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A brief review**

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DOI

[10.1016/j.ssci.2019.03.007](https://doi.org/10.1016/j.ssci.2019.03.007)

Publication date

2019

Document Version

Final published version

Published in

Safety Science

Citation (APA)

Wang, B., Wu, C., Li, J., Zhang, L., Huang, L., & Kang, L. (2019). Certified Safety Engineer (CSE) as a new official profession in China: A brief review. *Safety Science*, 116, 108-115.
<https://doi.org/10.1016/j.ssci.2019.03.007>

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Review

Certified Safety Engineer (CSE) as a new official profession in China: A brief review



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ARTICLE INFO

Keywords:

Work safety and health
Safety professionals
China
Certified Safety Engineer (CSE)

ABSTRACT

Developing a group of good safety professionals is a key foundation for improving a country's work safety and health. In China, the widespread concern and discussion on the development of safety professionals, or more specifically Certified Safety Engineers (CSEs) started in the early 1990s. In recent years, especially after 2002, China's CSEs entered into a holistic, systematic and rapid development period because of the formal establishment and implementation of the professional qualification system for CSEs in 2002. Moreover, CSE is now becoming the most important profession in the field of work health and safety in China, and it has been officially approved by the central government. China has rich experiences on the development and cultivation of CSEs. However, these experiences were little known to the outside world due to the lack of efficient communication. Firstly, this paper briefly reviews the history and development of CSEs in China. Then, the administrative regulation and important requirements (such as capacity requirements and the knowledge framework) regarding CSEs in China are briefly introduced. This research aims at promoting the cooperation and exchange of information on the development and cultivation of safety professionals between China and other countries, to offer useful evidence and suggestions for the development of safety professionals.

1. Introduction

Work safety and health has always been a common topic in China. Fortunately, in the past several decades, China's work safety and health has been improved steadily (Wang et al., 2018a,b,c). It is likely that the good safety professional is one of the main reasons for this improvement (Wang et al., 2018a,b). In fact, in the early 1990s, China has already begun to discuss the development of safety professionals, or more specifically Certified Safety Engineers (CSEs) (Wang, 1999; Ministry of Human Resources and Social Security of PRC, 1997; Yang, 2006; Liu, 2010). In 2002, China formally established and implemented a professional qualification system for CSEs. Since then, the Chinese government, as well as safety researchers and practitioners have attached great importance to the development of safety professionals (especially CSEs). China's CSEs then entered into a holistic, systematic and rapid development period, discussed in detail in Section 2. In fact, other Chinese professions than CSE are related to workplace health and safety (such as Certified Nuclear Safety Engineer (CNSE), Safety Evaluation

Engineer (SEE), and Certified Occupational Hygienist (COH)). However, only the CSE has been widely considered as the most important profession in the field of occupational health and safety, and it has been officially approved by the Chinese government (SCNPC, 2014). Therefore, in this paper, we restrict our study on the CSE.

According to Article 4 of the 'Provisional Rules of the Professional Qualification System for CSEs' (Ministry of Human Resources and Social Security of PRC, 2014) and Article 3 of the 'Regulations for the Management of CSEs' (The Central People's Government of PRC, 2007), Certified Safety Engineers (CSE) are a group of professional and technical personnel who pass the professional qualification examination for CSEs, and have the 'CSE's qualification certificate of Peoples' Republic of China (PRC)' as well as the 'CSE's Practice License of PRC' after the registration. They are mainly engaged in the tasks of work safety management and technology in production and business operation enterprises, or in the tasks of work safety services in intermediary work safety service agencies. The main work of CSEs in China includes: (1) work safety management, (2) work safety technology, (3) work-related

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<https://doi.org/10.1016/j.ssci.2019.03.007>

Received 22 August 2018; Received in revised form 6 March 2019

Available online 15 March 2019

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Table 1

Major events of the development of CSEs in China after 2002. Source: The Registration Management Information System for CSEs of the SAWS (2011), the Ministry of Emergency Management of PRC (original named SAWS), the Central People's Government of PRC, and the National Emergency Management Propaganda and Education Website.

