Industry 4.0 critical skills and career readiness of ASEAN TVET tertiary students in Malaysia, Indonesia and Brunei

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Abstract. Industry 4.0 is a time of serious disruptions whereby monumental changes are happening in the world of work, in the ways we teach and learn, and in the ways that we live our lives. Increased automation coupled with artificial intelligence are making humans obsolete, for instance, in the manufacturing and service industries. Intelligent machines are useful but human beings are losing livelihoods or becoming trapped in the ‘gig economy’. This empirical study collected and examined qualitative data related to Industry 4.0 critical skills outlined by the World Economic Forum from ASEAN student leaders at five tertiary polytechnics in Brunei, Indonesia and Malaysia. ‘Netnography’ data collection instruments were employed namely online interviews and group discussions within a cloud-based instant messaging and VOIP service together with face-to-face focus group discussions, where permissible. Results do not look too promising with a number of the participants still in the dark about what skills they need to acquire for Industry 4.0 and how they must hone those skills before they enter an uncertain world of work in 2020 and beyond. Clearly, ASEAN nations must move fast, un-train and retrain tertiary students in the vital skills needed to survive and succeed in the post-Industry 4.0 era.

1. Introduction

Whether we realise it or not, and regardless of what we think about the topic, the 4th Industrial Revolution is already starting to change the world around us. In a time when great changes are happening, seemingly at the blink of an eye, the action to take is to prepare to face the challenges of tomorrow, today. In the sphere of education or in the world of work, preparing for an era full of ‘disruptions’ will not be easy, but it must be done so that we can remain relevant and become more competitive. The World Economic Forum or WEF in its biennial ‘Future of Jobs Report’ lists ten indispensable skills for the Future of Work for year 2020 and beyond [1]: Solving complex problems, thinking critically, thinking creatively, managing other people, coordinating with other people, having emotional intellect, judging and making decisions, orientating towards service, having the ability to negotiate, and possessing flexibility of intellect. These skills used to be viewed as ‘soft’ skills, but they are now seen as critical and extremely vital for career entry and towards future career readiness [2]. Without a shadow of doubt, for the Industry 4.0 era and beyond, these skills will no more be seen as merely soft or inferior skills compared to technical and vocational skills, but as critical and vital skills that are required not just to endure but also to flourish in the workplace of the future [3].
Without these critical and vital skills, not only will the future generation of workers fail to secure future-oriented jobs, but they might also be unable to contribute to the Industry 4.0 economy and society at large, in a more industrious manner. As it is, these critical and vital skills are challenging for the younger generation to acquire without directed and sustained effort. Thus, tertiary education institutions must come to fore as one of the proving grounds to train critical and vital Industry 4.0 skills. This is due to the fact that, failure to acquire these skills will lower the career readiness levels of the younger generation of future workers. The construct of career readiness is linked to the idea of a notional bridge or preparatory stage that will signal the crossing from ‘campus life’ at colleges and universities into the real world of employment or ‘working life’ [4]. It is likely that tertiary level students who are not ready for future-oriented careers will find it hard to enter the job market of the future. As proposed by the National Association of Colleges and Employers in the United States [5]:

The career readiness of [university level] graduates is an important issue in tertiary education, the labor market, and the public arena. Yet, up until now, “career readiness” has been undefined, making it difficult [for us] to ensure the career readiness of today’s graduates.

The above is an important construct because it emphasises the teaching of skills that learners will need, to thrive in the future world of employment [6] [7]. This might sound like a no-brainer for those who have a high level of professionalism or skills in entrepreneurship [8]. Nevertheless, in the sphere of education, the focus on the past has always been on the teaching of theories rather than the acquisition and learning of applicable skills [9] [10]. This situation has led to a crisis in secondary and tertiary education, frequently referred to as the ‘skills gap’. The skills gap is the discrepancy between the skills that employers want from prospective workers and the skills that prospective workers actually possess. Simply put, employers are not going to waste time and money re-teaching and re-skilling their fresh employees with specific competences that the latter should have already possessed; companies want their new employees to start working with relevant skills that they already have from the outset. Nevertheless, many tertiary students are not getting the exposure to the relevant and correct work-related skills. Consequently, the result is a bizarre discrepancy between what companies want from their new employees and what recent college and university graduates can actually offer to their prospective employers. Career readiness tries to bridge and close this critical gap.

