Boston Information Technology Training Inventory

Overview

The Greater Boston area has long been home to a vibrant Information Communication Technology (ICT) cluster. Many firms in this region are seeking workers who can help build and innovate the future of the tech landscape. Positions like web developers, computer network architects, and software developers will all be essential in sustaining Boston's technology industry. But rather than training future workers for these types of roles, many training programs merely mirror the national framework for technology workforce development which primarily consists of training network and computer system administrators, computer systems analysts, and other, less innovative and inventive, positions focused on supporting current infrastructure.

This study finds that Boston's technology industry has a structural misalignment between the types of job training and position openings. While the database of training programs from this study is not exhaustive, it suggests that some high-demand occupations are left unfilled while some students are being trained for occupations which are already over-supplied within the region. This is especially important in the context of Boston's high concentration of these under-supplied positions; an analysis of the concentration of occupations relative to national averages reveals that IT positions which create new products and systems were twice as concentrated in the Boston area than the national average. The effects of the disparity between the supply and demand of these occupations can be observed through relatively low rates of job posting fillings in the industry throughout the region. This ultimately constrains growth within the industry and encourages recruiting from outside the area.

Furthermore, rates of diversity among the industry are low relative to the demographics of the surrounding regions and are also lower than those found in other established technology metropolitan areas. Programs that help train a diverse array of students for "developer" positions would meet tremendous success in terms of candidate placement upon completion while simultaneously enhancing the regional technology industry.

Research Findings

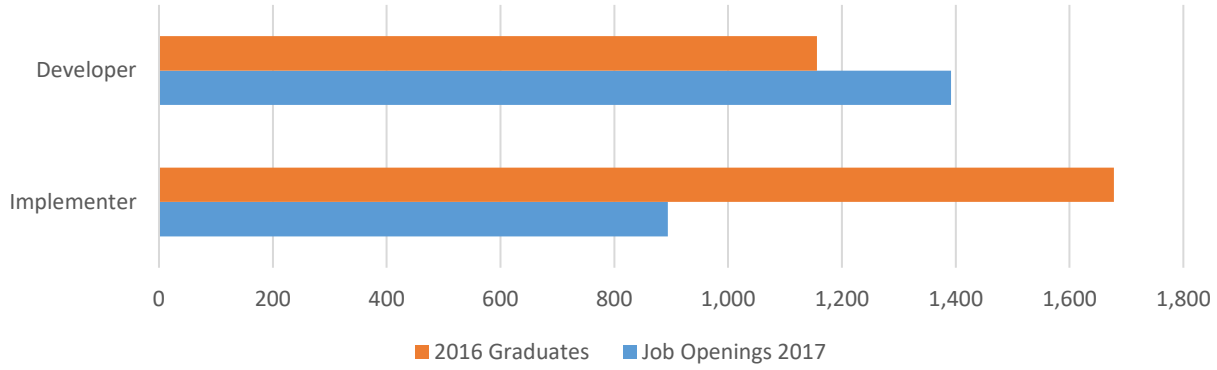
Greater Boston's Information and Communications Technology industry is a driving force in the regional economy. Technology jobs in Boston are growing faster than the national average but slower than other technology hubs across the nation. In the past year, over 1,500 "developer" and "implementer" jobs[1] were created in Greater Boston, translating to 5% growth or 1 percentage point greater than the national average.

In the sample area of Boston, technology job growth does not correspond with the available technology training programs. The sample area of Boston is currently training 1,678 "implementers" per year for 894 new job openings and 1,156 "developers" for 1,392 new job openings (Figure 1). Furthermore, since the sample of training programs in this study is not exhaustive, an even larger discrepancy is likely to be present. This research reveals that training programs are producing an excess number of "implementers" for the region and under-producing "developers". While the number of "implementers" trained may meet the market demand in Boston, "developer" training is lagging behind sustainable levels, especially considering that Boston hosts a concentration of "developer" positions that is twice that of the national average.

This shortage in "developer" training is likely a consequence of the bottleneck in talent recruitment that has appeared in recent years. Pathways into "developer" careers typically stem from only a small number of the most elite universities in Greater Boston which have a proven track record of producing top "developers". Conversely, it is uncommon for an individual with a Computer Science degree from outside of these top universities to be offered a "developer" position upon graduation because many of these programs merely demonstrate literacy in computer languages. In order to alleviate the shortage of those being trained for "developer" positions, new pathways to the positions must be explored and embraced by employers.

