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Demand of 21st Century Skills in the Construction Workforce

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This paper analyzes the job postings in the construction sector to identify the nature and demand of the soft skills that the construction industry is looking for in the employees. The construction industry, like other industries, is witnessing rapid change in the working environment because of factors such as increasing cultural diversity of the workforce, advancement in information technology and introduction of automation and artificial intelligence to perform routine jobs. Because of these changes, individuals need soft skills to succeed in the 21st century workplace. The job postings on the Job Bank Canada website in 2019 that were related to the construction sector were analyzed to identify the soft skills that are in demand in the construction industry. Out of the top 12 skills extracted from the job postings, seven skills are identified as the soft skills. "Team player" is the most sought-after skill in the construction industry, which appears in 56.4% of the job postings. Other soft skills in demand are "effective interpersonal skills," "excellent oral communication," "attention to detail," "reliability," "flexibility," and working in a "fast-paced environment." The analysis shows that the interpersonal and intrapersonal soft skills are in high demand in the construction industry.

Key Words: Soft skills, 21st century skills, Construction, Workforce, Team player

Introduction

The nature of the workplace is changing rapidly and the changed workplace requires a workforce with a new set of skills. A report from the National Research Council of the National Academies underscores the fact that because of changing nature of the workplace, individual workers of the future must be able to "adapt to new work environments, communicate using a variety of mediums and interact effectively with others from diverse cultures" (National Research Council, 2011, p.viii). The skills that individuals need can be broadly classified into hard skills and soft skills. Hard skills are required to perform the technical and managerial jobs and the skills have been a part of education and training for a long time. Soft skills, on the other hand, "are those personal attributes and interpersonal qualities that are intangible" (Robles, 2012, p.462). As such soft skills can be further divided into the interpersonal skills, which are essential in interaction with others, and intrapersonal skills, which are

talents or abilities that reside within the individual and aid him or her in the problem solving. Examples of the latter type of the skills are adaptability, self-organization, and self-motivation.

As the nature of the workplace and the nature of the routine jobs of yesterday are evolving rapidly, technical and managerial skills are necessary but not sufficient to accomplish a job effectively. From a series of workshops, the National Research Council identified three clusters of skills - Cognitive, Intrapersonal, and Interpersonal skills - as the 21st century skills essential for the future workforce (National Research Council, 2011). Cognitive skills include "nonroutine problem solving, critical thinking, systems thinking," interpersonal skills include "complex communication, social skills, team-work, cultural sensitivity, dealing with diversity," and intrapersonal skills include "self-management, time management, self-develop, self-regulation, adaptability, executive function" (National Research Council, 2011, p.2). These skills can be broadly classified as soft skills to differentiate them from the 'hard skills' which have been traditionally established as a minimum requirement for the professional and technical jobs. The soft skills and 21st century skills are used interchangeably in this paper as researchers in the past have been using "soft skills" contrasting them with the "hard skills" as in the papers by Bradley et al. (2020) and Zuo et al. (2018). However, it should be noted that some experts dislike the term "soft skills" as the term may downplay their importance (National Research Council, 2011). The soft skills are

Construction industry, like all other industries, is also experiencing a rapid change in the workplace. Unlike in many other industries, the soft skills, however, have been essential components of a successful workforce in the construction industry, as the workforce always requires coordinating among different stakeholders, multidisciplinary teams, and the trades. Zuo et al. (2018) have shown that the soft skills contribute to the project success factors of the construction projects. Although there have been studies to establish the connection between the soft skills and success of the construction projects, there is a gap in understanding the nature of the soft skills that the construction industry is currently looking for in the employees.

The purpose of this paper is to analyze the nature of the soft skills in demand in the construction industry and discuss how the soft skills correspond with the three clusters of 21st century skills identified by the National Research Council (2011). The data set used in this research is construction related job postings on the Job Bank Canada website in 2019.

Construction Job Postings Data

Job Bank is Canada's national employment service that connects the employers with the job seekers. Employment and Social Development Canada delivers Job Bank on behalf of the Canada Employment Insurance Commission, in collaboration with provincial and territorial governments (Job Bank, 2020a). The jobs can be posted on the platform by the employers and by other job boards too. The data used in this research is job postings on the Job Bank platform related to the construction industry from the year 2019. As Coronavirus Disease 2019 (Covid-19) affected all the sectors including the construction sector from early 2020, the data from 2020 was avoided and data from the year 2019 was used as the latest available data. The data, upon the request of the researcher, was sent by the Job Bank Canada team. The data "includes all the jobs in the Construction industries (North American Industry Classification System (NAICS); any code that starts with 23 - Construction) and all jobs with the most common National Occupational Classification (NOC) codes in the Construction industries (NAICS) minus accounting and housekeepers" (Job Bank, 2020b). The data also includes "all jobs that happen to have the word 'Construction' in it no matter which industry it falls under"

(Job Bank, 2020b). Although the job postings considered in this research are for positions in Canada only, the diverse range of job postings allows observing the general trend in the construction industry.

