

What Industry Wants from Requirements Engineers in China?

An Exploratory and Comparative Study on RE Job Ads

Chong Wang
School of Computer Science
Wuhan University
Wuhan, China
cwang@whu.edu.cn

Yaqian Tang
School of Computer Science
Wuhan University
Wuhan, China

Peng Liang
School of Computer Science
Wuhan University
Wuhan, China
liangp@whu.edu.cn

Maya Daneva
University of Twente
Enschede, The Netherlands
m.daneva@utwente.nl

Marten van Sinderen
University of Twente
Enschede, The Netherlands
m.j.vansinderen@utwente.nl

Abstract

[Background] Publications on the professional occupation of Requirements Engineering (RE) reported on market demands for both RE and non-RE qualifications and indicated the state-of-the-practice of RE roles in industry. However, prior research was not from the perspective of the RE area in the Software Engineering Body of Knowledge (SWEBOK). Nor, they shed light on the industry needs of RE professionals in China. **[Aims]** This paper focused on RE-specific tasks and skills sought after in China, from the perspective of RE activities elaborated in SWEBOK. **[Method]** Using an empirical qualitative research method, we selected and analyzed 535 job ads from China's two largest job portals. Job titles and descriptions of these ads were analyzed to uncover RE-relevant responsibilities in the categories of RE activities in SWEBOK as well as RE skills. **[Results]** We identified the qualifications, experience and skills demanded by Chinese employers. Specifically, we reported 23 RE tasks demanded in the 535 job ads, from the perspective of SWEBOK RE activities. **[Conclusion]** Our findings reveal that in China's job market, 'requirements engineer' is explicitly used as a title of job ads. Plus, around 78% of the selected job positions want the employees to perform tasks in requirements elicitation. Editing requirements specification is the most in-demand

task in RE activities. In addition, employers placed more emphasis on both RE-specific and broad industry experience.

CCS Concepts • Software and its engineering → Requirements analysis.

Keywords Requirements Engineering Practice, RE Job Market, Requirements Engineer, Job Ads, Exploratory Study

ACM Reference Format:

Chong Wang, Yaqian Tang, Peng Liang, Maya Daneva, and Marten van Sinderen. 2020. What Industry Wants from Requirements Engineers in China?: An Exploratory and Comparative Study on RE Job Ads. In *ESEM '20: ACM / IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM) (ESEM '20), October 8–9, 2020, Bari, Italy*. ACM, New York, NY, USA, 11 pages. <https://doi.org/10.1145/3382494.3410672>

1 Introduction

The tasks and skills related to requirements in software engineering (SE) have been elaborated in the body of requirements engineering (RE) knowledge (e.g. the Software Engineering Body of Knowledge, SWEBOK [3]) for more than 20 years. Teachers of RE courses in many universities teach students on RE practices that align with this body of knowledge. In fact, the textbooks in RE (e.g. [13]) that teachers use do address all these tasks. In industry, however, RE practitioners are used to creating their own RE-related tasks and skills not only reflecting their specific understanding on RE roles, but also the demands of specific businesses. As collectively concluded in empirical studies on the RE occupation in various countries and geographic regions [4, 5, 10, 15], there is an incongruity between RE practices in industry and in RE textbooks. Furthermore, the perspectives that RE professional job descriptions take on the RE roles have both similarities and differences across countries and regions. For example, the published studies [4, 5, 10, 15] collectively reported that RE positions titled 'Requirements Engineer' did not exist

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

ESEM '20, October 8–9, 2020, Bari, Italy

© 2020 Association for Computing Machinery.

ACM ISBN 978-1-4503-7580-1/20/10...\$15.00

<https://doi.org/10.1145/3382494.3410672>

in Europe [5, 10], South America [4], and North America [11, 15]. Whereas, similar RE tasks and competencies were identified from the RE job ads in the job markets in Germany [10] and the Netherlands [5]. However, the regions differ in the demanded technical competencies of RE professionals, where the Latin American study [4] signals a higher demand for proficiency in RE methods and tools than the European studies [5, 10] which emphasize the critical role of soft skills in the RE professional occupation.

The present study contributes to this discussion, by providing insights on this incongruity as observed in the Chinese IT market. Our motivation to focus on an Asian country, i.e. China, rests on the fact that Asia has the world's biggest labor market, however the RE profession in this market is under-researched. We felt motivated to understand what Chinese employers demand from RE professionals by identifying the qualifications and experience sought after as per RE job ads in China. To this end, we collected and analyzed job ads posted in the first quarter of 2019 on two most popular Chinese job-seeking websites, i.e., 51job and Zhilian. Specifically, we explored what RE professional knowledge and skills were demanded from job seekers. Unlike previous works which analyzed both RE/non-RE professional qualifications and personal educational/working experience of job seekers [5, 10, 15], our exploratory study: (1) focuses solely on RE and non-RE tasks and skills wanted in China's IT job market; (2) maps the RE tasks identified from job ads to the categories of RE activities in order to explore the mapping between RE qualifications demanded in practice and RE knowledge obtained from textbooks; and (3) compares the findings in China's IT job market to those in Canada on the same topic (our 2017 study in [15]), in order to identify the difference as well as the trend of RE demands in practice.

In the rest of this paper, Section 2 summarizes the background and related work. Section 3 presents our research objective, research questions, and research process. Section 4 reports the results. Section 5 discusses and compares our findings with our previously published works. Section 6 is on limitations and Section 7 concludes this study.