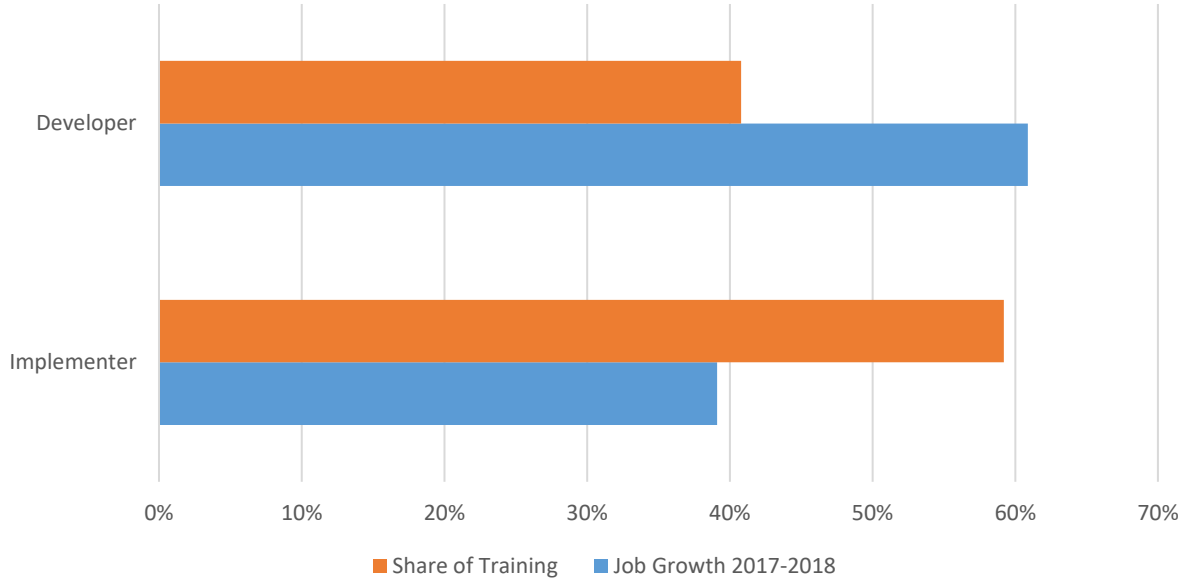
[1] In this study, the classifications of "developer" and "implementer" were adopted as a method of categorizing occupational segments where industry growth is occurring. "Developer" occupations are those that create new products (software, networks, etc.) while "implementer" occupations are those that deploy technology across an organization (See Methodology for further explanation). Implementer positions include third-party organizations, such as those provided by temporary agencies.

Figure 1: IT Graduates and Job Openings in Sampled Area of Boston



In Greater Boston, available technology positions are going unfilled at higher rates relative to the national averages. While the national monthly average rate for filling IT job (unique jobs) postings is around 21 percent, Boston's workforce system is only filling 14 percent of these positions during the same timeframe.[2] Given these low rates of filling vacant employment opportunities, IT companies must increase the workload for already employed workers or face stagnating growth. Furthermore, training for technology positions are misaligned with historical growth. In the Boston area, "developer" roles accounted for 61% of all IT job growth while training for these roles only accounted for 41% of IT training. Conversely, training for "implementer" roles accounts for 59% of all IT training, even though "implementer" roles only accounted for 39% of growth in Boston IT jobs (Figure 2).

Figure 2: Job Growth and Share of Training Across Implementers and Developers in Sampled Area of Boston



[2] Emsi. 2018.2

The location quotients (concentrations of workers relative to national averages) for the IT industry in Greater Boston reveal that Boston is a hotspot for both Developer and Implementer occupations. Implementer positions were, on average, 1.23 times more concentrated here compared to the rest the United States (Table 1*: Location Quotient for Implementers in Greater Boston*). This finding is not surprising, as Greater Boston's thousands of businesses require IT support in the form of "implementers" who work through both in-house and third-party operations. This concentration would likely be higher if not for the Region's relatively high cost of living[3] and cost of office real estate[4] that make distant data centers a cost-effective decision. Boston is home to an even higher concentration of new product creators and developers. "Developer" positions were 2.01 times more prevalent than the national average (Table 2).