Year	Major event
2003	The SAWS and the Ministry of Human Resources and Social Security of PRC issued the 'Implementation Measures of Professional Qualification Examination for CSEs'. The SAWS proposed a plan/target that is "developing a team of high-quality CSEs in China who not only understand safety, but also is good at managing".
2004	The SAWS promulgated the 'Registration Management Measures for CSEs'. The SAWS and the Ministry of Personnel of PRC began to carry out the national professional qualification examination system for CSEs. China held its first national professional qualification examination for CSEs. Luo et al. (2004) edited and published the 'CSEs' Handbook'.
2005	The SAWS issued a circular on the 'Continuing Education for CSEs'. The SAWS issued a circular on the 'Registration Management of CSEs'. The SAWS issued a circular on printing and issuing the 'Continuing Education Outline for CSEs 2005'.
2006	The 'Eleventh-Five-Year Plan for Work Safety' formulated by the State Council of PRC in 2006 stressed that China should formulate or amend the regulations and rules with regard to the practice qualification for CSEs. Meanwhile, this policy document suggested that China should make full use of CSEs through further improving the practice system of employees of intermediary work safety service organizations. The SAWS issued a circular on developing the legislation investigation of the 'CSE Regulations'.
2007	The 'Regulations for the Management of CSEs' (The Central People's Government of PRC, 2007) was approved by the SAWS and adopted. The SAWS and the Ministry of Human Resources and Social Security of PRC issued a circular on implementing the supplementary provisions of the 'Provisional Rules of the Professional Qualification System for CSEs'. The SAWS and the Ministry of Human Resources and Social Security of PRC issued a circular on implementing the relevant principles of the 'Regulations for the Management of CSEs'.
2008	The SAWS and the Ministry of Human Resources and Social Security of PRC issued a circular on printing and issuing the 'Registered Qualification Examination Outline for Junior (Assistant) CSEs'.
2009	The SAWS issued a circular on the problems related to safety training and examination of CSEs. The Department of Policies, Laws and Regulations of the SAWS issued the 'CSE Regulations (Draft for Comments)'.
2010	The 'CSE Regulations' were included in the 'Legislative Plan of the SAWS in 2010' published by the SAWS in 2010.
2011	The SAWS issued the 'Guidelines to Strengthen the Work of CSEs'. The 'Twelfth-Five-Year Plan for Work Safety' formulated by the State Council of PRC in 2011 stressed that China should implement the education and training program for excellent CSEs, improve the professional qualification system for CSEs, and establish and perfect the supporting policy for the use and management of CSEs. Meanwhile, this policy document suggested that China should develop CSE firms (which are intermediary service organizations established in accordance with the law and undertaking to provide professional services of CSEs).
2012	The Registration Management Information System for CSEs of the SAWS formally put into use, which can help improve the efficiency and quality of the CSE registration management works. Luo et al. (2012) published the 'CSEs' Handbook (Second Edition)'.
2013	The SAWS issued a circular on 'Holding a National Forum on Promoting the Development of CSE Firms' on December 4, 2013, and this forum was held on December 12, 2013.
2014	The 'Work Safety Law of PRC' revised in 2014 formally established the professional qualification system for CSEs, which was the first time that the professional qualification system for CSEs was mentioned in the 'Work Safety Law of PRC'.
2016	The CSE was included in the 'Catalogue of National Professional Qualification' for the first time. The 'Several Opinions on Accelerating the Reform and Development of Work Safety' promulgated by the State Council of PRC in 2016 stressed that China should improve the professional qualification system for CSEs.
2017	The SAWS and the Ministry of Human Resources and Social Security of PRC promulgated the 'Measures on Classified Management of CSEs'. The 'Thirteenth-Five-Year Plan for Work Safety' formulated by the State Council of PRC in 2017 stressed that enterprises should be equipped with a number of CSEs in accordance with the law.
2018	The SAWS issued the 'Rules of the Professional Qualification System for CSEs (Draft for Comments)' and the 'Implementation Measures of the Professional Qualification Examination for CSEs (Draft for Comments)' to amend the 'Provisional Rules of the Professional Qualification System for CSEs' and the 'Implementation Measures of Professional Qualification Examination for CSEs' adopted in 2002 and 2003 respectively. The SAWS issued the 'Professional Qualification Examination Outline for Intermediate CSEs (Draft for Comments)' and the 'Professional Qualification Examination Outline for Junior (Assistant) CSEs (Draft for Comments)'.

accident investigation and analysis, (4) the prevention and treatment of occupational hazards, and (5) other work safety services (e.g., safety evaluation, safety consulting, safety detection and inspection, and safety education and training) (The Central People's Government of PRC, 2007; SAWS, 2018).

In recent years, CSEs as a new profession in China has been gradually accepted and approved by the government, the employers, the society, as well as more and more people, and it has played an important role in work safety promotion (Wang, 2014; SAWS and Ministry of Human Resources and Social Security of PRC, 2017). For example, the 'Work Safety Law of PRC' (SCNPC, 2014) revised in 2014 formally established the professional qualification system for CSEs. The implementation of the professional qualification system for CSEs and the development of safety professionals (especially CSEs) in China are of

worldwide concern. The Chinese experience can be learned by others, but also China should learn from other countries, specifically from the industrialized countries. It seems that language is still a barrier to gaining access to the Chinese policies, regulations, standards and approaches on the development and cultivation of CSEs. This paper emphasizes certain basic information regarding this issue. This study can also provide useful evidence and suggestions for the future development and cultivation of safety professionals both within China and in other countries (Wang et al., 2017).

The remainder of this paper is organized as follows: Section 2 reviews the history and development of CSEs in China; Section 3 introduces the administrative regulation regarding CSEs in China; Section 4 explains the important requirements (such as capacity requirements and the knowledge framework) for CSEs in China; and Section 5

concludes this paper.