Analysis and Results

The methodology adopted in this paper is to analyze the job postings data using statistical tools to get insight into the nature of job postings, required level of education, experience, and skills. The skills data set is further visualized using word clouds and clustering. The data includes 36,075 unique job postings from 9,623 unique employers. As some postings have more than one position available, the 36,075 job postings had 86,354 construction related vacancies advertised on the Job Bank platform in 2019. The data set includes information on date of the job postings, number of days the jobs remain open, name of the province, required length of study (shown in Table 1), required skills and few other details. Each employer is identified by a unique identifier and each job posting has a unique identifier too. The required year of experience is included in the data as one of the skills required.

Table 1

Highest level of education and corresponding openings

Level of education	**Length of study names from the data set**	**No of postings (per cent)**	**No of vacancies (per cent)**
High School	Secondary (high) school graduation certificate	15490 (42.9%)	34220 (39.6%)
Apprenticeship	Registered Apprenticeship certificate	1281 (3.6%)	2562 (3.0%)
Other trades	Other trades certificate or diploma	3845 (10.7%)	8206 (9.5%)
College less than 1 yr	College, CEGEP [Collège d'enseignement général et professionnel] or other non-university certificate or diploma from a program of 3 months to less than 1 year	274 (0.8%)	442 (0.5%)
College 1-2 yr	College, CEGEP or other non-university certificate or diploma from a program of 1 year to 2 years	836 (2.3%)	1077 (1.2%)
College/CEGEP	College/CEGEP	1109 (3.1%)	1440 (21.7%)
Bachelor	Bachelor's degree	875 (2.4%)	1039 (1.2%)
Masters and above	Master's degree and earned doctorate degree	65 (0.2%)	70 (0.1%)
Level n/a	No degree, certificate or diploma	12300 (34.1%)	37298 (43.2%)

Open-source statistical programming R (R Core Team, 2020) was used to analyze the data and to generate a “text corpus” of skills and the job postings. The “text corpus” is a table of job postings and the list of skills required for the job postings. A free version of RStudio (RStudio Team, 2020) was used as an integrated development environment platform to run the R program. Open-source data

mining tool Orange (Demsar et al., 2013) was used to perform the textual analysis on the text corpus generated from R. The analytical results are discussed in the corresponding sections below.

Level of Education and Experience

One of the information available in the data set is the length of study that refers to the highest level of education required for each job posting. Table 1 gives a summary of the length of study, corresponding number of postings and vacancies. A shorter identifier, shown as level of education in column 1 in Table 1, is used to represent the length of study results in this paper. Master's degree and doctorate degree are merged into one as Masters and above for further analysis. Out of the 36,075 job postings, 15,490 (43%) postings required only high school whereas 940 postings required bachelor's degree or higher level of education (Table 1).

Interestingly, more than 12,300 (34%) job postings, which in total have 37,298 vacancies (43%), require no degree, certificate, or diploma (Table 1). There may be two reasons for this. First, the jobs may be looking for workers requiring no formal education or training. Second, the employers may not be asking specifically for any education requirement as the level of education is offset by the level of experience specific to the job. An analysis of the years of experience required for the job postings against the level of education was done to analyze this point further. The results of the number of vacancies vs sought-after level of experience are plotted for different levels of education in Figure 1.