2. Review of research literature
The introduction section highlights key constructs addressed in this empirical research paper. This current section defines and reviews those constructs to elucidate the links between critical Industry 4.0 skillsets and the future world of work, to answer this research question: Are ASEAN tertiary level students ready to face an era full of job market and work-related disruptions?

2.1. Critical and vital Industry 4.0 skillsets for future-oriented workers
Schwab [11] highlights not just the problems that the next industrial revolution might give rise to but also some of the opportunities that it might bring as technological developments push to combine different domains from physical realities to biological systems to digital innovations. In Schwab’s own words, apart from both rapidity and scope, “The fourth industrial revolution is unique because of the growing harmonization and integration of so many different disciplines and discoveries” (p. 15). For the layperson on the street, the easiest way to make sense of what is happening is by looking for patterns of disruptions. For instance, an Industry 4.0 enterprise today does not need to have a physical premise to operate from. In fact, this business venture might be staffed by just one or very few individuals but making profits that will make larger factories envious. Ideas, in the here and now, have the power to create wealth and ‘knowledge products’ are fast becoming tangible commodities that are sold and bought across the globe. Accordingly, the keyword that Schwab and other proponents of Industry 4.0 keep repeating is disruption [3] because, with reference to Industry 4.0 processes, disruption is not viewed in negative light [12]. In this sense, the disruptions brought by the 4th
Industrial Revolution also bring opportunities for growth that must be managed and faced head on. As Schwab sees it [11]:

The reality of disruption and the inevitability of the impact it will have on us does not mean that we are powerless in the face of it. It is our responsibility to ensure that we establish a set of common values to drive policy choices and to enact the changes that will make the fourth industrial revolution an opportunity for all. (p. 17)

The disruptions brought by Industry 4.0 can indeed be managed through education and training, particularly at tertiary level (i.e., in colleges and universities) [3], with directed focus on the acquisition of ten critical and vital Industry 4.0 skills as follows [1] [13]. Figure 1 depicts these vital skills graphically for ease of understanding.

**Figure 1.** Ten vital skills for Industry 4.0 as espoused by the WEF (edited and adapted)

The first critical/vital skill is solving complex problems. All future professions will require a degree of complex problem solving skills that should include subskills like breaking down problems into more manageable parts and combining solutions from intricate situations. The second critical/vital ability is being able to engage in critical thinking. This is the capacity to reason clearly, rationally and reasonably about what must be done or what could be believed. Critical thinkers can definitely become assets to their work organisations. The third critical/vital ability for future workers is being able to engage in creative thinking. Creativity is termed as the propensity to generate and to recognise novel concepts, opportunities or options that might be valuable in resolving different problems. Creative people are ‘ideas people’ who can regenerate the working processes in all working environments. The fourth is managing humans or people management. People management or people-related skills are indispensable for long-term career success because good people managers are really leaders who can get great things done without much oversight. The fifth is coordinating one’s work and one’s self
together with other people. Coordinating and working with other people are related to the capacity to organise the formal workflow to contribute to carrying out a task and also to deliver support to complete a given group effort. Coordinating also incorporates other critical/vital subskills such as, focusing on several tasks or activities at once, and arranging and changing focus as needed (i.e., the capacity to multi-task).

The sixth very important skill for the workplace for year 2020 and beyond in the Industry 4.0 era is the capacity to show emotional intellect or intelligence. This is the propensity to comprehend and cope with and use an individual’s feelings to release stress, to communicate, to show empathy, to rationally deal with problems and also to solve teething conflicts. The seventh skill is related to judging and making rational decisions. Judgement is the capacity to arrive at logical conclusions and measured choices. Judging followed by deciding must be done in tandem but both abilities need much practice and years of experience. The eighth skill is showing an orientation towards service and serving others. This skill relates to positive personality traits and an employee’s attitude to be obliging, considerate and always co-operative with other people. It is easy to imagine that workers with positive service orientation will be able to serve a company’s clients to the best of her or his abilities. The ninth skill for the Industry 4.0 epoch is showing an ability to negotiate matters. Negotiation necessitates a subset of interpersonal and communication skills so that positive results can be achieved for two or more parties (i.e., to arrive at ‘win-win’ outcomes for all involved in the negotiation process). The tenth and last critical/vital skill is being able to show flexibility in one’s thinking processes or cognitive flexibility for short. This skill is strongly linked to the capacity to change between dissimilar personas or roles, to switch between thinking of two or more concepts that do not connect and also to think about many different concepts or ideas at the same time. With all the ten skills, tertiary students in colleges, polytechnics and universities should be able to weather the challenges of Industry 4.0 better than others who do not possess them.