2. History and development of CSEs in China

2.1. History

For a country, cultivating a group of good safety professionals is a foundation to improve the nation's work safety. In 1983, the China Association for Science and Technology of Labor Protection (CASTLP) was set up, that became one of the most important academic communities in the field of safety science/work safety in China at that time (Yang, 2006; Liu, 2010). This body joined the China Association for Science and Technology in 1985, and changed its name to the China Occupational Safety and Health Association (COSHA) in 2003 (Liu, 2010). After a long-term research, practice and exploration, the experts from the CASTLP proposed a suggestion in the early 1990s, to the relevant government departments such as the Ministry of Labor of the PRC (now known as the Ministry of Human Resources and Social Security of PRC) to set up a professional title for safety engineers in the 'National Professional Titles' (Wang, 1999). In 1997, the Ministry of Human Resources and Social Security of PRC promulgated the 'Evaluation Criteria for Intermediate and Senior Technical Qualifications (Trial Implementation)', which meant that China formally established a professional title for safety engineers.

Moreover, in the process of establishing and promoting the national professional qualification system, the State Administration of Work Safety (SAWS) and the Ministry of Human Resources and Social Security of PRC jointly promulgated two important regulations on safety engineers: the 'Provisional Rules of the Professional Qualification System for CSEs' and the 'Measures on the Professional Qualification Certification of CSEs' in 2002. These two policy documents are a milestone in China's work safety history, because they are the first programmatic documents for CSEs issued by the Chinese government since the establishment of PRC in 1949, and mark the beginning of the establishment and implementation a professional qualification system for CSEs in China. The promulgation and implementation this professional qualification system for CSEs is of great significance for the cultivation and development of safety professionals in China.

After 2002, China's safety professionals (especially CSEs) entered into a holistic, systematic and rapid development period. We suggest that the period between 2002 and 2017 was the "golden period" for the development of China's CSEs. Table 1 shows some major events of the development of CSEs in China after 2002. The main content of some key regulations mentioned in Table 1 are explained in Section 3. As shown in Table 1, in order to promote the implementation of the professional qualification system for CSEs and to improve the quality of CSEs, the Chinese government put forward a series of policies and measures during more than ten years. In short, although CSE is still an emerging profession, it has reached full development in China over the last few years.

2.2. Development trends

In this paper we present the data concerning the candidates for the professional qualification examination for CSEs (the structure and content of the professional qualification examination for CSEs are introduced in Section 4), and new CSEs in China in each year between 2002 and 2013. This section provides an analysis of the development trends of CSEs in China.

Between 2004 and 2013, the cumulative number of the candidates for the professional qualification examination for CSEs in China was 0.973 million, of whom 0.216 million persons passed the professional qualification examination for CSEs. During this period, the number of applicants for the professional qualification examination for CSEs in China gradually rose, with a temporary decrease in 2005–2006 (see Fig. 1). Especially since 2010, the number rose very rapidly. This trend

indicates that CSE as a new profession in China has been gradually accepted and approved by the government, the employers, the society, as well as more and more people, and it has gradually started to play an important role in work safety management.

Fig. 1 also shows the evolution of the number of CSEs in China in each year between 2004 and 2013. During this period, the number of new CSEs rapidly rose before 2008, significantly declined in 2008–2009, and then remained relatively stable. The dramatic decrease which emerged in 2008–2009 and the relatively stable trend after 2009 warrants further explanation. Possible contributing factors include the sharp increase of CSEs before 2008, the employees' demand for CSEs, and the government's control. Meanwhile, why did a dramatic increase emerge in 2007–2008? A primary reason possibly is that an administrative regulation on CSEs, namely the 'Regulations for the Management of CSEs' (The Central People's Government of PRC, 2007), was approved and implemented in 2007. Article 6 of this regulation clearly outlines the following requirements for the number of CSEs in production and business operation entities, and intermediary work safety service agencies:

- (1) Any mine, construction entity or hazardous substance manufacturing/sales/storage organization with more than 300 personnel shall be staffed with CSEs in a number equivalent to no less than 15% of its work safety managers;
- (2) Any organization with less than seven work safety managers shall have at least one CSE;
- (3) Other production and business operation entities shall have CSEs or entrust qualified intermediary work safety service agencies with appointing CSEs to provide work safety services; and
- (4) Intermediary work safety service agencies shall be staffed with CSEs in a number equivalent to no less than 30% of their personnel specialized in providing work safety services.

It should be noted that there is a requirement for the number of enterprise's work safety managers in China. Any mine, construction entity or hazardous substance manufacturing/sales/storage organization with more than 300 personnel shall be staffed with work safety managers in a number equivalent to no less than 3% of its employees. The work safety managers in other production and business operation entities shall account for at least 2% of employees.