2 Background and Related Work

In the RE and Information Systems Research literature, some researchers explored personal factors demanded in job markets, such as age [2] and educational background [5, 15]. Whereas, several studies investigated RE tasks and skills by analyzing job ads in region-specific job markets: Germany [10], the Netherlands [5], Mexico and Brazil [4], and Canada [15]. Each provided empirical region-specific data on this topic. Collectively, these studies concluded that RE is predominantly an occupation for experts with soft skills and with Higher Education diplomas. The regions differ regarding the categories of job titles relevant to RE positions, and the demands for RE and non-RE tasks and skills as well as their

distribution against those categories. Compared to those previous studies, this work does not seek to group RE job titles into categories. The main difference to prior research is that the RE tasks identified in this paper are mapped to the RE activities in SWEBOK [3], in order to explore the mappings from the specific RE tasks expected in practice to the general RE activities defined in RE textbooks [6, 13]. None of the previously published studies has done this.

3 Research Process

3.1 Research Questions

The main objective of our work is to investigate the demands of RE roles in China's job market, from the perspective of the RE activities defined in the SWEBOK [3]. To this end, we formulate three research questions (RQs):

RQ1: *In China's job market, what job titles are set up for RE roles?* As indicated in [5, 10, 15], there was no RE position titled as 'requirements engineer'. Instead, lots of job titles, such as 'business analyst', 'software developer', 'project director' were used for RE professionals. It is interesting to know those job titles designed for RE positions in Chinese companies. The answer of this RQ would help researchers and practitioners better understand the terms and meanings that Chinese companies attach to the RE profession.

RQ2: *What tasks are requested for RE positions in China and which RE activities defined in the SWEBOK [3] are supported by these tasks?* This information would help us identify the specific tasks deemed essential for RE positions from the perspective of RE activities in SWEBOK [3] and their importance in China's job market.

RQ3: *What competencies are needed for RE roles in China?* We want to know the range of competencies that companies required for tasks in different RE roles. The answer of this RQ would help identify both RE and non-RE competencies expected from Chinese job seekers.

To answer these RQs, we planned and executed a qualitative data collection and analysis process that used job ads available in job posting repositories, namely portals. As reported in the latest systematic mapping study on knowledge extraction for SE labor [14], job portals were not only the earliest used on-line sources, but remain popular in online labor market analytics. Moreover, our choice for using portals was also motivated by previous research in using this data collection approach [5, 15].

We make the note that our research is exploratory [17] in nature: while it is informed by related work on the topic, it does not start with any preconceived idea of the answers to the RQs. Instead, it unearths the way in which the requirements engineer's job is conceptualized in Chinese companies. In this sense, our study is not confirmatory, i.e. we do not do the deliberate repetition of the same empirical study (e.g. [15]) for the purpose of determining whether the results of an earlier study can be reproduced (e.g. as indicated in [8]).

Table 1. Summary of data collection.

Job portal	Employed keyword	No. of collected job ads
51job	requirements engineer	990
	system analyst	533
	business analyst	521
	product manager	968
Zhilian	requirements engineer	709
	system analyst	198
	business analyst	326
	product manager	979
<i>Total:</i>		<i>5224</i>

3.2 Data Collection

To investigate the demands of RE roles in China’s job market, we choose two of the largest and also the most popular job search portals: 51job¹ and Zhilian², as the pool for our exploration. According to their ranks in China Alexa³, these two websites are the top 2 portals in the area of job search in China.

Since these two job seeking websites are not limited for IT professional positions, we first borrowed the keywords reported in [15] to make a pilot-searching. Surprisingly, around 40,000 job ads returned in the case in which that the only search word was ‘Engineer’. This hinted to us that it would not be feasible to employ the keywords reported in previous studies [5, 15] in the job ads collection in China. To narrow the scope of automatic search and also to concentrate on efficient RE job ads search, the employed keywords in this paper are derived from the description of ‘requirements engineer’ in [6] and the working experience of the authors.

Specially, we used ‘requirements engineer’ and its aliases reported in [6] – ‘system analyst’ and ‘business analyst’, and ‘product manager’ as the four keywords to conduct the automatic search of RE-related job ads in 51job and Zhilian. This search was performed on March 15, 2019 and returned a total of 5224 IT job ads from these two portals. As Table 1 indicates, the total number consisted of 1699 job ads collected by using the keyword ‘requirements engineer’, 731 ads by ‘system analyst’, 847 ads by ‘business analyst’, and 1947 ads by ‘product manager’.

3.3 Data Selection

Actually, it is a quite difficult and time-consuming task to manually analyze such a huge amount of online job ads collected from the specified two job portals. To perform our exploratory study within limited time, we use a sample size

calculator⁴ to calculate how many job ads are representative for our exploration. The results shows that at least 887 job ads should be included in the sample if the margin of error is set as 3% where the confidence level is 95% [12]. To simplify the selection criteria and minimize the requested sample size, we selected the first 125 job ads collected by each of the four keywords in each of the two job portals, according to their posting time in a descending order. In this way, 1000 job ads formed the initial dataset of our exploration. This set reflects the most recently posted ads. Using this set is a pragmatic choice also because we are interested in the most recent RE developments in the marketplace and not on job ads published long ago. Then, we compared the job titles, employers, and job position description of the selected job ads from the two job portals and removed 28 duplicate ads. Next, we defined the inclusion and exclusion criteria to use for the remaining 972 job ads for our analysis. These criteria were applied on the textual description of job positions in the job ads, and concentrated on (1) whether RE-centric responsibilities are mentioned the job ad, and (2) whether the job ad talks about at least one RE activity or the elaboration of this RE activity. After applying these two criteria, 437 job ads were excluded, and we got a final set of 535 job ads for code extraction, analysis, and synthesis in this study.