2.2. The career readiness of future-oriented workers in the Industry 4.0 era

The 4th Industrial Revolution will see developments in novel and cutting-edge technologies for instance artificial intelligence (AI), augmented and virtual reality environments for different applications from entertaining to learning to working (AR and VR), big data analytics for various uses and the Internet of Things to connect machines together (IoT) [14] [15]. These technological advancements, when adapted to and applied within the workplace, will enable radical ways to perform labour, bringing prospects for value creation to different industries and other interested stakeholders. Industry 4.0 is quickly altering the types of work that we do and how our work is performed. Because of these rapid changes, today’s tertiary graduates cannot stand to be left behind. In the next 10-20 years, today’s graduates will face newer and even more difficult challenges in the workplace, according to Deloitte’s global reports [16] [17]. In terms of readiness for the Industry 4.0 workplace, do students or would-be graduates in the ASEAN region know the essence of Industry 4.0 and how this will bear upon their future careers? In addition, are they really ready and prepared for the swiftly changing digitalised workplace landscape? These questions desperately need to be answered.

The construct of career readiness can explain whether tertiary students are ready to look for jobs and establish a career of their choosing. It is also a process of preparing students with the skills to acquire, maintain, and grow within a job [6] [7]. Yet, there is an often confusing mix of definitions, frameworks, policies and strategies for career readiness as an academic and social construct. The National Association of United States Colleges and Employers [5] established a classification, based on input from employers; the association expresses career readiness as the fulfilment and demonstration of essential abilities, aptitudes and propensities by future ready graduates that mark an effective changeover into their future places of work. The association also highlights eight competencies that are related to the notion of career readiness: Critical thinking and problem solving; very good verbal and written communiqué; working together with others in designated teams; knowledge of digital advancements; future oriented leadership; professional identity and labour ethics; positive job management; and finally, universal or intercultural know-how. Career readiness thus incorporates everything that a tertiary level student needs to know to launch a fruitful working life,
along with all of the accomplishments, stability and social mobility that entails. Figure 2 illustrates the eight competencies related to the notion of career readiness as explained in this paragraph.

With Industry 4.0 advancing, employers are definitely looking for a greater mix of skills in their future employees, including an amalgamation of both procedural, vocational and soft skills, with a strong capacity for creative thoughts and actions [2]. According to Carnevale, Smith and Strohl [18] the present global labour force needs future workers who can work in middle skilled and highly skilled jobs that will involve a blend of procedural and technical skills, and also theoretical knowledge. Nevertheless, employers presently struggle to find such competent future-oriented workers in abundance [19] [20]. Deloitte [16] [17] too highlights the importance of ‘core’ human capabilities (traditionally termed as soft skills in research literature in this discipline) like thinking creatively, solving seemingly impossible problems, building new social and business networks, communicating accurately and proficiently, showing emotional intellect and also being able to think critically.

**Figure 2.** Eight competencies in Career Readiness as defined by the NACE (edited and adapted)

What is most crucial is that preparing for the future must start by emphasising career readiness amongst today’s graduates. Career readiness should be seen as the foundation of workplace success, from the initial job search to maintaining continuous employment for the longest time. Since the landscape of the Industry 4.0 work environment will be complex and multifaceted, the best approach to prepare future-oriented tertiary graduates should be to shape their thoughts and then to provide a strong foundation to develop relevant skillsets prior to graduation. This should support them to find and to secure gainful employment.

2.3. *Getting prepared for a future world of work full of serious and sudden disruptions*

The rapid strides toward Industry 4.0 will change the future of work starting with how employers demand skillsets that will affect graduate employability in future [21]. Other studies found that the unemployment rate among youths is rapidly rising due to critical skills mismatch [17]. In 2020, the World Economic Forum [22] believes that most of the current work-related skills will possibly not be considered crucial or vital in most occupations. Another study on engineering students and employers found that the students focus more on technical skills compared to employers who value more
personal and behavioural attributes in their workers [23]. This mismatch might result in even higher rates of unemployment among tertiary undergraduates of the future. Indeed, the employment landscape has changed over the years where there are now major transformations in Industry 4.0 business models. Major transformations in new technologies and the integration of high-tech programs with physical systems drive employers to demand for a steady supply of skilled human capital so as to align with innovations practised by their respective organizations.