Table 1: Location Quotient for Implementers in Greater Boston[5]

Occupation	**Description**	**United States**	**Boston-Cambridge-Newton, MA-NH**
15-1111	Computer and Information Research Scientists	1.00	1.66
15-1122	Information Security Analysts	1.00	1.44
15-1121	Computer Systems Analyst	1.00	1.19
15-1131	Computer Programmers	1.00	1.07
15-1141	Database Administrators	1.00	1.13
15-2031	Operations Research Analysts	1.00	1.67
15-1199	Computer Occupations (All Other)	1.00	1.31
15-1142	Network and Computer Systems Administrators	1.00	1.15
	Average:	1.00	1.23

Table 2: Location Quotient for Developers in Greater Boston[6]

Occupation	**Description**	**United States**	**Boston-Cambridge-Newton, MA-NH**
15-1132	Software Developers, Applications	1.00	1.67
15-1133	Software Developers, Systems Software	1.00	3.06
15-1134	Web Developers	1.00	1.54
15-1143	Computer Network Architects	1.00	1.58
	Average:	1.00	2.01

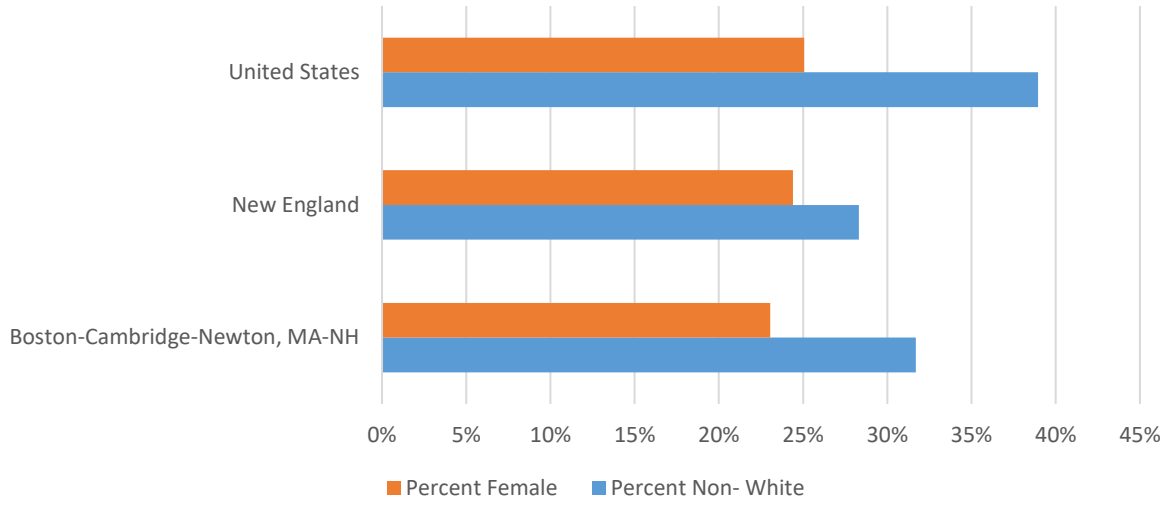
[3] MIT Cost of Living Calculator. http://livingwage.mit.edu/metros/14460. 2018.
[4] "Boston Office Market Report". Lincoln Property Company Second Quarter 2017 Report.
[5] QCEW Employees - Emsi 2018.3
[6] Ibid.

Demographic Profile

Employment diversity is a national issue throughout the technology industry, and the Boston and New England regions are not exceptions. Boston, the counties of Greater Boston, as well as the entire New England region were all below the national averages for both gender and racial diversity in 2017.