Specifically, the selection process was made in two steps by applying the inclusion and exclusion criteria. First, the first two authors conducted a pilot study on 160 out of 972 job ads (20 job ads × 4 search keywords × 2 job portals). They checked the relevance of job ads to the three RQs and made the selection independently, resulting in 91.2% agreement on the exclusion of RE relevant job ads. After discussing and resolving all the disagreements, they got a consensus on the inclusion of 85 job ads for code extraction. Next, the second author completed the selection of the final 535 job ads. Finally, both the first and the third author participated in the random validation of the included 535 job ads.

3.4 Data Extraction and Analysis

To answer our three RQs, job titles of 535 job ads and their position descriptions were analyzed for code extraction. Table 2 shows the extracted data items and the corresponding data analysis methods for these three RQs. Qualitative analysis techniques from the Grounded theory (GT) approach [1] were adopted for all the three RQs to extract codes and select codes from textual descriptions of job ads. Regarding RQ1, GT is the only method employed to analyze the titles of included job ads. As for RQ2, we used GT to extract RE tasks from the position descriptions of job ads, and adopted the definition of RE in SWEBOK [3] to introduce five RE activities as the categories of these extracted RE tasks. These five RE activities are requirements elicitation, requirements

¹<https://www.51job.com/>

²<https://www.zhaopin.com/>

³<https://alexa.chinaz.com/>

⁴<https://www.checkmarket.com/sample-size-calculator/>

Table 2. Extracted data items and their analysis methods used for RQs.

#	Extracted data item	Origins in a job ad	Data analysis method	Relevant RQ
1	job title	title of a job ad	GT	RQ1
2	task	responsibility, job description	GT + Predefined classification	RQ2
3	competency	requirements, qualifications, skills	GT + Predefined classification	RQ3

Table 3. Job titles and their categories of 535 job ads.

Category of job titles (with total no. of job ads)	Job title (with no. of job ads for each)
Manager (220)	product manager (191), project manager (12), operation/test/R&D director (6), technical manager (5), product/technical director (3), sales manager (3)
Analyst (201)	system analyst (51), business analyst (30), pre-sale analysis engineer (17), product/operation/analysis specialist (12), data analyst (9), product/system analysis assistant (6)
Engineer (102)	requirements engineer (65), analysis engineer (34), pre-sale engineer (6), solution engineer (5), system engineer (2)
Consultant (9)	product/implementation consultant (9)
Designer (9)	product/user experience designer (3)

analysis, requirements specification, requirements validation, and requirements management. As for RQ3, GT is used to extract RE and non-RE competencies from the job requirements or qualifications in job ads, and the RE competencies reported in [6] are extended to group the competencies extracted from our included 535 job ads. In this exploratory study, non-RE competencies refer to the ones that could not be directly related to RE exclusively, e.g. ‘to support project tracking’, ‘to collaborate with sales department and provide necessary technical support’, etc.

Similar to the selection process described in Section 3.3, the code extraction process in this subsection was conducted by the first two authors and executed in two steps: pilot extraction of the same sampled 160 job ads and complete extraction of all the 535 job ads.

4 Results

4.1 Answer to RQ1: Job Titles Used for RE Positions

Table 3 lists 20 types of job titles identified in our 535 job ads. We grouped these titles into five categories, i.e. Manager, Analyst, Engineer, Consultant, and Designer. These five categories are defined by the first and the third author according to their professional RE experience in China. We found that in China’s job market; ‘Manager’ is the largest category covering six job titles from 220 job ads. Next, the categories of ‘Analyst’ and ‘Engineer’ include, respectively, seven job titles that are mentioned in 201 job ads and five job titles from 102 job ads. For the categories of ‘Consultant’ and ‘Designer’, there is only one job title in each category.

Also, Table 3 reports that in each of the five job title categories, several sub-categories are introduced to group job

titles with similar or almost the same responsibilities. Taking the largest category ‘Manager’ as an example, six job titles, i.e. ‘product manager’, ‘operation/test/R&D director’, ‘project manager’, ‘technical manager’, ‘product/technical director’, and ‘sales manager’, are grouped to represent the RE role responsible for software development management. Similarly, we found that in the category of ‘Engineer’, the number of jobs that had the title ‘requirements engineer’ is much greater (i.e. 65) than that of other positions for engineers. Finally, we observed that in these 20 sub-categories, product manager, requirements analyst, and requirements engineer are the top 3 in-demand RE roles in China’s job market, according to the number of their occurrence (191, 76, and 65 respectively).

Furthermore, we found that the 535 job ads were posted by 484 companies, in which 468 companies explicitly provided their application domains in 45 business sectors. We observed that 328 out of these 468 companies (69%) served the following five domains: computer software (151 companies), Internet and E-commerce (85 companies), IT services (43 companies), electronic technology/semiconductor/integrated circuit (23 companies), and communication/telecommunications/network devices (21 companies). In addition, only 469 out of the 484 companies made their sizes open in the websites, referring to the approximate number of employees in those companies. Specifically, there are less than 20 employees in 38 companies, 20-99 in 53 companies, 100-499 in 222 companies, 500-999 in 40 companies, 1000-9999 in 78 companies, and more than 10000 in 28 companies.

Table 4. Coding results of RE tasks in requirements elicitation.

