysis and ICT works. Furthermore, education also correlated with the cognitive ability of senior workers, whereas those with higher education also have higher cognitive abilities. In addition, senior workers with more cognitively demanding and productive occupations have positive implications for their cognitive function as well.

This study becomes essential in an aging society. Preventing or delaying the age-related decline in cognitive abilities can be done by giving analysis work and extending the education to senior workers. The lower ability in language and visuospatial skills will affect senior workers to interact with ICT jobs. Therefore, further research needs to develop methods to enhance senior workers' language and the visuospatial ability for them to fit with the future type of work that mainly uses ICT.

References

Atalay, K., Barrett, G. F., and Staneva, A., The effect of retirement on elderly cognitive functioning, *Journal of Health Economics*, vol. 66, pp. 37–53, 2019.

Badan Pusat Statistik, *Proyeksi Penduduk Indonesia 2010-2035*, 1st Edition, BPS-Statistics, Jakarta, 2013.

Badan Pusat Statistik, *Statistik Penduduk Lanjut Usia Di Indonesia 2019*, BPS, Jakarta, 2019.

Banks, J., and Mazzonna, F., The effect of education on old age cognitive abilities: evidence from a regression discontinuity design, *Economic Journal*, vol. 122, no. 560, pp. 418–48, 2012.

Bantoft, C., Summers, M. J., Tranent, P. J., Palmer, M. A., Cooley, P. D., and Pedersen S. J., Effect of standing or walking at a workstation on cognitive function : a randomized counterbalanced trial, *Human Factors*, vol. 58, no.1, 2015.

Biazus-sehn, L. F., Barreto, F., Firth, J., and Souza, F. D., Effects of physical exercise on cognitive function of older adults with mild cognitive impairment : a systematic review and meta-analysis, *Archives of Gerontology and Geriatrics*, vol. 89, 2020.

Bixter, M. T., Blocker, K. A., and Rogers, W. A., 8-Enhancing social engagement of older adults through technology, *Aging, Technology and Health,* vol. 8, pp. 179-214, 2018.

Boland, E. M., et al., Associations between sleep disturbance, cognitive functioning and work disability in Bipolar Disorder, *Psychiatry Research*, vol. 230, no. 2, pp. 567–74, 2015.

Bonsang, E., Adam, S., and Perelman, S., Does retirement affect cognitive functioning, *Journal of Health Economics*, vol. 31, no. 3, pp. 490–501, 2012.

Börsch-Supan, A., et al., Data resource profile: the survey of health, ageing and retirement in Europe (share), *International Journal of Epidemiology*, vol. 42, no. 4, pp. 992–1001, 2013.

Boston University School of Public Health: Cognitive changes with aging, Available: https://sphweb.bumc.bu.edu/otlt/MPH-Modules/PH/Aging/mobile_pages/Aging5.html, 2013.

Brough, P., Jhonson, G., Drummond, S., Pennisi, S., and Timss, C., Comparisons of cognitive ability and job attitudes of older and younger workers, *Equality, Diversity, and Inclusion: An International Journal*, vol. 30, no. 2, pp. 105–26, 2011.

Charles, L. E., et al., Work hours and cognitive function: the multi-ethnic study of Atherosclerosis, *Safety, and Health at Work*, vol. 11, no. 2, pp. 178–86, 2020.

Cheung, F., and Wu, A. M. S., Older workers' successful aging and intention to stay, *Journal of Managerial Psychology*, vol. 28, no. 6, pp. 645–60, 2013.

Choi, Y., Park, S., Cho, K. H., and Chun, S. Y., A change in social activity affect cognitive function in middle-aged and older Koreans : analysis of a Korean Longitudinal Study on Aging (2006 – 2012), *International Journal of Geriatric Psychiatry*, vol. 31, no. 8, 2016.

Chung, J., et al., A study on the relationships between age, work experience, cognition, and workability in older employees working in heavy industry, *Journal of Physical Therapy Science*, vol. 27, no. 1, pp. 155–57, 2015.

Converso, D., Sottimano, I., Guidetti, G., Loera, B., Cortini, M., and Viotti, S., Aging and workability : the moderating role of job and personal resources, *Frontiers in Psychology*, vol. 8, no. 2262, 2018.

Dijk, D. M. V., Rhenen, W. V., Murre, J. M. J., and Verwijk, E., Cognitive functioning, sleep quality, and work performance in non-clinical burnout: the role of working memory, *PLoS ONE*, vol. 15, no. 4, pp. 1–22, 2020.