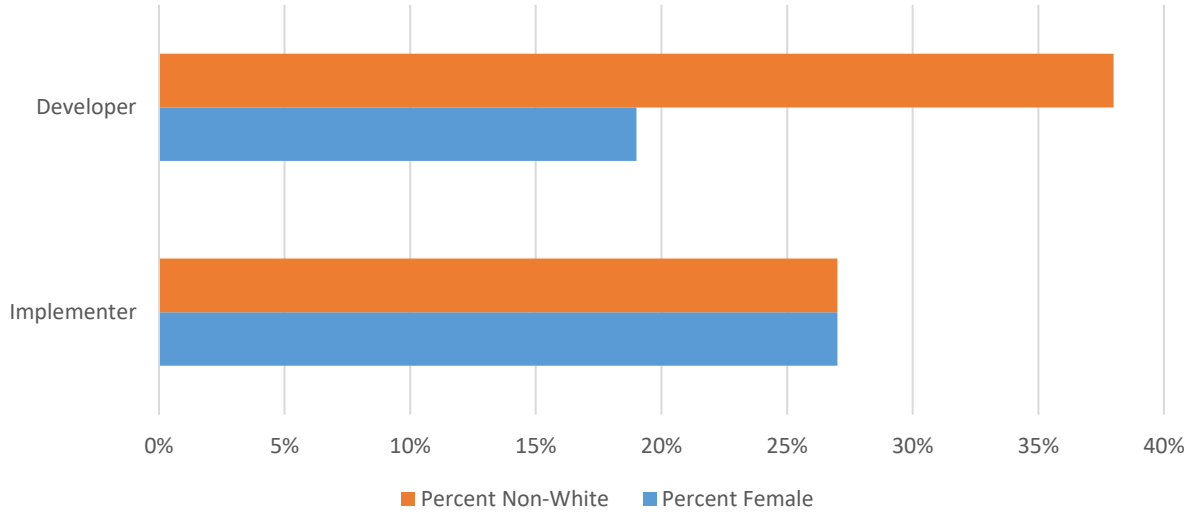
While Boston has a greater percentage of non-white employees than the rest of New England, racial diversity in both regions remains at least 5 percentage points below the national average (Figure 3). IT positions were not exempt from this trend and were usually slightly lower in diversity than most occupations in Greater Boston.

Figure 3: Gender and Racial Diversity in IT Industry (2017)



Diversity varied greatly by position. “Developers” tended to be relatively more racially diverse though simultaneously male dominated. This trend was exhibited by all technology occupation types across the country. However, “implementer” positions in the three target regions exhibited equal levels of gender and racial diversity (Figure 4). This revelation presents a number of opportunities to increase workplace diversity in the tech industry. Greater emphasis should be placed in hiring more “developers” of diverse backgrounds, especially women. “Implementer” occupations would also benefit from initiatives that particularly emphasize hiring those from diverse backgrounds.

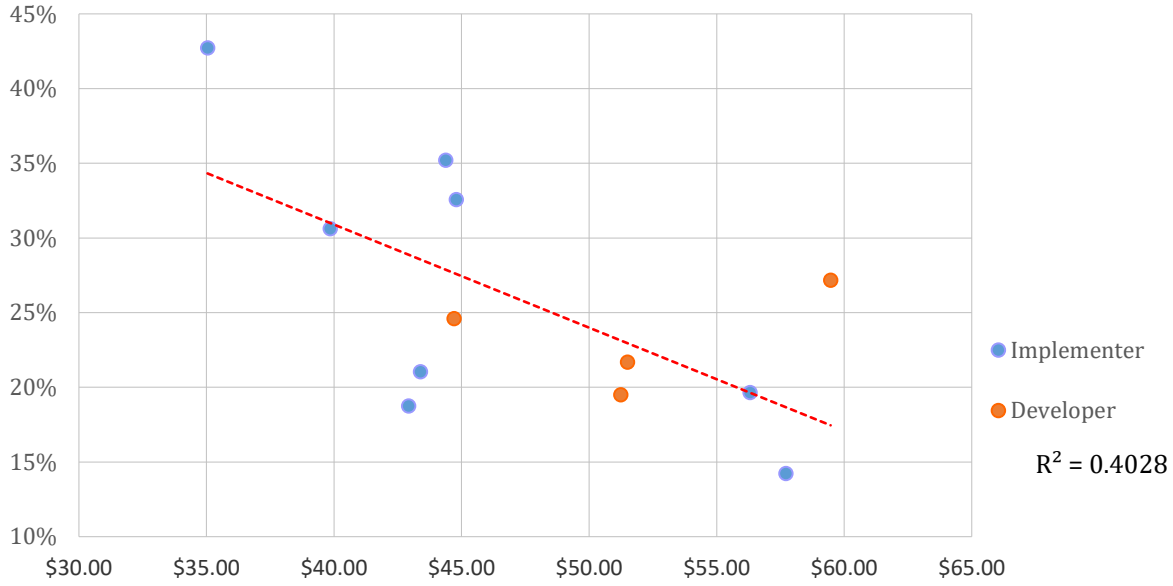
Figure 4: Gender and Racial Diversity in the United States by Occupational Classification (2017)



Women are far less likely than men to occupy positions in higher paying IT occupations throughout Greater Boston. Figure 5 illustrates the visible negative correlation between the percentage of females in IT occupations and the median hourly earnings. In other words, there are generally higher percentages of women in lower paying IT occupations and lower percentages of women in higher paying IT occupations. Furthermore, a study done by the National Center for Women and Information Technology of Education Statistics found that women in the USA comprised only 18% of Computer Science degrees.[7] A potential recourse to these findings includes revamping training programs which help train women, including those who already trained, to acquire skill sets that are required among the higher paying "developer" occupations. Empowering women through increased "developer" trainings can help mitigate this trend of economic disenfranchisement in the IT sector.