RE task (with total no. of occurrences)	RE sub-task (with sub-total no. of occurrences)	Description
Market survey (141)	Market/Industry analysis (103)	To investigate and analyze market or industry status of a product, e.g. ‘responsible to investigate the product market, especially its development trends and industry trends.’
	Competitive product investigation (83)	To investigate the status of competitive products, e.g. ‘to collect and analyze competitor information.’
	Target customer analysis (31)	To identify target customer or client base of a product, e.g. ‘to identify target customers through market segmentation and competitor analysis.’
	Product vision definition (15)	To specify product vision, e.g. ‘to provide detailed description of product vision and target market.’
	Product positioning definition (8)	To specify the position or target of a product, e.g. ‘to select target segments and determine product positioning.’
Requirements acquisition based on feedback (120)	Operational data tracking (63)	To monitor and track operational data of a product, e.g. ‘to monitor and analyze the operational data of delivered products.’
	User feedback tracking (53)	To monitor and track user feedback of a product, e.g. ‘to track market effects and user feedback for collecting evolutionary requirements.’
	Product issue tracking (8)	To identify and track issues or problems of a product, e.g. ‘to discover and solve product problems, and continuously optimize software product.’
Interaction with customers (99)	Communicating with customers (94)	To communicate with customers in various ways, e.g. ‘to communicate detailed requirements with key users.’
	Organizing focus group (10)	To elicit user requirements by using focus groups, e.g. ‘responsible to organize focus groups and communicate with customers.’
User behavior analysis (31)		To analyze users’ operations and behaviors generated in the process of using a product, e.g. ‘to analyze the statistics of user behavior, and to mine and identify user requirements.’
Scope and requirements definition control (10)		To specify the scope of functionalities and quality included in a product, e.g. ‘to control the scope of requirements’.
Reporting requirements survey results (8)		To document the results of requirements survey, e.g. ‘to mine potential user requirements and document requirements survey report’.

4.2 Answer to RQ2: RE Tasks and Subtasks

This subsection reports the RE tasks for RE positions in China and the relevance of these tasks to the five RE activities introduced in Section 3.4. We note that because of the space limitation, all the RE tasks and sub-tasks extracted from RE jobs falling into these five RE activities are listed in <https://tinyurl.com/y7ab28ym>.

4.2.1 RE tasks for requirements elicitation

As shown in the first and second columns of Table 4, 417 out of the included 535 job ads explicitly state 13 RE-related tasks in the stage of requirements elicitation, and those 13 RE tasks fall into seven categories. We observed that the

top three categories of RE tasks relevant to elicitation are ‘market survey’ (141 ads), ‘requirements acquisition based on feedback’ (120 ads), and ‘interaction with customers’ (99 ads). Furthermore, these three categories respectively cover five, three, and three elaborated RE tasks.

4.2.2 RE tasks for requirements analysis

We found that in China’s job market, 328 out of 535 job ads indicate five RE tasks in requirements analysis. More specifically, 249 included job ads gave general descriptions to the responsibility related to requirements analysis, e.g. ‘to organize user requirements’ or ‘to understand and analyze

Table 5. Coding results of RE tasks in requirements validation.

RE task (with total no. of occurrences)	Description
Assisting developers with requirements understanding (104)	To avoid misunderstanding of requirements when delivering requirements to developers or project teams, e.g. ‘to assist system architect and system analyst understand requirements.’
Requirements test (68)	To identify the feedback that systems generated under a specified situation to remove potential uncertain issues in requirements, e.g. ‘to cooperate with testers for requirements testing, including specifying test focus and testing business process.’
Requirements review (57)	To invite stakeholders, including users, developers, tester, etc., to work together to check whether there exist issues or problems in requirements specifications, e.g. ‘responsible for requirements statement and requirements review.’
Requirements confirmation (34)	To assure whether or not a product, service, or system meets the needs of the customer and other identified stakeholders, e.g. ‘responsible to re-communicate and confirm requirements with customers.’
Requirements verification (33)	To evaluate whether or not a product, service, or system complies with a regulation requirements specification or imposed condition, e.g. ‘to evaluate whether the product meets specific business requirements.’

requirements’, which is coded as the RE task ‘general requirements analysis and organization’ in this paper. Besides, ‘prototyping’ was the most demanded task for requirements analysis stated in 125 job ads, e.g. ‘to develop prototype for products’. Moreover, employers also gave attention to ‘feasibility analysis’ (e.g. ‘to understand and mine effective requirements and their values’ and ‘responsible for project resources allocation’), ‘requirements prioritization’ (e.g. ‘to organize business departments for requirements prioritization’), and ‘defining data specification’ (e.g. ‘to convert analytical requirements into data schema, based on requirements and implementation plan’). These three tasks are included in 36, 9, and 3 job ads, respectively.

4.2.3 RE tasks for requirements specification

Regarding requirements specification, two RE tasks, i.e. ‘requirements documentation’ and ‘requirements modeling’ are identified in 249 out of the included 535 job ads. The first task is covered in all 249 job ads and denotes the responsibility of writing requirements specifications. Plus, we observed that in the 535 ads, various terms were used to represent requirements specifications, such as ‘requirements document’, ‘requirements manual’, ‘requirements analysis document’, ‘requirements specification document’. Whereas, the second task aims at conceptual design and representation of requirements, and it occurs in 20 job ads.

4.2.4 RE tasks for requirements validation

In 203 out of the 535 ads, we found that five RE tasks gave support to requirements validation. As in Table 5, ‘assisting developers with requirements understanding’ is the most in-demand RE tasks, covering 104 job ads. The other four

reported RE tasks are ‘requirements test’, ‘requirements review’, ‘requirements confirmation’, and ‘requirements verification’, accounting for 68, 57, 34, and 33 ads respectively.

4.2.5 RE tasks for requirements management

We identified five RE tasks supporting requirements management, in 218 out of the 535 job ads. The most frequently mentioned task is ‘requirements status/issue tracking’ (in 146 job ads). Besides, ‘requirements change management’ (e.g. ‘complete control and management of requirement changes’) and ‘requirements improvement’ (e.g. ‘to identify optimization improvements from the entire process of business by means of quantitative analysis’) are also sought after, accounting for 53 and 44 job ads respectively. The remaining two identified RE tasks for requirements management are ‘requirements quality control’ and ‘requirements based release planning’ (19 and 13 job ads respectively).