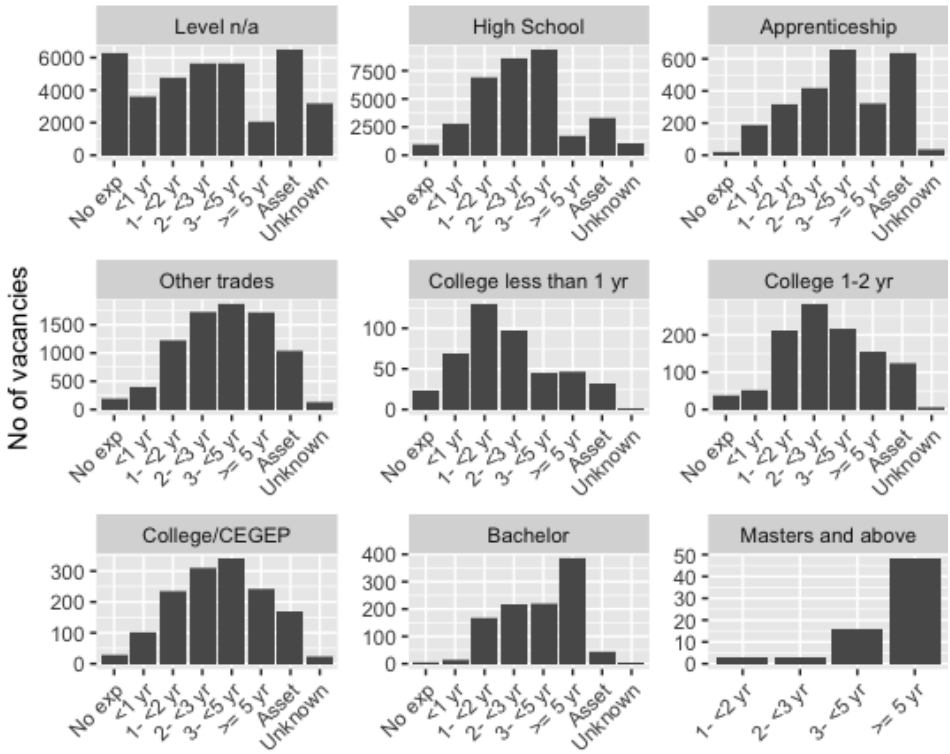

Figure 1. Number of vacancies and required experience for different levels of education

A large share of the vacancies that do not require any specific level of education (Level n/a in Figure 1) also does not require any experience or require experience less than one year. Therefore, it cannot

be conclusively said that experience is used as a proxy for education and training in job postings that do not specify the required level of education. Although many vacancies are advertised without any specific education requirement and without any previous work experience, the vacancies that specify the required level of education and training also prefer people with previous work experience (Figure 1). For example, a large share of vacancies requiring bachelor's degree and above also requires experience of 5 years or more. Most of the other postings that specify the required education level also ask for 1-5 years of experience.

21st Century Skills in the Construction Jobs

As discussed earlier, the workplace in the construction industry is changing significantly from the workplace of yesterdays in many ways. Advancement in technology, introduction of artificial intelligence (AI), computers, and automation to perform complex routine tasks, and a workforce with diverse cultural backgrounds are some of the factors that require a separate set of skills to complete the projects successfully. A successful construction company needs individuals who are not only technically sound but also are able to navigate the changing workplace effectively.

Textual analysis was carried out on the data set of skills from the job postings. Figure 2 shows the combined word clouds of single words (unigrams) and two words (bigrams) extracted from the skills data set. Words that are too common to indicate any significance such as "construction," "steel-toed," "boots," "hard," "hat," "year(s)," and numbers are removed from the plot.

Figure 2. Word cloud diagram of single and double words in the skills

The word cloud in Figure 2 is plotted only for the most frequently occurring words above 5000 occurrences. The word cloud shows that most commonly occurring words in the skills are "materials," "equipment," "demanding," and "specifications." One of the prominently occurring soft skills from the list of single words is "communication." The plot of two words on the same diagram shows that "team player," "attention detail," "effective interpersonal," "fast-paced environment," "interpersonal skills," and "oral communication" are most commonly sought-after soft skills in the construction industry. To visualize the skills in their entirety, a cloud diagram for the complete sentences used in

the skills is shown in Figure 3. The word cloud is plotted without removing numbers and stop words and it includes all the commonly occurring phrases too. “Team player,” “Effective interpersonal skills,” “Attention to detail,” and “Excellent oral communication” are some of the most commonly featuring soft skills in the job postings.