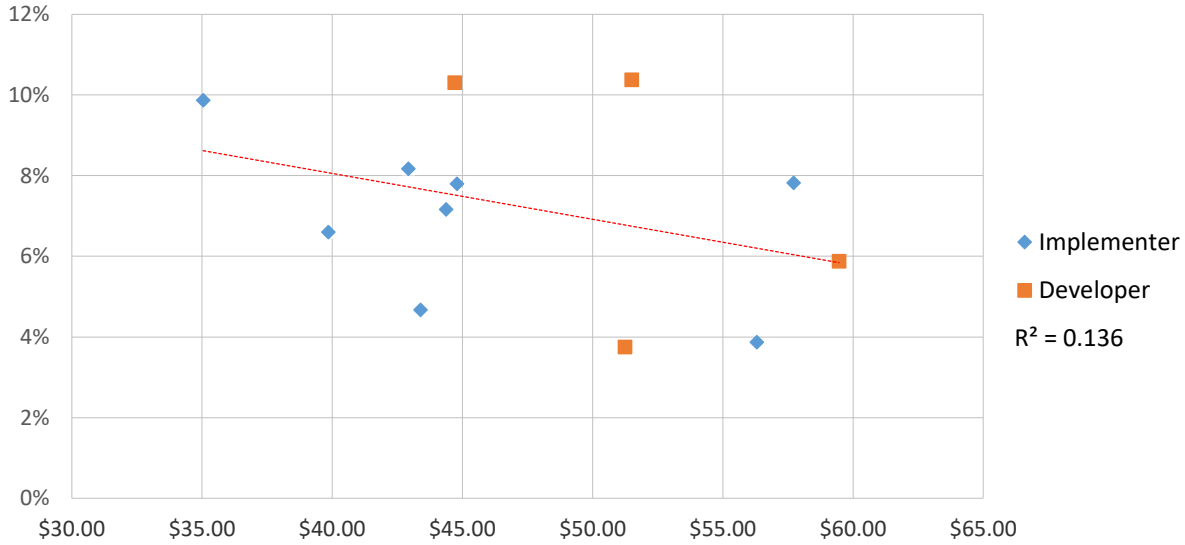
[7] Catherine Ashcraft, Elizabeth Eger, and Michelle Friend. "Girls in IT: The Facts". National Center for Women & Information Technology (NCWIT). 2018.

Figure 5: Percentage of Females in Each IT Occupation by Median Pay



Higher paying IT occupations also generally hire lower percentages of African American or Black, and Hispanic or Latino individuals. As was the case with female IT occupations, African American or Black individuals and Hispanic or Latino individuals are more heavily represented among lower-wage IT occupations than in higher-wage IT occupations (Figure 6). While the negative correlation between these is less pronounced than it is among female IT employees, the trend remains visibly discernable. This disconnect reflects a lack of opportunities and training available for the select groups. Increasing access to career development and training opportunities for these individuals would help mitigate the shortage of "developers" in the region while benefiting women and minority IT candidates, workplaces, and communities alike.