4.2.6 Summary of RE tasks in RE activities

By summarizing the RE tasks identified in five RE activities, we totally found 23 different RE tasks demanded in the included 535 job ads. Furthermore, Figure 1 zooms in the percentage of the top 10 in-demand RE tasks in the job ads set. We observed that the top 2 in-demand RE tasks are ‘requirements documentation’ in requirements specification activity and ‘general requirements analysis and organization’ in requirements analysis activity, covering 46.5% of the included job ads for each. The third important RE task is ‘requirements status/issue tracking’ in support of requirements management activity, followed by ‘project and customer analysis’ task in requirements elicitation activity and ‘prototyping’ in

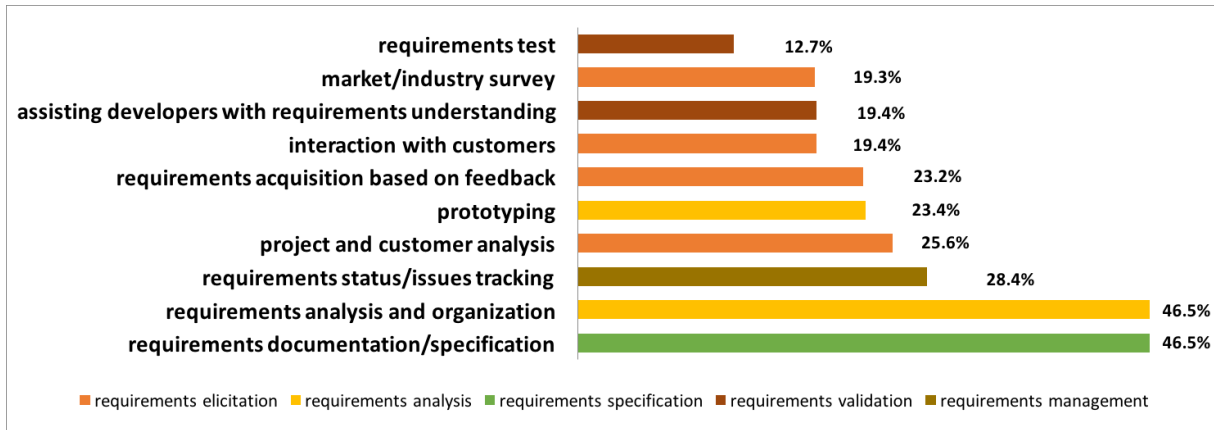


Figure 1. Top 10 in-demand RE tasks extracted from job ads.

requirements analysis activity. Furthermore, Figure 1 indicates the percentage of job ads that explicitly state the top-10 RE tasks allocated into the RE activities (in SWEBOK [3]). We observed four tasks contributing to requirements elicitation, two tasks specifically for requirements analysis, two tasks dedicated to requirements validation, one task used for requirements specification, and one task employed for requirements management.

4.3 Answer to RQ3: RE and non-RE competencies

Figure 2 shows the occurrences of RE competencies in the 535 job ads. We found that 228 ads (42.6%) explicitly demanded RE experience (e.g. ‘more than five year experience in requirements analysis’, or ‘experience in requirements analysis of large business system is preferred’), and 187 job ads (35%) asked for competencies in RE tools (e.g. requirements modeling tools - Mind Manager and prototyping tool - Rose). In addition, 85 ads (15.9%) demanded job seekers to have experience in applying RE methods, e.g. ‘to master requirements analysis techniques and requirements management methods’. However, only 60 job ads (11.2%) mentioned RE knowledge, such as ‘familiar with theory of requirements engineering’.

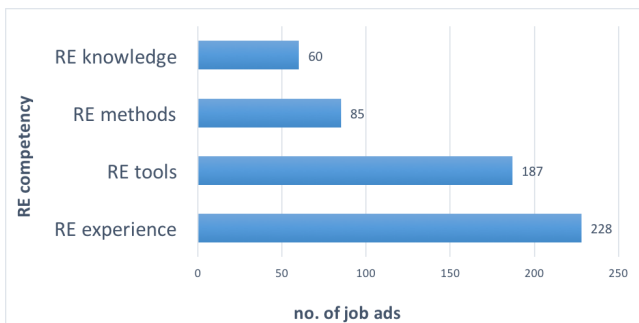


Figure 2. Distribution of job ads over RE competencies.

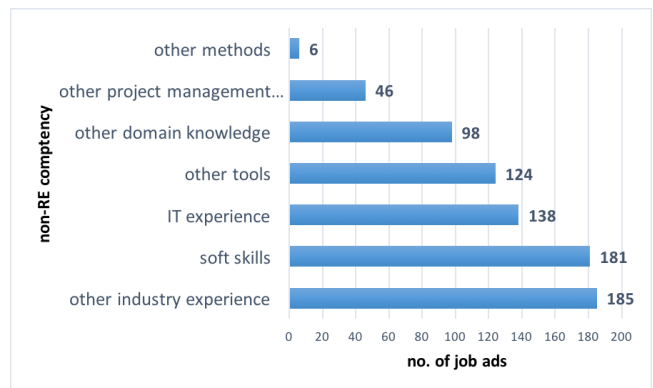


Figure 3. Distribution of job ads over non-RE competencies.

