UNDERSTANDING WORKFORCE ATTRIBUTES BY EXPLORING EMPIRICAL CAREER PATHWAYS OF CYBERSECURITY PROFESSIONALS

Information Technology and Decision Sciences

November 8, 2018

Dan J. Kim, Ph.D.
University of North Texas
Need for Cybersecurity Workforce

• The 2018 Global Risk Report by the World Economic Forum has listed cybersecurity attacks as the second most likely cause of global instability behind environmental disaster.

• Cybersecurity workforce participation will grow at 10% annually from 2015 to 2020, and that annual spending on cybersecurity will reach $170 billion (Morgan, 2015).
### Table 6: Top-Ten Most Difficult to Find and Most Important Technical Skills, 2017

<table>
<thead>
<tr>
<th>Technical Skill or Capability</th>
<th>Percentage Selecting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Most Difficult to Find (% Selecting)</td>
<td>Most Important to Organization (% Selecting)</td>
</tr>
<tr>
<td>Security / Cybersecurity</td>
<td>1 (52.2%)</td>
<td>1 (50.6%)</td>
</tr>
<tr>
<td>Analytics / Business Intelligence / Big Data / Data Scientist</td>
<td>2 (41.7%)</td>
<td>2 (36.0%)</td>
</tr>
<tr>
<td>Analyst --- Business (a)</td>
<td>3 (23.3%)</td>
<td>3 (31.0%)</td>
</tr>
<tr>
<td>Functional Area Knowledge</td>
<td>4 (20.9%)</td>
<td>4 (21.6%)</td>
</tr>
<tr>
<td>Architecture / Architect --- Application / Solution (b)</td>
<td>5 (18.0%)</td>
<td>5 (19.9%)</td>
</tr>
<tr>
<td>Cloud</td>
<td>6 (17.4%)</td>
<td>8 (19.1%)</td>
</tr>
<tr>
<td>ERP (Enterprise resource planning)</td>
<td>7 (16.9%)</td>
<td>5 (19.9%)</td>
</tr>
<tr>
<td>Architecture / Architect --- Data / Information (c)</td>
<td>8 (15.9%)</td>
<td>10 (15.3%)</td>
</tr>
<tr>
<td>Architecture / Architect --- Enterprise (d)</td>
<td>9 (15.3%)</td>
<td>13 (11.7%)</td>
</tr>
<tr>
<td>Software Packages / COTS (e.g., ERP, CRM, DBMS, etc.) (e)</td>
<td>10 (13.8%)</td>
<td>11 (14.0%)</td>
</tr>
<tr>
<td>Agile Software Development</td>
<td>11 (12.6%)</td>
<td>9 (15.6%)</td>
</tr>
<tr>
<td>IT Project Manager</td>
<td>12 (12.2%)</td>
<td>5 (19.9%)</td>
</tr>
</tbody>
</table>

(a) New item added in 2017. However, “Business Analysis” appeared on the list of soft skills in 2015 and was 4th on most difficult to find and 3rd on most important.
(b) In 2015, “Architecture / Architect --- Application / Solution” was “Application / Solution Architecture.”
(c) In 2015, “Architecture / Architect --- Data / Information” was “Data / Information Architecture.”
(d) In 2015, “Architecture / Architect --- Enterprise” was “Enterprise Architect.”
(e) New item added in 2017.

n = most senior IT leader in 769 unique organizations
Career Paths of Cybersecurity Professionals

• There are many opportunities for cybersecurity workforce
• There are many career paths with different workforce attributes (factors)
Factors Affecting Career Path

Leadership, Knowledge Skills, Ability Credentials, Experience, Citizenship, Security Clearance, etc.
Not easy to see a big picture
Review on Previous Relevant Work

Existing Industry Frameworks

• Cybersecurity Career Pathway by CyberSeek (www.cyberseek.org)
• CompTIA Cybersecurity Career Pathway (certification.comptia.org/certifications)
• EC-Council Career Path by CAST (Center for Advanced Security Training)
• SANS training/certification roadmap (www.giac.org/certifications/get-certified/roadmap)
Common Cybersecurity Feeder Roles