Figure 6: Select Diversity Groups in Each IT Occupation by Median Pay*



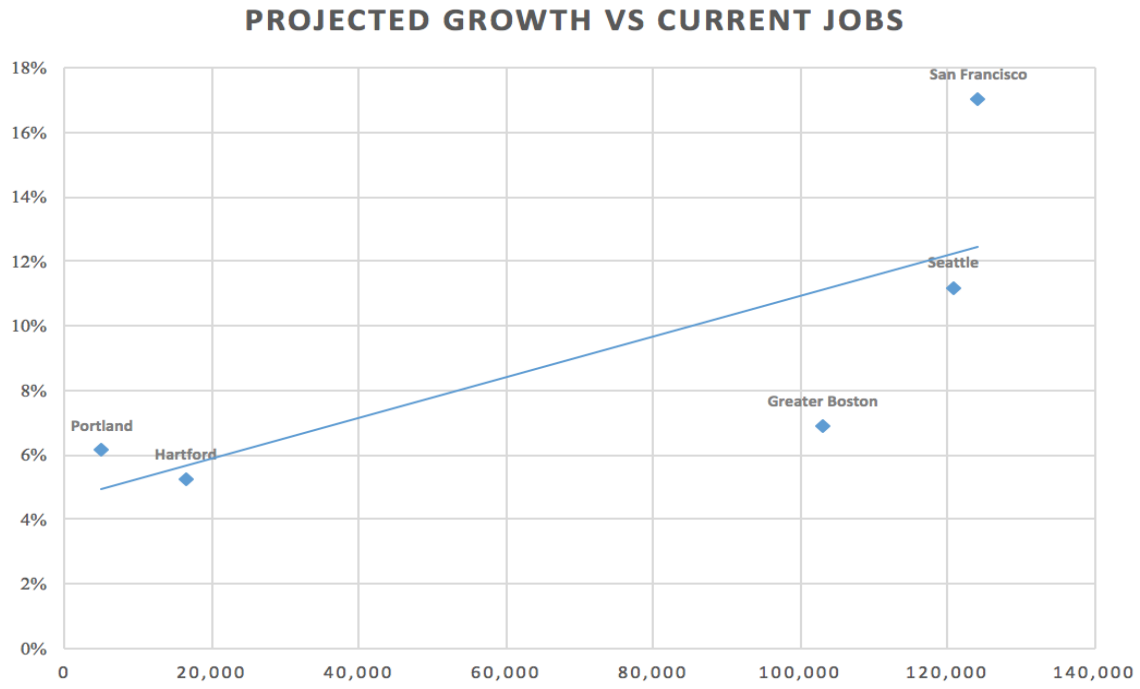
* Select Diversity Groups include African American or Black, and Hispanic or Latino individuals.

The types of occupations filled by underrepresented populations may be just one part of the picture. Promotion into management roles is another facet in which women and minorities are often underrepresented. A 2018 report by Ascend found that Asians in the Bay Area technology sector between 20117 and 2015 were the largest racial cohort, yet were also the least likely to become Managers and Executives.[8] While this study may have been limited to the Bay Area technology sector, other studies have highlighted similar findings across industries and geographic regions.[9] Promotions and management opportunities for all people, regardless of gender, race, or ethnicity are important in maintaining an effectual work environment, attracting top talent, and ensuring that every worker's talents are developed to their full potential.

Potential Impacts on Industry Growth

Data suggests that some growth potential may be lost due to an insufficient number of graduates prepared for "developer" positions in the Boston area. While job postings are abundant, positions in the Boston region have a relatively high proportion that go unfilled. This problem is further exacerbated by the fact that candidates for such positions are not being trained locally. By percentage, Boston is filling the fewest of its postings out of any of the selected cities that are similar. This likely plays a role in forecasting the region's future growth, which is low relative to that of cities with similar numbers of IT employment (Figure 7).[10]

Figure 7: IT Employment Vs. Projected Growth in Selected Regions 2018-2023



[8] Ascend. "The Illusion of Asian Success: Scant Progress for Minorities in Cracking the Glass Ceiling from 2007–2015". 2017.
[9] Buck Gee and Denise Peck. Harvard Business Review. "Asian Americans are the Least Likely Group in the U.S. to be Promoted to Management". 2018.
[10] Emsi. 2018.2

Conclusions

This report highlights the incongruity between IT occupation supply and demand within the Boston region. Part of this difference is due to variance in the sub-industry pathways; while "developer" occupations are typically offered only to graduates of top universities or top talent already working within the industry, "implementer" positions can arise from a number of different pathways. High school graduates with technical program training, graduates of community college, and four-year degree holders from both technical and non-technical (if technical program training is undertaken) backgrounds are all pathways one can take to an "implementer" role.

Attaining a "developer" position requires more than a degree; it requires networking, showcasing of talent and abilities (e.g. a GitHub account portfolio), and proving that a candidate is a business-minded problem solver. Given the relatively high barriers to entry into "developer" positions, a range of new pathways ought to be explored. A partnership between NOVAworks in Silicon Valley and Stanford University provides an example for circumventing the occupational bottleneck. Participants in the NOVAworks programs were allowed to network at a Stanford career fair to demonstrate the work that they had done, resulting in the program's highest-ever placement rates.