Regarding non-RE competencies (Figure 3), we found out ‘other industry experience’ (e.g. ‘working experience in portable energy storage related products’, or ‘work experience in cosmetics industry’) and ‘soft skills’ seem to be the two most demanded non-RE competencies, since they account for 34.6% and 33.8% of the 535 job ads respectively. Also, employers gave much attention to IT experience (e.g. ‘work experience in IT software’ or ‘work experience in well-known Internet companies’), other tools (e.g. Office software), and other domain knowledge (e.g. ‘familiar with financial and business knowledge’), since they account for 25.8%, 23.2%, and 18.3% of the 535 job ads respectively. Only few job ads asked for experience on using other methods (e.g. design pattern, software development process, etc.)

Furthermore, Figure 4 zooms in the top 10 soft skills mentioned in 181 job ads that explicitly asked for these skills. We found that the most important skills to companies are the communication skills (mentioned in 147 job ads and accounting for 81.2% of the 181 job ads). The other most frequently mentioned skills are teamwork skills (60.2%), sense of responsibility (58.6%), and learning skills (54.7%), since they account for more than 50% of the 181 job ads.

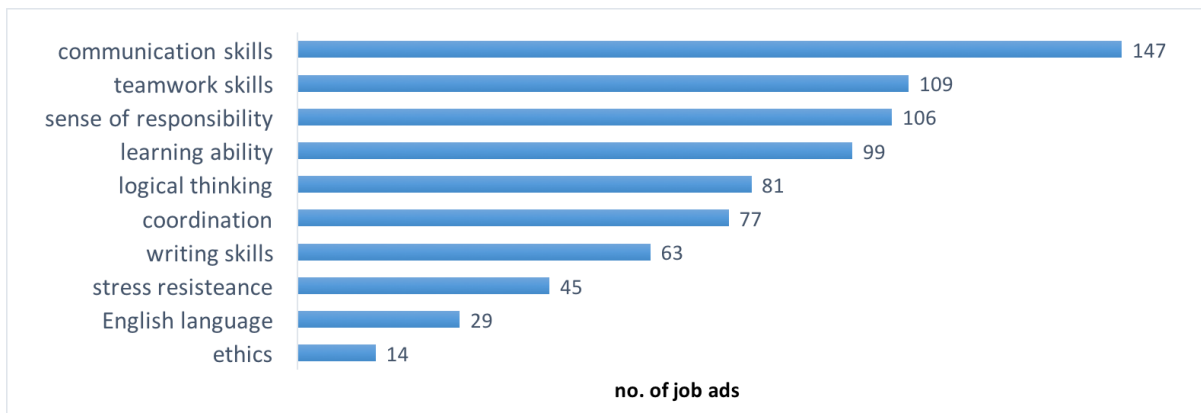


Figure 4. Top 10 soft skills included in RE job ads.

5 Discussion

5.1 Implications of our findings

For RQ1, our results indicate that Chinese companies explicitly use the job titles ‘requirements engineer’ and ‘requirements analyst’. As shown in Table 3, 63.7% of the jobs in the Engineer category refer to ‘requirements engineer’. This means that the Chinese market is well aware of the specific knowledge, competencies, and professional values that serve as a source of identity [9] for job holders with this title. This observation is in stark contrast with studies in other countries (e.g. Germany [10], the Netherlands [5], and Canada [15]) that found no use of such a job title. However, despite the strong identity of RE professionals in the Chinese market, RE roles are also included in jobs that are in the categories of managers, analysts, designers, and consultants. This means that, similarly to the findings in [5, 10, 15], RE roles received broad coverage in job titles in industry.

For RQ2, in terms of RE tasks contributing to the key RE activities (as per the SWEBOK [3]), we observed that requirements elicitation is the most frequently demanded RE task (see Figure 1). As presented in Section 4.2.1, around 77.9% of the included 535 job ads requested qualification referring to ‘requirements elicitation’. On one hand, this means that Chinese employers expected job seekers to take responsibilities in collecting requirements. On the other hand, this finding signals the significance of requirements elicitation, as the first phase of RE, in any software projects. Furthermore, as shown in Figure 1, ‘requirements documentation’ and ‘general requirements analysis and organization’ are the top-2 in-demand RE tasks. This may possibly suggest that Chinese businesses perceive analyzing requirements and writing requirements specifications as the most important responsibilities for the RE role.

For RQ3, we found that RE is an occupation for experienced professionals and not for ‘freshmen’. Chinese companies demand not only RE experience, but also general IT experience and industrial experience in a particular business

sector. This might suggest that the employers want experienced candidates well aware of the particular RE challenges and issues specific to each sector. Regarding soft skills, communication skills by far are the most frequently mentioned. This is unsurprising, knowing that requirements elicitation is the most frequently mentioned activity in demand.

5.2 Comparison on the findings in China and Canada

Here we compare our findings to those of our 2017 study on RE jobs in Canada [15]. We chose it because of its recency and also because it was done by ourselves and, hence, it was possible to minimize construct validity threats. We took its context [15] as an example of a Western market. We acknowledge that comparisons with other markets are an important part of building our knowledge of the RE profession as complete as possible, however because of space limitations in this paper we did not include a thorough comparative analysis across multiple countries (e.g. [4, 5, 10]). We consider this a line for our immediate future research.

5.2.1 Comparison on RE job titles

We compared the categories and their sub-categories of job titles reported in the job ads in Canada [15] and China. First, in Canada’s job market, eleven categories of job titles were reported for RE roles; while only five categories were identified from online job ads in China. The reason for this could be that more terms with similar or almost the same meanings were employed by companies in China to title RE positions, resulting in less categories of job titles. Second, for the categories of managers and analysts, the numbers of their sub-categories reported in China’s market were greater than that in Canada. The reason could be that in China, scope of sub-categories was narrower than that in Canada to contain less job titles for managers and analysts. In contrast, for the categories ‘Engineer’, ‘Consultant’, and ‘Designer’, much less sub-categories were designed to cover more job positions in

Table 6. Comparison on RE tasks in RE activities over countries.