Surveys conducted by the United Nations [24] [25] show that there are currently 1.8 billion youths between the ages of 15 and 29 years. Asia’s youth population remains stable whilst Africa’s youths are increasing rapidly. The latter is anticipated to dominate more than 50% of the world’s youth populace by year 2050 [26]. In Malaysia, the Department of Statistics Malaysia [27] notes that there are 14.6 million youths aged between 15 and 39. The statistics indicate that the current majority population is dominated by youths. And, they are expected to become prime movers to boost the national economy by contributing to the nation’s workforce. By 2030, it is predicted that 50% of two billion youths around the globe will be ill equipped with the aptitudes, capabilities or formal learning required to enter the global labour force [16] [17]. Much attention has also been focused on the unemployment rates of recent graduates from various fields of academic study. Data show that 35% of unemployed graduates are from the social sciences, commerce and law fields followed by engineering, applied industrial fields and construction technologies with 24.1% of unemployment whilst science, mathematics and computing are at 11.3% [28]. Malaysia produces a notable number of educated graduates, that being said Khazanah Research Institute [29] found that the annual unemployment rate increased steadily from 9.94% in 2011 to 10.92% in 2018. The latest figure is an alarming sign for Malaysian youths, especially in the coming years since Malaysia is moving forward to the post-Industry 4.0 era. It is expected that the same challenges, difficulties and problems that Malaysian youths face are also applicable to youths from other nations in the South East Asian (ASEAN) region, as this empirical research will show.

3. Methods for research and data collection procedures
This research project collected and examined ‘thick’ qualitative data [30] [31] related to the ten Industry 4.0 critical and vital skills as outlined by the World Economic Forum [13] [22] from 39 student leaders (n = 39) from five different tertiary polytechnics in Brunei, Indonesia and Malaysia; one polytechnic each in Brunei and in Indonesia, and three in Malaysia. These student leaders are alumni of an ASEAN level experiential ‘summer camp’ training program that focuses specifically on critical Industry 4.0 skills and abilities [3].

The experiential summer camp training program is only open to student leaders for two reasons. First, they are in a position to influence other students at their respective polytechnics. And second, they are the cream of the cream, as it were, being the best students in their tertiary polytechnics not just in terms of their academic grades but also in having the soft skills and potentials to become future-oriented workers and even organizational spearheads. The 39 student leaders were between 21 to 24 years old (during the time of writing), and they are nearly equally represented in terms of gender with 22 males (56%) and 17 females (44%). The population under study were either in the second last or last semester (final year) of studies in different technical and vocational fields vying either for their diplomas or first degrees. Data were collected in 2018 and early 2019.

Kozinets’ [32] ‘Netnography’ data collection instruments were employed namely online interviews and group discussions within a cloud-based instant messaging and VOIP service together with face-to-face focus group discussions, where permissible (mainly for the participants from within Malaysia) [33] [34]. The online interviews and group discussions were organised within the cloud-based instant messaging and VOIP service, and express permissions were sought from the participants prior to actual data collection. Permissions were also sought from participants of the face-to-face focus group sessions. That being said, only data from the cloud-based instant messaging and VOIP service (i.e., WhatsApp) will be presented in this research paper due to the large body of textual data collected from our fieldwork. Several questions or prompts were posed during the data collection period relating to ten critical skills for Industry 4.0, as depicted in Figure 1. As the norm in fully qualitative research
efforts, data gathering and analysing happened in unison due to the close relationships between the lead researcher and our research participants.

4. Presentation and analysis of ‘thick’ qualitative data from this empirical study
Salient data from this research project are presented and analysed below, based on key themes that emerged from reading, analysis and further re-reading of the data. As the data were collected online in textual form, any ambiguities were quickly dealt with allowing for better co-construction of the data and making sure that only what the participants really wanted to say were collected and critically analysed. The names provided are fictitious names selected by the participants to guard their real selves. At the same time, the quotes that they provided are minimally edited to preserve the meanings of what they wanted to express, although translations were necessary as most of them mixed English with Bahasa Malaysia, Bahasa Indonesia or Bahasa Melayu Brunei (Malay language, Indonesian Malay language or Brunei Malay language).