Another possible method for developing new pathways might involve an investigation into the technical and non-technical skills and abilities "implementer" roles have, and how well those skills transfer to the skillsets required among "developer" roles. Programs that then focus on the skillsets that "implementers" lack would have better placement rates among "developer" occupations. This pathway would particularly help increase access to "developer" roles by allowing entry for workers from all ranges of education and backgrounds.

Investigating the quality of "implementer" programs is another area of interest. The Boston region is training an abundance of "implementers," but those candidates may not meet the qualifications or expectations of regional employers and end up employed outside the area. Furthermore, it is unlikely that a program which failed to produce quality "implementers" would meet much success in transforming "implementers" into "developers". A comprehensive examination of success rates across programs would provide a clearer picture of the IT training landscape, allowing for more guided and effective decision making.

Examining the potential for programs which create opportunities for low-income, underrepresented, entry-level workers to enter the types of elite institutions which tend to generate sought-after "developer" candidates is another way to increase access to these roles. If "developer" firms generally only hire those who graduate from elite institutions, increasing access to elite educational institutions should lead to increased access to "developer" roles.

Moving forward, training programs should leverage Boston's relatively diverse labor pool to develop and attract the best and the brightest to the field, with particular emphasis on women, people of color, and low-income individuals. Efforts to diversify the Boston IT industry should occur throughout the labor supply chain; Training programs should pursue diverse talent by establishing pipelines with regional colleges, high schools, and communities. Part of this initiative should include increasing long-term exposure to careers within Tech. Interest and opportunity early in an individual's education can have a longstanding impact in garnering interest and achieving goals. Early exposure to the field can ensure that IT attracts the future innovators of the world.

Ultimately, a system which can test IT candidates on their abilities and then connect qualified candidates with employers would aid in creating fluidity and transparency within the IT labor market. Such a system would benefit job candidates and employers alike; candidates receive access to a recruitment platform that verifies and displays their abilities while employers benefit from a simpler process which reduces risks associated with new hires. This system would also help break down some of the present barriers to entering "development" careers and help fill the regional demand with a skilled and qualified workforce.

Methodology and Appendix

The Economic Advancement Research Institute (EARI) was engaged by SkillWorks and Hack.Diversity to conduct a supply-side analysis of technology and other computer-related education and training programs in Greater Boston within Suffolk, Norfolk and Middlesex counties (sample area of Boston) (n=123). These counties were selected as they account for over 85% of total technology jobs in Greater Boston. The goal of the project is to create an inventory of training programs that includes occupation and skill focus, prerequisites, customer base, capacity, employer engagement, outcomes, and other key elements. The data will be used to provide a better understanding of the current landscape of available opportunities for residents to be trained for a technology career. This information will also provide insights into how resources should be invested to support the present and future technology labor pool. The research was conducted in two stages: secondary (desktop) research and primary research.

The first phase involved desktop research to identify technology-related education and training programs in the sampled area of Boston. Resources included the Eligible Training Provider List (ETPL), industry association lists (CompTIA providers, etc.), university and college catalogues (IPEDS), NETL, for-profit training programs, and internet searches. The second phase involved telephone interviews (with option for online intake) with all program providers. Finally, comparable technology clusters around the country were identified for analysis. The selected clusters were located in Seattle (WA), San Francisco (CA), Oakland (CA), Hartford (CT), Portland (ME), and New York (NY), and Newark (NJ).

To better analyze the occupational landscape in the technology industry, 14 Standard Occupational Classifications (SOC) were selected: Computer and Information Research Scientists (15-1111), Computer Systems Analysts (15-1121), Information Security Analysts (15-1122), Computer Programmers (15-1131), Software Developers Applications (15-1132), Software Developers Systems Software (15-1133), Web Developers (15-1134), Database Administrators (15-1141), Network and Computer Systems Administrators (15-1142), Computer Network Architects (15-1143), Computer Occupations All Other (15-1199), Operations Research Analysts (15-2031). It is also important to note that “youth” programs are excluded in the sample of technology and other computer-related education and training programs in the sample area of Norfolk, Suffolk, and Middlesex.

The classifications of “Developer” and “Implementer” were adopted as a method of categorizing occupational segments where industry growth is occurring. They are defined here:

1. "Developer" – an occupation that creates new products (software, networks, etc.);
2. "Implementer" – an occupation that deploys technology across an organization;

This study did not determine the quality of work performed by technology professionals and graduates in the sample area of Boston. Performance data may be helpful in analyzing factors such as technology workforce development and the general success of different types of training programs.