Drag, L. L., Bieliauskas, L. A., Langenecker, S. A., and Greenfield, L. J., Cognitive functioning, retirement status, and age: results from the cognitive changes and retirement among senior surgeons study, *Journal of the American College of Surgeons*, vol. 211, no. 3, pp. 303–7, 2010.

Findsen, B., Older workers' learning within organizations: issues and challenges, *Educational Gerontology*, vol. 41, no. 8, pp. 582–89, 2015.

Fisher, G. G., Chaffee, D. S., Tetrick, L. E., Davalos, D. B., and Potter G. G., Cognitive functioning, aging, and work: review and recommendations for research and practice, *Journal of Occupational Health*, vol. 22, no. 3, pp. 1–23, 2017.

Galy, E., Cariou, M., and Mélan, C., What is the relationship between mental workload factors and cognitive load types, *International Journal of Psychophysiology*, vol. 83, no. 3, pp. 269–75, 2012.

Grzywacz, J. G., Segel-karpas, D., and Lachman, M. E., Workplace exposures and cognitive function during adulthood : evidence from a national survey of midlife development and the O Ã NET, *Journal of Occupational and Environmental Medicine*, vol. 58, no. 6, pp. 535–41, 2016.

Heinrichs, R. W., The duality of human cognition: operations and intentionality in mental life and illness, *Neuroscience and Biobehavioral Reviews*, vol. 108, pp. 139–48, 2020.

Heryanah, H., Ageing population dan bonus demografi kedua di Indonesia, *Jurnal Populasi*, vol. 23, no. 2, pp. 1–16, 2015.

Hessel, P., Does retirement (really) lead to worse health among European men and women across all educational levels? *Social Science and Medicine*, vol. 151, pp. 19–26, 2016.

Ilmarinen, J. E., Aging workers, *Occupational Environment Medicine*, vol. 58, no. 8, pp. 546-552, 2005.

International Labour Organization, Older Workers: What Age Means for the Labour Force, Available:

https://www.ilo.org/global/about-the-ilo/multimedia/audio/WCMS_358943/lang--en/index.htm.

Kaufman, D. M., and Milstein, M. J., *Kaufman's Clinical Neurology for Psychiatrists: Dementia*, 7th Edition, MD Departments of Neurology and Psychiatry Montefiore Medical Center Albert Einstein College of Medicine Bronx, New York, 2013.

Kolz, A. R., Mcfarland, L. A., and Stanley B., Cognitive ability and job experience as predictors of work performance, *The Journal of Psychology : Interdisciplinary and Applied*, vol. 132, no. 5, pp. 37–41, 2010.

Kuncel, N. R., Ones, D. S., and Sackett, P. R., Individual differences as predictors of work, educational, and broad life outcomes, *Personality and Individual Differences*, vol. 49, no, 4, pp. 331–36, 2010.

Li, H., et al., Trajectories of age-related cognitive decline and potential associated factors of cognitive function in senior citizens of Beijing, *Current Alzheimer Research* vol. 11, no. 8, pp. 806–16, 2014.

Lorenz, M., Rüßmann, M., Strack, R., Lueth, K., and Bolle, M., Engineered product & infrastructure, digital transformation, strategy: man and machine in industry 4.0 how will technology transform the industrial workforce through 2025?, Available: https://www.bcg.com/publications/2015/technology-business-transformation-engineered-products-infrastructure-man-machine-industry-4.

MacNaughton, et al., The impact of working in a green-certified building on cognitive function and health, *Building and Environment*, vol. 114, pp. 178–86, 2017.

Madonna, M., Monica, L., Anastasi, S., and Nardo, M. D., Evolution of cognitive demand in the human-machine interaction integrated with industry 4.0 technologies, *WIT Transactions on the Built Environment*, vol. 189, pp. 13–19, 2019.

Mark, B., and Hughes, D. J., Individual difference correlates of self-perceptions of creativity, *The Creative Self*, vol. , 185–218. http://dx.doi.org/10.1016/B978-0-12-809790-8/00011-X, 2017.

Maylasari, I., Rachmawati, Y., Wilson, H., Nugroho, S. W., Sulistyowati, N. P., Dewi, and F. W. R., *Statistik Penduduk Lanjut Usia 2019*, 1st Edition, BPS-Statistics, Jakarta, 2019.

Mazzonna, F., and Peracchi, F., Ageing, cognitive abilities and retirement, *European Economic Review*, vol. 56, no. 4, pp. 691–710, 2012.

Mccarthy, J., Heraty, N., Cross, C., and Cleveland, J. N., Who is considered an 'older worker'? extending our conceptualization of 'older' from Organisational Decision Maker Perspektif, *Human Resource Management Journal*, vol. 24, no. 4, pp. 374–93, 2014.