4.1. “Industry 4.0? What Industry 4.0?” - Confusion and ignorance
The 39 participants described themselves as being “really lucky” to be able to join the ASEAN level experiential summer camp training program on critical and vital Industry 4.0 skills. As ‘Mister Bear’ from ‘Polytechnic of Selangor, Malaysia’ explained: “The biggest problem is that us students hear about Industry 4.0 all the time. But no one, I mean no one, actually comes to us and tries to teach us about Industry 4.0 and how to prepare for it.” This has led to many tertiary students getting confused and they ended up just ignoring the whole notion of Industry 4.0. ‘Malikha’ from ‘Polytechnic of Indonesia’ lamented:

It’s the same story in my country actually. Our President always talks about Industry 4.0 and we read about it in the online news. We also know that our country spends a lot of money on Industry 4.0 but at our campus the lecturers just teach the normal subjects. They don’t talk about the critical skills or career readiness… I guess maybe they’re confused too. I think, of course, it will get better, but I want all my lecturers to really focus and teach us how to fully prepare for this Industry 4.0 thing. I’m okay, I already know even if it’s just a bit. But what about all my juniors?

For ‘Juliana’ from ‘Polytechnic of Brunei’, the issue is very serious because she thinks many of the juniors in her tertiary institution are still quite ignorant about what Industry 4.0 really entails. She feels that the current economic prosperity that her country relishes in is making the younger population too comfortable. She commented:

For my country, the situation is serious. As you might know, our country is running out of oil. So, we need to prepare for Industry 4.0. When the oil runs out – and it’ll run out, no doubt about that – what jobs can we do? Young people will definitely become unemployed just when we graduate. What then? I think the government is doing a lot to diversify the economy. But for me, that’s besides the point. The point is what are we, the young people doing, to prepare for an uncertain future? As a student leader, I’m trying to open the eyes of all my juniors right now. Yes, we’re a rich country now. But the future will be full of disruptions!

4.2. “Are we learning all the so-called relevant skills?” - Low levels of preparedness
The issue of career readiness was also raised many times, by nearly all of the participants. They worry that their juniors especially, will not have the necessary skills to secure Industry 4.0 related jobs and have to “become slaves of the Gig Economy”. ‘Danish’ from ‘Polytechnic of Penang, Malaysia’ had this to say: “I’m worried that my juniors and young people like us will become slaves of the Gig
Economy. Are we all going to be Food Panda delivery people? Or just drive our Grab cars in the future?” Danish and the other Malaysian participants also mentioned that in Malaysia, the starting salary for junior entrants in the labour force seems to be stuck in the 1980s and 1990s. Due to this, some of their seniors have to “accept their fates” and become food delivery personnel, ride hailing drivers and do other types of Gig Economy work, even though they possess tertiary level diplomas and degrees. ‘Altair’ from ‘Polytechnic of Indonesia’ added her point of view:

I think that young people in ASEAN are not learning the proper skills for this Industry 4.0. Also, even if we have skills, work is not guaranteed for us… before you know it, there’ll be machines that can do things better and faster. Even in our country, some of the big fast food restaurants now they’re using machines to take orders and we see the same thing at some cinemas and even at our larger airports. Imagine! You learn Business Management to become a fast food service Manager but then these places don’t need Managers anymore because machines are there. So then, what job can you get with your lame ass degree that you spent millions and millions [Indonesian Rupiah] on?

Without a doubt, not all of the participants view the Industry 4.0 era in positive light. Some of them see it as a “conspiracy”. In the words of ‘Jessica’ from ‘Polytechnic of Brunei’: “You know what? I think this Industry 4.0 is really about rich people getting richer and richer. Normal people like me, young people also, we just stay at the bottom level and try to live with our small salaries.” Jessica and some of the other participants strongly believe that even though they have the right qualifications, and the critical and vital skills needed for Industry 4.0 jobs, they all might end up just doing lowly paid jobs, short term contract jobs and other jobs that do not come with normal and expected job security because of the way the world is rapidly changing around us.