According to the data from the SAWS, there were 0.286 million CSEs in China in 2017, which indicates that the CSE has become one of the important safety professional resources in China. Unfortunately, according to the data from the National Bureau of Statistics of PRC, the total working-age population (15–64 years) in China in 2017 was 900 million, CSEs only accounted for 0.03% of the total workforce. This shows that there is still a great lack of CSEs in China at present. Therefore, China has an urgent need to strengthen the development and cultivation of CSEs. In addition, it is certain that the development of China's CSEs has an optimistic prospect in the future because of the increasing demand of the government, the enterprises and the society for safety professionals (especially CSEs). For example, according to Article 19 of the 'Work Safety Law of PRC' (SCNPC, 2002), the mines and construction entities as well as those engaged in the production, selling and storage of hazardous substances shall establish a management organ (which is an internal organ) for work safety or employ directly full-time personnel for the work safety management. Other entities who employ over 300 people shall establish an administrative organ for work safety or have full-time personnel for the work safety management. If they have fewer than 300 employees, they must have full-time or part-time personnel for the work safety management or entrust the engineering technicians who are equipped with the relevant professional technical qualifications as provided by the state to provide services in the work safety management. It should be noted that these people are employees of the enterprise. On August 31, 2014, the 'Work Safety Law of PRC' (SCNPC, 2002) was revised. The above-mentioned

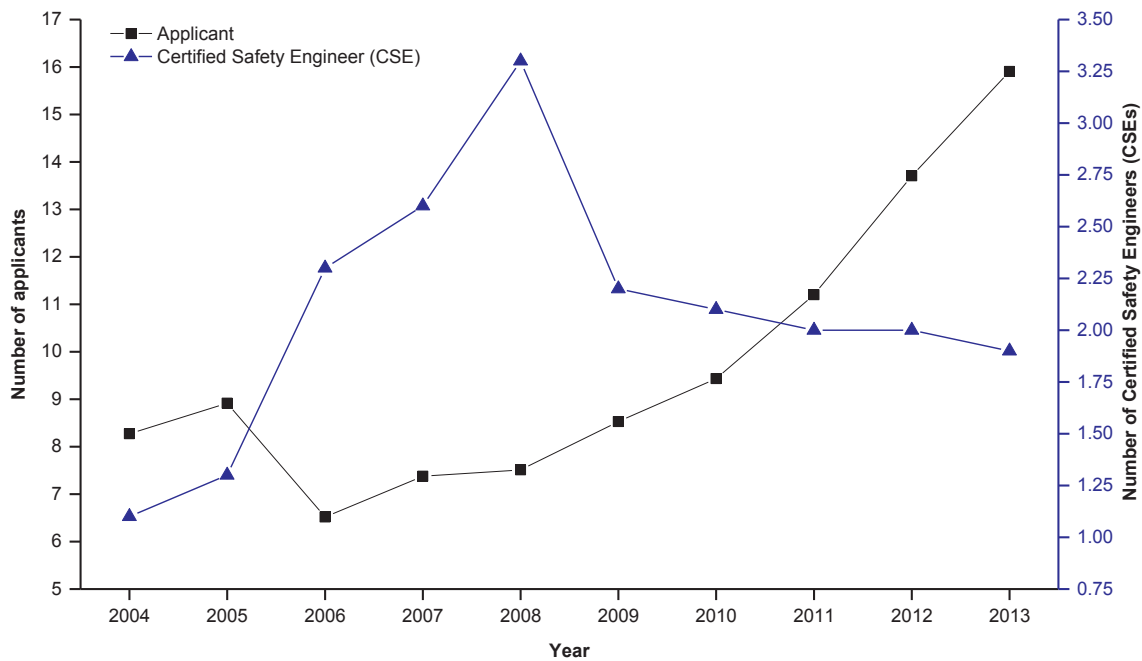


Fig. 1. Annual numbers of candidates for the professional qualification examination for CSEs, and new CSEs in China in each year from 2004 to 2013. Source: Wang (2014) and the Learning Sohu (2017).

Article 19 was changed to Article 21 of the ‘Work Safety Law of PRC’ (Revised edition) (SCNPC, 2014), and “300 employees” of the above-mentioned Article 19 was modified to “100 employees”. This suggests that the demand for safety professionals (including CSEs) was going to continue to grow in the years since 2014 in China.

To understand the characteristics of CSEs in China, Wang (2014) did a statistical analysis on CSEs in China in 2013. His study drew three important conclusions:

- (1) CSEs are mostly clustered in the more economically developed areas in China, such as Shandong, Jiangsu, Sichuan, Shanghai and Guangdong. This suggests that China’s developed areas have a high demand for CSEs because they pay more attention to work safety. In other words, China’s developed areas form good employment prospect for the CSEs.
- (2) The highest percentage of graduates by employing industry is found in construction, which could be because construction accidents are happened frequently and bring about a large number of fatalities in China at present, and the construction industry is one of the mainstays of the national economy that has developed rapidly in China in the past few years (Wang et al., 2018c). Construction is followed by the dangerous chemical industry as employer of CSEs (Wang et al., 2018d).
- (3) In China, the key type of employment unit of CSEs was the enterprise (see Fig. 2). The “Work Safety Law of PRC” places the legal requirements for the employment of safety professionals (including CSEs) at the enterprise level. Therefore, since the “Work Safety Law of PRC” that was promulgated and implemented in 2002, the demand for CSEs at the enterprise level has increased rapidly in China.
- (4) Most of China’s CSEs have undergraduate degrees and college degrees. It should be noted that ‘college degrees’ in China are lower than ‘undergraduate degrees’. Of China’s CSEs in 2013, 51.36% had undergraduate degrees, and 36.62% had college degrees (see Fig. 3). This suggests that the quality of China’s CSEs is relatively high.
- (5) Most of China’s CSEs were young people. For example, among all China’s CSEs in 2013, 44.07% of them were 36–45 years old and 29.35% were under 35 years old (see Fig. 4).

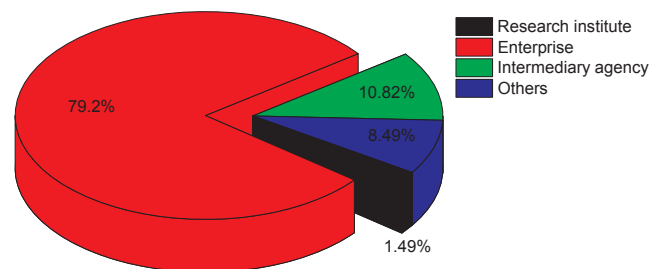


Fig. 2. Distribution of the types of employment unit. Source: Wang (2014). Notes: Intermediary agency refers to a service hired (or contracted) in by the enterprise.

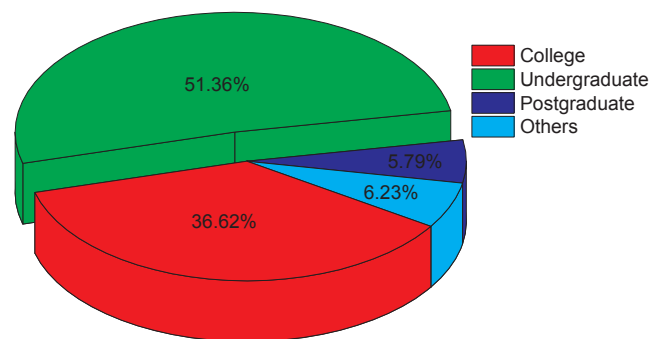


Fig. 3. Distribution of degrees. Source: Wang (2014)

3. Administrative regulation on CSEs in China

In order to promote the implementation of the professional qualification system for CSEs and the development of CSEs, six important regulations related to CSEs in China (see Table 1), namely the ‘Provisional Rules of the Professional Qualification System for CSEs’ (Ministry of Human Resources and Social Security of PRC, 2014), the ‘Measures on the Professional Qualification Certification of CSEs’ (Ministry of Human Resources and Social Security of PRC, 2014), the

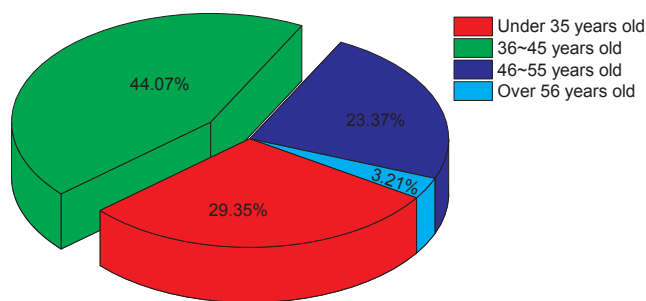


Fig. 4. Distribution of age. .
Source: Wang (2014)

‘Implementation Measures of Professional Qualification Examination for CSEs’ (Ministry of Human Resources and Social Security of PRC, 2014), the ‘Registration Management Measures for CSEs’ in 2004 (Shaanxi Administration of Work Safety, 2005), the ‘Regulations for the Management of CSEs’ (The Central People’s Government of PRC, 2007) and the ‘Measures on the Classified Management of CSEs’ (SAWS, Ministry of Human Resources and Social Security of PRC, 2017), have come into effect since 2002. Table 2 briefly introduces these administrative regulations. The important requirements for CSEs (such as the requirements for the professional qualification examination of CSEs) in the regulations in Table 2 are described in detail in Section 4.

4. Important requirements for CSEs in China

4.1. Requirements for the professional qualification examination of CSEs

Articles 8–11 of Chapter 2 of the ‘Provisional Rules of the Professional Qualification System for CSEs’ (Ministry of Human Resources and Social Security of PRC, 2014) propose a series of requirements for the professional qualification examination of CSEs. This section briefly introduces these requirements.

Firstly, the professional qualification examination of CSEs adopts the unified examination outline and paper (which is a government standard), and is held once per year in principle.

Secondly, the SAWS is responsible for drawing up the examination subjects, compiling the examination outline, writing the books for examination, and producing the examination paper, as well as making a unified plan for the relevant work to be completed before the examination such as pre-examination training.