Figure 3. Word cloud of complete sentence of the skills

The top 12 most sought-after skills and frequency of their occurrence as percentage of job posting are shown in Table 2. Only 12 skills are listed in the table as there are only three more skills corresponding to the soft skills in the list up to 31st most sought-after skills. “Excellent written communication,” which is one of the soft skills in the cluster of interpersonal skills, is 31st most sought-after skill that is shown in the bottom row of Figure 3. Out of the top 12 skills, seven can be identified as the soft skills. The soft skills are highlighted rows in the table. The soft skills were then grouped into the three clusters of 21st century skills to visualize demand for these skills in the construction industry. Although many of these soft skills are not exactly worded as in the list of 21st century skills identified by the National Research Council (2011), a close correspondence can be established as shown in the second column of the table. Out of the seven soft skills, three skills can be broadly classified in the cluster of interpersonal skills and remaining four in the cluster of intrapersonal skills. Among the top skills advertised by the employers, no close correspondence could be established with any of the skills in the cognitive skills cluster. The cognitive skills cluster includes nonroutine problem solving, critical thinking, and systems thinking (National Research Council, 2011, p.2). The analysis indicates that further study is needed to examine the importance of the cognitive skills in the construction sector and and to identify the reasons for the absence of these skills in the current job postings. Moreover, the nature of demand of 21st century skills in other sectors and the approach other sectors are taking to hire employees with cognitive skills can provide further insight into the current gap in the construction sector.

Although these soft skills may not be completely new skills in demand in the construction industry, the importance paid by the employers on these skills are important pointers for education providers. In preparing the 21st century workforce, the education providers need to identify ways to introduce these new skills in the formal and informal education and training such as project-based learning (Bell, 2010) and game-based learning (Qian & Clark, 2016). In the case of education providers in the construction sector, these new skills need to be imparted without compromising and limiting the traditional hard skills and job related technical and managerial knowledge. The challenge is not only

in introducing these skills in the formal education and in training programs but also in measuring how well the learners are acquiring the skills and in recognizing their progression. These new set of skills must be made a part of the curricula, instruction, and assessment (Geisinger, 2016).

Table 2

Top 12 skills and correspondence of soft skills with 21st century skills

Top 12 skills	21st century skills	No of occurrences	% of job postings
Team player	Interpersonal: Team-work	20,353	56.4%
Physically demanding		17,546	48.6%
Steel-toed safety boots		16,416	45.5%
Attention to detail	Intrapersonal: Self-management	12,926	35.8%
Various locations		12,416	34.4%
Handling heavy loads		12,155	33.7%
Reliability	Intrapersonal: Executive function	11,867	32.9%
Valid driver's licence		11,692	32.4%
Flexibility	Intrapersonal: Adaptability	11,189	31.0%
Fast-paced environment	Intrapersonal: Time-management	10,915	30.3%
Effective interpersonal skills	Interpersonal	10,371	28.7%
Excellent oral communication	Interpersonal: Complex communication	9,991	27.7%

Conclusion

Like in all other industries, the 21st century workplace in the construction industry has changed significantly because of many factors internal and external to the work environment. One of the internal factors inducing the change is the workforce itself, which has more cultural diversity than before. AI, automation, information technology, and tasks moving from brick-in-mortar office rooms to virtual environments are some of the factors that are shaping the current workplace both internally and externally. Realizing the swift change in the workplace, the National Research Council identified few soft skills as 21st century skills essential for the workforce across the industries (National Research Council, 2011). Job posting from the construction industry in 2019 on Job Bank Canada website was analyzed to examine the nature of the soft skills in demand in the industry and their correspondence with the skills listed as 21st century skills.

The analysis shows that soft skills are highly sought-after skills in the construction workforce. Out of the top 12 skills, seven skills were soft skills that the employers were looking for in the employees. "Team player" is at the top of the list with 56.4% job postings requiring the candidates to have this skill. According to the clustering suggested by the National Research Council workshop (2011), these seven skills can be organized in the following clusters.

> Cognitive skills - none
> Interpersonal skills - three ("Team Player," "Effective interpersonal skills" and "Excellent oral communication")
> Intrapersonal skills - four ("Attention to detail," "Reliability," "Flexibility" and "Fast paced environment")

The soft skills are in high demand in the construction industry and a large majority of the employers wants their employees to be a team player and to be equipped with effective interpersonal skills. They want individuals who pay attention to the details, are both reliable and flexible, and are ready to work in a fast-paced environment. The study also shows that cognitive soft skills such as nonroutine problem solving, critical thinking, and systems thinking are not mentioned explicitly in the required skills set.

From this research, it is evident that the employers in the construction industry are looking for individuals with interpersonal and intrapersonal soft skills. This finding points to the fact that the soft skills need to be a major part of the formal education and training of the construction workforce. The education providers need to devise a strategy to impart these skills in the graduates to meet the demand of the skills that are essential in the 21st century workplace. The challenge for the educators, however, may not only be on how to coach these skills but also on recognizing progression of the learners in mastering these skills.

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