Nexø, M. A., Meng, A., and Borg, V., Can psychosocial work conditions protect against age-related cognitive decline ? results from a systematic review, *Occupational Environment Medical*, vol. 73, pp. 487–96, 2016.

O'Regan, C., Cronin, H., and Kenny, R. A., The Irish longitudinal study on aging: Mental Health And Cognitive Function, Trinity College Dublin, Ireland, 2016.

Ogawa, K., Kawamura, T., and Matsushita, K., Research in economics effects of cognitive ability and age on giving in dictator game experiments, *Research in Economics*, vol. 74, no. 4, pp. 323–35, 2020.

Özdemir P. G., et al., The influence of shift work on cognitive functions and oxidative stress, *Psychiatry Research*, vol. 210, pp. 1219–25, 2013.

Sabbath, E., Andel, R., Zins, M., Goldberg, M., and Berr, C., Domains of cognitive function in early old age: which ones are predicted by pre-retirement psychosocial work characteristics?, *Occupational and Environmental Medicine*, vol. 73, no. 10, pp. 640-7, 2016.

Salthouse, T. A., Consequences of age-related cognitive declines, *Annual Review of Psychology*, vol. 63, pp. 201–26, 2012.

Salthouse, T. A., Do cognitive interventions alter the rate of age-related cognitive change, *Intelligence*, vol. 53, pp. 86–91, 2015.

Salthouse, T. A., When does age-related cognitive decline begin?, *Neurobiology of Aging*, vol. 30, no. 4, pp. 507–14, 2009.

Shacklock, K., Brunetto, Y., and Shacklock, K., A model of older workers' intentions to continue working, *Personnel Review*, vol. 40, no. 2, pp. 252–75, 2011.

Szcześniak, D., and Rymaszewska, J., The usefulness of the SLUMS Test for diagnosis of mild cognitive impairment and dementia, *Psychiatria Polska*, vol. 50, no. 2, pp. 457–72, 2016.

Tariq, S. H., Tumosa, N., Chibnall, J. T., Perry, M. H., and Morley, J. E., Comparison of the Saint Louis University mental status examination and the mini-mental state examination for detecting dementia and mild Neurocognitive Disorder - a pilot study, *American Journal of Geriatric Psychiatry*, vol. 14, no. 11, pp. 900–910, 2006.

Tombaugh, T. N, and Mclntyre, N. J., The mini-mental state examination, *Progress in Geriatrics*, vol. 40, no. 9, pp. 922–35, 1992.

Torbeyns, T., et al., Bike desks in the office : physical health, cognitive function, work engagement, and work performance, *Journal of Occupational and Environmental Medicine*, vol. 58, no. 12, pp. 1257–63, 2016.

Vasconcelos, A. F., Older workers as a source of wisdom capital : broadening perspectives, *Revista de Gestao*, vol. 25, no. 1, pp. 102–18, 2018.

Virtanen, M., et al., Long working hours and cognitive function : the Whitehall II study, *American Journal of Epidemiology*, vol. 169, no. 5, pp. 596–605, 2009.

Weintraub, S., et al., Measuring cognition and function in the preclinical stage of Alzheimer's disease, *Alzheimer's and Dementia: Translational Research and Clinical Interventions*, vol. 4, pp. 64–75, 2018.

World Health Organization, Decade of Healthy Ageing 2020-2030, Available: https://www.who.int/publications/m/item/decade-of-healthy-ageing-plan-of-action.

Yang, L., Wu, J., Hu, Z., Gao, F., and Hu, X., Effects of workload on human cognitive performance of exposure to an extremely cold environment, *Physiology, and Behavior,* vol. 230, pp. 113296, 2021.

Biographies

Kristiana Asih Damayanti is a Ph.D. student in the Department of Industrial Engineering and Management, Institut Teknologi Bandung, Indonesia, and also a faculty member of the Industrial Engineering Department, Universitas Katolik Parahyangan, Indonesia. She is researching cognitive aging, especially in senior workers.

Ari Widyanti is an Associate Professor in the Department of Industrial Engineering and Management, Institut Teknologi Bandung, Indonesia. She earned bachelor's and master's degrees from ITB, and a Ph.D. degree from the University of Groningen, the Netherlands. Her research interest includes cognitive ergonomics and usability engineering.

Yassierli is a Professor in the Department of Industrial Engineering and Management, Institut Teknologi Bandung, Indonesia. His bachelor's and master's degrees from ITB, and a Ph.D. degree from Virginia Polytechnic Institute and State University, USA. His research interest is in industrial ergonomic and occupational safety.