RE activity	RE task	
	<i>in Canada’s job market, 2017 [15]</i>	<i>in China’s job market, 2019</i>
Requirements elicitation	coordination with stakeholders , requirements elicitation/research, translation of requirements	market survey, requirements acquisition based on feedback, customers communication , user behavior analysis, scope and requirements definition, reporting requirements survey
Requirements analysis	solution design, requirements analysis, prototyping , process analysis, prioritization management, feasibility analysis	general requirements analysis and organization, prototyping, feasibility analysis, requirements prioritization , defining data specification
Requirements specification	requirements specification/ documentation	requirements documentation , requirements modeling
Requirements validation	quality assurance/ testing	assisting developers with requirements understanding, requirements test, requirements review, requirements confirmation, requirements verification
Requirements management	requirements management , project management, timeline management	requirements status/ issue tracking, requirements change management , requirements improvement, requirements quality control, requirement based release planning

China than in Canada. One reason could be that in China’s job market, less types of job titles were used for RE positions. Another reason could be that the authors specified more abstract categories for job titles posted in China’s job market, e.g. for the category of ‘Engineer’.

5.2.2 Comparison on RE tasks

Table 6 compares RE tasks reported in the job ads posted in Canada and China, from the perspective of RE activities in an RE process. Note that the task in bold means similar or almost the same responsibility reported in the job market of both Canada and China.

Specifically, we found that for requirements elicitation, requirements specification, and requirements management, only one RE task (i.e. communication with customers, requirements specification/documentation, and requirements change management for each RE activity respectively) was demanded in job ads of both China and Canada. As for requirements analysis, four RE tasks were requested in both countries. However, companies in China and Canada did not demand similar tasks or the same responsibility for requirements validation.

5.2.3 Comparison on RE and non-RE competencies

The top half of Table 7 compares the ranks and percentages of RE competencies expected from the job seekers of these two countries. We found that Chinese companies placed more expectations on applicants to have RE experience and also use RE tools, rather than RE methods. It seems that employers in both China and Canada value applicants’ RE project management knowledge. Whereas, the bottom half of Table 7 shows the ranks and percentages of RE competencies

demanded in China and Canada. We observed that five non-RE competencies (i.e. soft skills, other methods, other domain knowledge, other project management knowledge, and other tools) score relatively low in terms of occurrences in Chinese job ads compared to job ads in Canada.

The differences could be possibly traceable to cultural and organizational factors. To understand exactly what we observe more research is needed, possibly by collecting insights from companies in both countries. One possible explanation for the frequent presence of soft skills in RE job ads in Canada is traceable to the Canadian government’s position [7] on the importance of soft skills and of soft skill education for any service sector jobs. We do not suggest that soft skills are less important in China - the results just indicate that Chinese companies do not seem to state soft skills explicitly in job ads. This does not mean that soft skills are less important for hiring; it might well be possible that the importance of soft skill is a piece of tacit knowledge shared in the IT sector in China. This is a hypothesis that could be analyzed in follow-up empirical studies in Chinese companies.

6 Limitations

Our exploratory study has some limitations. First, we used only ‘requirements engineer’ and its three aliases given in [6] as the keywords to search RE job ads in two portals. That is, our work excluded possibly RE-relevant job ads with other titles (e.g. ‘administrator’ and ‘architect’) when collecting job ads. Next, as mentioned in Section 3.3, only 1000 out of the collected 5224 job ads were selected as the initial dataset for manual analysis and synthesis in this study. Would the results differ if we employ all the nine keywords used in [5] and [15] to collect more job ads, or if we analyze all the 5224 job ads collected by using the four keywords specified

Table 7. Comparison on rank and percentage of RE and non-RE competency over countries.

Competency		Canada 2017 [5]		China 2019			
		Rank	Percentage	Rank	Change in Rank	Percentage	Change in Percentage
<i>RE competency</i>	RE method	1	33%	3	↘	15.9%	↘
	RE experience	2	20%	1	↗	64.6%	↗
	RE project management knowledge	3	11%	4	↘	11.2%	→
	RE tools	4	6%	2	↗	35%	↗
<i>non-RE competency</i>	Soft skills	1	86%	1	→	85.6%	↗
	SE experience	2	64%	\	\	\	\
	Other experience	3	57%	\	\	\	\
	Other technique (knowledge)	4	53%	3	↘	36.2%	↘
	Other method	5	48%	8	↗	1.2%	↘
	Other domain knowledge	6	33%	6	→	19.6%	↘
	Other project management knowledge	7	23%	7	→	9.2%	↘
	Other tools	8	22%	5	↗	24.8%	→
	Other industry experience	\	\	2	\	37%	\
IT experience	\	\	4	\	27.6%	\	

in Section 3.2? We conjecture that there is a good chance that our observations would be similar if more job ads with more job titles are included. However, we think that it is worthwhile looking in job ads with more titles, which would give us a broader understanding on the perception of RE roles in practice.

Second, we acknowledge that in reality some jobs related to the RE roles would never appear in portals. This is because seasoned IT specialists often land new jobs by leveraging their professional networks. Plus, in China, internal recommendation and campus recruitments are two popular ways to inform job seekers (e.g. undergraduate or master students in universities) about the demands for specific positions. As for internal recommendations, university graduates who now work in companies usually send the details of available jobs to the research groups in which these graduates had worked prior to joining the companies. These research groups then help attract applicants. As for campus recruitments, the demands of RE positions would be forwarded to the students by the corresponding departments of universities. To completely understand the companies' expectations of professionals at these RE positions and roles, more research is needed, e.g. in-depth interviews with practitioners on how they found RE-related employees and what capabilities companies focused on in job interviews.