APPENDIX

Appendix A: Breakdown by SOC Code

SOC	2017 Jobs	2018 Jobs	2017 - 2018 Change	2017 - 2018 % Change	Annual Openings	2017 - 2018 Openings	2017 - 2018 Replacement Jobs	Annual Replacement Jobs	Job Category
15-1111	790	830	40	5%	92	92	52	52	Implementer
15-1121	10,798	11,072	274	3%	954	954	680	680	Implementer
15-1122	2,408	2,515	107	4%	265	265	159	159	Implementer
15-1131	3,949	4,020	71	2%	316	316	245	245	Implementer
15-1132	22,115	23,129	1,014	5%	2,407	2,407	1,393	1,393	Developer
15-1133	19,793	20,041	248	1%	1,506	1,506	1,247	1,247	Developer
15-1134	3,019	3,091	72	2%	280	280	208	208	Developer
15-1141	2,003	2,052	49	2%	175	175	126	126	Implementer
15-1142	6,352	6,470	118	2%	505	505	387	387	Implementer
15-1143	3,994	4,052	58	1%	311	311	252	252	Developer
15-1199	6,733	6,875	142	2%	587	587	444	444	Implementer
15-2031	2,713	2,806	93	3%	251	251	157	157	Implementer
	100,892	**103,511**	**2,619**	**3%**	**9,151**	**9,151**	**6,520**	**6,520**	

Appendix B: Diversity Breakdown by Region

Category	United States	New England	Boston-Cambridge-Newton, MA-NH	Middlesex County, MA	Suffolk County, MA	Norfolk County, MA
Developers						
Jobs (2017)	1,550,333	101,210	57,526	30,913	12,085	5,923
Jobs (2018)	1,608,871	103,919	59,089	31,577	12,754	5,982
Hispanic or Latino % of Occupation	4.9%	2.6%	2.5%	2.3%	3.0%	2.2%
White % of Occupation	56.4%	66.6%	63.9%	61.3%	61.4%	67.8%
Black or African American % of Occupation	4.4%	2.0%	1.8%	1.5%	2.5%	2.6%
Asian % of Occupation	32.5%	27.6%	30.6%	33.6%	31.7%	26.3%
Implementers						
Jobs (2017)	1,907,760	97,079	42,953	19,917	11,248	4,582
Jobs (2018)	1,950,938	98,792	43,969	20,351	11,673	4,616
Hispanic or Latino % of Occupation	7.2%	4.0%	4.1%	3.9%	4.8%	3.4%
White % of Occupation	64.9%	77.0%	74.2%	72.8%	71.0%	75.7%
Black or African American % of Occupation	9.4%	4.0%	4.1%	3.4%	5.5%	5.8%
Asian % of Occupation	16.5%	13.7%	16.1%	18.4%	17.1%	13.9%

Specific Areas of Focus

SOC	Description	2018 - 2022 Change	Median Hourly Earnings	Typical Entry Level Education	2018 - 2022 % Change	Black, African American,
15-2031	Operations Research Analysts	291	$35.04	Bachelor's degree	8%	10%
15-1199	Computer Occupations, All Other	339	$44.70	Bachelor's degree	4%	10%
15-1143	Computer Network Architects	106	$57.72	Bachelor's degree	2%	8%
15-1142	Network and Computer Systems Administrators	268	$42.92	Bachelor's degree	3%	8%
15-1141	Database Administrators	125	$44.38	Bachelor's degree	5%	7%
15-1134	Web Developers	182	$39.85	Associate's degree	5%	7%
15-1133	Software Developers, Systems Software	365	$56.31	Bachelor's degree	2%	4%
15-1132	Software Developers, Applications	3,147	$51.24	Bachelor's degree	11%	4%
15-1131	Computer Programmers	25	$43.39	Bachelor's degree	1%	5%
15-1122	Information Security Analysts	324	$51.51	Bachelor's degree	11%	10%
15-1121	Computer Systems Analysts	649	$44.79	Bachelor's degree	5%	8%
15-1111	Computer and Information Research Scientists	115	$59.44	Master's degree	12%	6%

Of the positions included in this report, software developers (applications) are projected to have the most new openings over the next 4 years. Simultaneously, this position has only 4% of its positions occupied by Black, African American, Hispanic, or Latino employees.

Web Developers are the most accessible position included in the occupation of this report, requiring only an associate degree, but still exhibited low levels of diversity.