4.3. “We can’t imagine what the future would bring…” - Disruptions and uncertainties
Thinking about the future should bring a sense of wonder if not optimism, especially for a group of 39 young and active student leaders who are the crème de la crème of their tertiary institutions. However, after they have learned and acquired the ten critical Industry 4.0 skills through the ASEAN level experiential summer camp training program, more uncertainties abound compared to optimism. According to ‘Sheila’ from ‘Polytechnic of Perak, Malaysia’, the future is quite scary for her and her peers. She explained, “I’m an engineering student right and I focus on public works. Okay, so I have all the Industry 4.0 skills already and I’m happy. But, can I be sure that I’ll get a job as soon as I graduate?” The fear she felt is due to the fact that some branches of engineering are becoming obsolete or do not require new entrants in the near future. Undeniably, some traditional jobs are fast becoming outdated because newer and newer skills are needed to not just thrive but also to survive in the Industry 4.0 era and beyond. Sheila’s concerns are shared by ‘Raden Ayu Yusra’ from ‘Polytechnic of Indonesia’:

As a business accounting D3 [diploma] student, I used to be happy doing my course. But now? I’m so scared. What’ll happen to me, when I graduate? My lecturer she said, very soon accounting will be done by A.I. that doesn’t make mistakes and can work 24/7. She said to us, after this we should do a degree in accounting systems or something like that, so that we can program and control A.I. systems. But, wait a minute! What the hell happened? I spent like nearly 3 years with this diploma and then now I need to study some more? My parents don’t have a diamond mine! Even now, my elder brother actually did a loan to help me with my studies. And, now what? Study some more? Will this new degree [academic specialisation] be still relevant when I graduate then?

The concerns of both these female undergraduates are not unfounded, given the fact that the post-Industry 4.0 era will be full of disruptions to established systems and filled with uncertainties for young people as junior professionals. The obsolescence of some academic specialisations is not something to be ignored due to the fact that tertiary education costs a lot of money and time; and yet,
these finite investments now do not guarantee the future, for young people who are desperate to find future oriented-work. Having said that, there is perhaps light at the end of the tunnel, as ‘Pengiran Muda’ from the ‘Polytechnic of Brunei’ commented:

Back to the topic about the Gig Economy that Danish said [from Polytechnic of Penang, Malaysia]. I think there’s actually two ways if we want to look at it. Yes, some young people will choose to be delivery drivers for food or shared cars [ride hailing]. But, there’s also choice. At my campus, some lecturers said we must be brave to become entrepreneurs and start our own online business. I took that challenge! My friends and me, we do electronics and systems instrumentation engineering. Getting electronics parts is damn hard in my country, everything is so limited! So, we buy components cheap from AliExpress and other sources from China. We opened up our online shop about 1 year plus now business is booming like crazy! Even people from Sabah, Sarawak and Kalimantan are ordering. For me, this is one way to deal with the disruptions [of Industry 4.0]. Yeah, I know not everyone can create the same opportunities. But, think about it. There are many doors opened to young people nowadays!

5. Summary and conclusions
In terms of preparing for the future, results from this empirical research effort do not look promising with a number of participants still in the dark about what skills they need to acquire for Industry 4.0 and how they must hone those skills before they enter an uncertain world of work full of disruptions. Clearly, ASEAN nations must move even faster and equip youngsters, particularly young tertiary level students, with the critical and vital skills needed to survive in the post-Industry 4.0 era. Figure 3 illustrates the main challenges that ASEAN tertiary students are facing with reference to critical and vital Industry 4.0 skills in Malaysia, Negara Brunei Darussalam and the Republic of Indonesia.

Figure 3. Issues related to Industry 4.0 critical/vital skills as faced by ASEAN TVET tertiary students

In general, all of the participants in this empirical research project have already been exposed to the critical/vital skills of Industry 4.0. They have acquired and they have practised the ten critical/vital skills during their ‘summer camp’ program in Malaysia. At the same time, they are still bugged with confusion and ignorance, low levels of preparedness and also a sense of fear due to the disruptions and uncertainties brought by the Industry 4.0 period. Without a doubt, the governments in these ASEAN
nations should play a more central and proactive role so that the career readiness levels of these youngsters could be raised and so that they could become future-oriented and future ready workers.

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