7 Conclusions and Future Work

This study made two contributions: (1) it is the first study to provide an empirical analysis of data from a context that so far evaded the attention of RE and SE researchers, namely China. As such, it adds up to the collective body of knowledge on the RE profession in various contexts; and (2) it compared

and contrasted the RE job aspects of China with those of a Western marketplace (Canada).

Our exploration and comparison added new knowledge. Our study revealed the following four characteristics of the state-of-the-practice of RE jobs in China: (1) unlike IT marketplaces in other countries, 'requirements engineer' is indeed used for RE roles in China; (2) 'requirements documentation', 'general requirements analysis and organization', and 'requirements status/issues tracking' are the top three task-related qualifications. Plus, requirements elicitation is the most frequently mentioned activity in demand; (3) for the applicants, having RE experiences is identified as the most important competency for most of the RE positions; (4) six identical or similar RE tasks were reported in both China and Canada, but different concerns on RE and non-RE competencies were identified in these two countries.

As our next step, we plan to collect and analyze more job ads, from the two portals specified in this work, as well as other popular job websites in China. Also, we will conduct a survey to investigate the gap between practitioners and educators on the RE tasks and skills reported in this exploratory study, to provide a deeper understanding on the state-of-the-practice of RE roles in Asia. Last, we will conduct a comparative evaluation of the results from those countries in prior studies, e.g. [4, 5, 10]. This effort is directed towards theory-building [16] regarding the RE profession.

Acknowledgments

This work is supported by the National Key Research and Development Program of China (2018YFB1003800) and the National Natural Science Foundation of China (61702378, 61972292).

References

- [1] Marilyn P. Annells. 1996. Grounded theory method: philosophical perspectives, paradigm of inquiry, and postmodernism. *Qualitative Health Research* 6, 3 (1996), 379–393.
- [2] Sebastian Baltes, George Park, and Alexander Serebrenik. 2020. Is 40 the new 60? How popular media portrays the employability of older software developers. (2020). <https://doi.org/CoRRabs/2004.05847>
- [3] Pierre Bourque and Richard E. Fairley. 2014. *Guide to the Software Engineering Body of Knowledge, Version 3.0 (SWEBOK Guide V3.0)*. IEEE.
- [4] Angélica Toffano Seidel Calazans, Roberto Ávila Paldês, Eloisa Toffano Seidel Masson, Isabel Sofia Brito, Kiane Mabel Fialho Rezende, Emeli Braosi, and Nathacia Indayara Pereira. 2017. Software requirements analyst profile: a descriptive study of Brazil and Mexico. In *Proceedings of the 25th International Requirements Engineering Conference (RE'17)*. IEEE, Lisbon, Portugal, 196–204.
- [5] Maya Daneva, Chong Wang, and Patrick Hoener. 2017. What the job market wants from requirements engineers? an empirical analysis of online job ads from the Netherlands. In *Proceedings of the 11th International Symposium on Empirical Software Engineering and Measurement (ESEM'17)*. IEEE, Toronto, Canada, 448–453.
- [6] Christof Ebert. 2012. *Systematisches Requirements Engineering: Anforderungen Ermitteln, Spezifizieren, Analysieren und Verwalten* (4th ed.). Dpunkt.
- [7] FutureWorx. 2019. *Building A Pan - Canadian Soft Skills Framework*. Technical Report. Canada.
- [8] Omar S. Gómez, Natalia Juristo, and Sira Vegas. 2010. Replications types in experimental disciplines. In *Proceedings of the 4th International Symposium on Empirical Software Engineering and Measurement (ESEM'10)*. ACM, Bozen, Italy, 1–10.
- [9] Adam M. Grant, Justin M. Berg, and Daniel M. Cable. 2014. Job titles as identity badges: How self-reflective titles can reduce emotional exhaustion. *Academy of Management Journal* 57, 4 (2014), 1201–1225.
- [10] Andrea Hermann. 2013. Requirements engineering in practice: there is no requirements engineer position. In *Proceedings of the 19th International Working Conference on Requirements Engineering: Foundations for Software Quality (REFSQ'13)*. Springer, Essen, Germany, 347–361.
- [11] Kim Hertz and Paola Spoletini. 2017. Are requirements engineering courses covering what industry needs? a preliminary analysis of the United States situation. In *Proceedings of the 8th International Workshop on Requirements Engineering Education and Training at the 28th International Requirements Engineering Conference (REET@RE'18)*. IEEE, Banff, Canada, 20–23.
- [12] Glenn D. Israel. 1992. *Determining Sample Size*. Fact Sheet PEOD-6. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Florida, U.S.A.
- [13] Soren Lauesen. 2002. *Software Requirements: Style & Techniques* (4th ed.). Addison-Wesley.
- [14] Maria Papoutsoglou, Apostolos Ampatzoglou, Nikolaos Mittas, and Lefteris Angelis. 2019. Extracting knowledge from on-line sources for software engineering labor market: a mapping study. *IEEE Access* 7 (2019), 157595–157613.
- [15] Chong Wang, Pengwei Cui, Maya Daneva, and Mohamad Kassab. 2018. Understanding what industry wants from requirements engineers: an exploration of RE Jobs in Canada. In *Proceedings of the 12th International Symposium on Empirical Software Engineering and Measurement (ESEM'18)*. ACM, Oulu, Finland, Article 41, 10 pages.
- [16] Roel Wieringa and Maya Daneva. 2015. Six strategies for generalizing software engineering theories. *Science of Computer Programming* 101 (2015), 136–152.
- [17] Robert K. Yin. 2017. *Case Study Research and Applications: Design and Methods* (6th ed.). Sega.