Thirdly, the Ministry of Human Resources and Social Security of PRC is responsible for examining and approving the examination subjects, the examination outline and the examination questions (see Section 4.3), as well as organizing the implementation of the examination affairs. Meanwhile, the SAWS and the Ministry of Human Resources and Social Security of PRC jointly supervise, inspect and guide the examination, as well as determine the qualified benchmarks of the examination.

Finally, all PRC citizens can apply to take part in the professional qualification examination of CSEs if they were to abide by the national laws and regulations, as well as meet one of the following conditions:

1. A person has a secondary school diploma majoring in safety engineering (in China, there are about 200 institutions of higher education can offer safety engineering majors at present. Interested readers can find some information on safety engineering majors in China in a study by Zhang et al. (2018) in English.) or engineering economics and has been engaged in business related to work safety for at least seven years, or a person has a secondary school diploma majoring in other fields and has been engaged in business related to work safety for at least nine years.
2. A person has a college diploma majoring in safety engineering or

Table 2
Some representative Administrative regulation on CSEs. Source: Ministry of Human Resources and Social Security of PRC (2014), Shaanxi Administration of Work Safety (2005), The Central People’s Government of PRC (2007), as well as State Administration of Work Safety (SAWS) and Ministry of Human Resources and Social Security of PRC (2017).

No.	Year	Issuing department	Regulation	Brief description
1	2002	SAWS, Ministry of Personnel of PRC	Provisional Rules of the Professional Qualification System for CSEs	To make provisions for the examination, certification, responsibility and penalty of CSEs.
2	2002	SAWS, Ministry of Personnel of PRC	Measures on the Professional Qualification Certification of CSEs	To make provisions for the application conditions, the certification organization, the certification procedure, as well as the application time and requirements for the professional qualification certification of CSEs.
3	2003	SAWS, Ministry of Personnel of PRC	Implementation Measures of Professional Qualification Examination for CSEs	To outline clear regulations and requirements for the professional qualification examination for CSEs, such as the organization, the management, the implementation, the subjects, the time etc., of the professional qualification examination for CSEs.
4	2004	SAWS	Registration Management Measures for CSEs	To explain the registration, the practice scope and requirement, the rights and duties, as well as the penalty of CSEs, and to regulate the registration management and the practical behaviours of CSEs.
5	2007	SAWS	Regulations for the Management of CSEs	To strengthen the management of CSEs (such as the requirements for the continuing education, the rights and duties of CSEs, as well as the supervision and administration of CSEs), and to protect the CSEs practicing in accordance with the law.
6		SAWS, Ministry of Human Resources and Social Security of PRC	Measures on the Classified Management of CSEs	To improve the qualification system for CSEs, it classifies CSEs into seven professional categories, namely: (1) coal mine CSEs, (2) other metal and non-metal mine CSEs, (3) chemical CSEs, (4) metal smelting CSEs, (5) construction CSEs, (6) road transport CSEs, and (7) other CSEs (excluding fire control CSEs). Meanwhile, CSEs are divided into three different levels: (1) Senior CSEs, (2) Intermediate CSEs, and (3) Junior (Assistant) CSEs.

Table 3

Examination subjects for the professional qualification examination of Intermediate CSEs, and their goals and main content. Source: Professional Qualification Examination Outline for Intermediate CSEs (Draft for Comments) (SAWS, 2018).

Subject category	Subject	Goal	Main content
Public subject	Laws and Regulations on Work Safety	To test the ability of professional and technical personnel to use the laws, regulations, rules and standards on work safety to solve practical work safety problems.	Includes: (1) the legal system of work safety, (2) the 'Work Safety Law of PRC', (3) the special safety laws (including the 'Mine Safety Law of PRC', the 'Fire Control Law of PRC', the 'Special Equipment Safety Law of PRC', the 'Road Traffic Safety Law of PRC', and the 'Construction Law of PRC'), (4) the legal requirements related to work safety in other laws (including the 'Criminal Law of PRC', the 'Administrative Punishment Law of PRC', the 'Labour Law of PRC', the 'Labour Contract Law of PRC', and the 'Emergency Response Law of PRC'), (5) administrative regulations on work safety (e.g., the 'Regulations on the Work Safety License', the 'Regulations on the Safety Supervision of Coal Mines', and the 'Regulations on Safety management of Construction Projects'), and (6) other regulations and important documents on work safety (e.g., the 'Measures on the Classified Management of CSEs', the 'Regulations for the Management of CSEs', and the 'Regulations on Safety Training of Production and Business Operation Entities').
	Work Safety Management	To test the work safety management ability of professional and technical personnel to identify, evaluate, and control the hazardous and harmful factors; to investigate and control hazards, to improve the work environment; to formulate safety regulations and procedures, to manage safety-related behaviours; to make work safety management more effective and comprehensive; to improve the enterprise's accident investigation, statistics, analysis, prediction, early-warning and emergency rescue, by applying the basic theories and approaches of work safety management.	Includes: (1) the basic theory of work safety management, (2) work safety supervision, (3) the work safety responsibility system, (4) work safety standardization, (5) safety evaluation, (6) safety culture, (7) major dangerous chemical hazard installations, (8) work safety rules and regulations, (9) safety operation procedures, (10) work safety investment and safety liability insurance, (11) safety technical measures, (12) the safety facility "three simultaneousness" system of construction projects, (13) equipment and facility safety, (14) environmental management at workplaces, (15) work safety education and training, (16) work safety check and hazard management, (17) personal protective equipment management, (18) dangerous operation management, (19) emergency management, (20) the investigation and analysis of work-related accidents, (21) statistical analysis of work safety, and (22) safety risk control.
	Foundation of Work Safety Technology	To test the ability of professional and technical personnel to identify, analyse, and evaluate the dangerous and harmful factors existing in the workplaces and the operation process by using safety technologies and standards, and to take appropriate technical measures to eliminate and reduce the accident risk.	Includes: (1) mechanical safety technologies, (2) electrical safety technologies, (3) special equipment safety technologies, (4) fire-prevention and explosion-protection technologies, and (5) hazardous chemical safety technologies.
Professional subject	Professional Practice of Work Safety	To test the ability of professional and technical personnel to master the knowledge concerning professional safety technologies, to analyse and solve practical work safety problems by comprehensively using work safety laws, regulations, standards and policies, as well as work safety theories and approaches.	Includes: (1) professional safety technologies [including seven professional categories: (i) coal mine safety technologies (such as coal mining technologies, coal mine ventilation technologies, and gas prevention and control technologies), (ii) metal and non-metal mine safety technologies (such as mine geological disaster prevention and control technologies, mine water disaster prevention and control technologies, and mine fire prevention and control technologies), (iii) chemical safety technologies (such as chemical process safety technologies, safety technologies of chemical construction projects, safety technologies for the chemical storage and transportation), (iv) metal smelting safety technologies (such as sintering and pelletizing safety technologies, coking safety technologies, and ironmaking safety technologies), (v) construction safety technologies (such as construction machinery safety technologies, safety protection technologies, and safety technologies for the scaffold used in construction), (vi) road transport safety technologies (such as road passenger transport safety technologies, road freight transport safety technologies, and emergency rescue technologies for road transport accidents), and (vii) other safety technologies (excluding fire control technologies)], and (2) safety case analysis.

Notes: The 'Professional Practice of Work Safety' is divided into seven professional categories as shown in Table 3 and adopts the classified examination approach. Candidates for professional qualification examination for Intermediate CSEs should choose a professional category according to their work needs when they apply for this examination.

engineering economics and has been engaged in business related to work safety for at least five years; or a person has a college diploma majoring in other fields and has been engaged in business related to work safety for at least seven years.

3. A person has a bachelor's diploma majoring in safety engineering or engineering economics and has been engaged in business related to work safety for at least three years, or a person has a bachelor's

diploma majoring in other fields and has been engaged in business related to work safety for at least five years.

4. A person has a second bachelor's degree or a graduate diploma majoring in safety engineering or engineering economics and has been engaged in business related to work safety for at least two years, or a person has a second bachelor's degree or a graduate diploma majoring in other fields and has been engaged in business

Table 4
Eight key rights of CSEs in China. Source: the ‘Regulations for the Management of CSEs’ (The Central People’s Government of PRC, 2007) and the ‘Rules of the Professional Qualification System for CSEs (Draft for Comments)’ (SAWS, 2018).

No.	Right
1	Using the professional title of “CSE” and their own registration certificate.
2	Being engaged in work safety practices within the scope specified by laws and regulations.
3	Participating in the inspection and acceptance of safety facilities of construction projects and issuing their opinions.
4	Making comments and suggestions for any work safety requirements that fail to accord with the relevant laws, rules and regulations, and reporting them to the relevant regulatory departments.
5	Participating in the continuing education of CSEs.
6	Obtaining the corresponding labour remuneration.
7	Appealing against the violation of their own rights.
8	Enjoying other rights prescribed by laws and regulations.

- related to work safety for at least three years.
- A person has a master’s degree majoring in safety engineering or engineering economics and has been engaged in business related to work safety for at least one year, or a person has a master’s degree majoring in other fields and has been engaged in business related to work safety for at least two years.
 - A person has a doctor’s degree majoring in safety engineering or engineering economics, or a person has a doctor’s degree majoring in other fields and has been engaged in business related to work safety for at least one year.

4.2. Main skills of CSEs

At present, China has adopted clear requirements for the main skills of Intermediate CSEs and Junior (Assistant) CSEs. Unfortunately, the official requirements for Senior CSEs have not yet been released. The SAWS issued the ‘Rules of the Professional Qualification System for CSEs (Draft for Comments)’ in 2018 (see Table 1). This regulatory document provides a capability framework for Intermediate CSEs and Junior (Assistant) CSEs respectively.

Firstly, the intermediate CSE shall have the following important capacities regarding work safety:

- familiarity with laws, regulations and rules related to work safety;
- mastering the basic knowledge of work safety, the principles of accident prevention and control, work safety management approaches, as well as safety-related standards, norms, and specifications;
- ability to independently practice work safety in entities engaged in the production, selling and storage of hazardous substances and the high-risk industry (e.g., mining, metal smelting, construction, and road transport);
- understanding the work safety situation and development trends at home and abroad;
- ability to investigate, analyse, and evaluate work-related accidents/incidents in depth;

- ability to achieve solutions to difficult work safety problems;
- extensive work experience in work safety;
- ability to independently provide work safety services (mainly including work safety management services and work safety consulting services) and to write reports related to work safety (such as accident investigation reports, and work safety evaluation reports) by applying the relevant professional knowledge; and
- ability to guide the work of Junior (Assistant) CSEs.

Secondly, the Junior (Assistant) CSE shall have the following important capacities regarding work safety:

- understanding laws, regulations and rules related to work safety;
- mastering the basic knowledge of work safety, the principles of accident prevention and control, work safety management approaches, as well as safety-related standards, norms, and specifications;
- having a certain capacity for daily work safety management and the investigation and analysis of typical accidents; and
- ability to resolve general management and technical problems related to work safety.

4.3. Knowledge framework for CSEs

In China, the basic knowledge framework for Intermediate CSEs has been developed. Unfortunately, the knowledge framework for Junior (Assistant) and Senior CSEs has not yet been developed. Therefore, this section only introduces the basic knowledge framework for Intermediate CSEs. In 2018, the SAWS issued the ‘Professional Qualification Examination Outline for Intermediate CSEs (Draft for Comments)’ (SAWS, 2018) (see Table 1). According to this government document, there are four examination subjects of the professional qualification examination for Intermediate CSEs, which are the ‘Laws and Regulations on Work Safety’, the ‘Work Safety Management’, the ‘Foundation of Work Safety Technology’ and the ‘Professional Practice of Work Safety’, and are divided into two categories (including the public subject and the professional subject), as shown in Table 3. According to Table 3, we can understand the basic knowledge framework for Intermediate CSEs in China. Moreover, in China, Intermediate CSEs are qualified and excellent CSEs, and most of CSEs are Intermediate CSEs. Therefore, the basic knowledge framework for Intermediate CSEs can represent the general knowledge framework for CSEs. In other words, Table 3 provides a general knowledge framework for CSEs in China.

4.4. Rights and duties of CSEs

According to the ‘Regulations for the Management of CSEs’ (The Central People’s Government of PRC, 2007) and the ‘Rules of the Professional Qualification System for CSEs (Draft for Comments)’ (SAWS, 2018), CSEs shall enjoy eight key rights (see Table 4) and shall perform five important obligations (see Table 5).

Table 5
Five important obligations of CSEs in China. Source: the ‘Regulations for the Management of CSEs’ (The Central People’s Government of PRC, 2007) and the ‘Rules of the Professional Qualification System for CSEs (Draft for Comments)’ (SAWS, 2018).

No.	Obligation
1	Abiding by the laws, regulations and standards related to work safety.
2	Complying with their professional ethics and undertaking the relevant legal liabilities.
3	Protecting the interests of the nation and the public, as well as the legitimate rights and interests of employers.
4	Keeping all the commercial and technical secrets they know in the work process strictly confidential.
5	Not being employed by two or more units simultaneously.

5. Conclusions

A group of good safety professional can be seen as the absolute foundation for the improvement of work safety and health. Therefore, cultivating a group of good safety professionals is essential for a country. In fact, in the early 1990s, China already began to widely discuss the development of safety professionals, or more specifically CSEs. In 2002, China formally established and implemented the professional qualification system for CSEs. Since then, under the support and encouragement of the Chinese government at all levels, China's CSEs have entered into a holistic, systematic and rapid development period. At present, CSE has become the most important profession in the field of work health and safety in China, and it has been officially approved by the Chinese government.

Obviously, the Chinese experiences on the development and cultivation of CSEs have been very rich. This paper emphasizes certain basic information regarding China's CSEs, including the history and development of CSEs, as well as the administrative regulation and important requirements (such as capacity requirements and the knowledge framework) on CSEs. Moreover, there should be no boundaries between countries on science and technology. China should actively advance cooperation and exchange on the development and cultivation of safety professionals between China and other countries to promote the development and advancement of safety professionals to get a safer and better environment in China and the rest of the world.

Acknowledgements

The authors would like to thank Professor Andrew Hale and Dr. Dennis Hudson for their very useful suggestions and great help. This study is supported by the National Natural Science Foundation of China (No. 51534008), and the Hunan Provincial Innovation Foundation for Postgraduate (No. CX2018B048).

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssci.2019.03.007>.

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