- Networking
- Software Development
- Systems Engineering
- Financial and Risk Analysis
- Security Intelligence

Core Cybersecurity Roles

- Cybersecurity Consultant
- Entry-Level
  - Cybersecurity Specialist / Technician
- Mid-Level
  - Cybersecurity Analyst
  - Cyber Crime Analyst / Investigator
  - Incident Analyst / Responder
  - IT Auditor
- Advanced-Level
  - Cybersecurity Manager / Administrator
  - Penetration & Vulnerability Tester
  - Cybersecurity Engineer
  - Cybersecurity Architect

(Source: www.cyberseek.org)
CompTIA Career Pathway

CompTIA certifications align with IT infrastructure and cybersecurity career paths, with each added certification representing a deepening of your expertise. Core certifications, like CompTIA A+, lay the groundwork for the specialized pathway certifications, and additional professional certifications cover necessary IT skills like project management.
EC-Council offers a range of Information Security courses, starting from the bare essentials for fundamental preparation till they reach the most advanced and highly technical training.

CAST courses lie within the top layer of InfoSec training where professionals challenge their own knowledge and become subject matter experts.

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Issues and Our Approach

Drawbacks of existing industry frameworks
• Categorized by own products/types (e.g., certifications, training courses, job demands, etc.)
• A Priori (i.e., top-down) approach

Our approach,
• Take a posteriori (i.e., bottom-up) approach
• Map career progressions through job transitions
Research Purpose

• Develop a cybersecurity career path map
  – To show career progressions through work role transitions with detailed required elements (e.g., credentials, skillsets, knowledge, experience) associated with each role
  – To find key jobs within cybersecurity and common transition opportunities
  – Identify current empirical trends in experience and education preferences
Methodology

• Dataset: Over 1,000 CVs of cybersecurity professionals from “indeed.com” containing cybersecurity work roles

• Capturing:
  work role transitions and key elements

• Data Coding:
  Work role level/type, education time/type, location, certification type/#, skillsets, experience, military service, security clearance, etc.
# Cybersecurity Professional Job Transitions

<table>
<thead>
<tr>
<th>Current Job Title (Pn)</th>
<th>Administrator</th>
<th>Analyst</th>
<th>Architect</th>
<th>Auditor</th>
<th>Consultant</th>
<th>Director</th>
<th>Engineer</th>
<th>Manager</th>
<th>Other</th>
<th>Other (Security)</th>
<th>Specialist</th>
<th>Technician</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrator</td>
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<tr>
<td>Analyst</td>
<td></td>
<td>39%</td>
<td>26%</td>
<td></td>
<td>22%</td>
<td>13%</td>
<td>17%</td>
<td>21%</td>
<td>30%</td>
<td>33%</td>
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<tr>
<td>Architect</td>
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<td></td>
<td></td>
<td>2%</td>
<td>1%</td>
<td>5%</td>
<td></td>
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<tr>
<td>Auditor</td>
<td></td>
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<td></td>
<td>17%</td>
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<td></td>
<td>4%</td>
<td>1%</td>
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<td></td>
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<tr>
<td>Consultant</td>
<td>4%</td>
<td></td>
<td>16%</td>
<td></td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
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<tr>
<td>Director</td>
<td>2%</td>
<td></td>
<td>43%</td>
<td>16%</td>
<td>33%</td>
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<td>1%</td>
<td>5%</td>
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<tr>
<td>Engineer</td>
<td>13%</td>
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<td>8%</td>
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<tr>
<td>Manager</td>
<td>5%</td>
<td>29%</td>
<td>33%</td>
<td>11%</td>
<td>7%</td>
<td>21%</td>
<td>1%</td>
<td>7%</td>
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<tr>
<td>Other</td>
<td>26%</td>
<td>29%</td>
<td>17%</td>
<td>16%</td>
<td>33%</td>
<td>9%</td>
<td>38%</td>
<td>58%</td>
<td>40%</td>
<td>33%</td>
<td>33%</td>
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<tr>
<td>Other (Security)</td>
<td>50%</td>
<td>6%</td>
<td>33%</td>
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<td>25%</td>
<td>7%</td>
<td>21%</td>
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<td>14%</td>
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<td>50%</td>
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CYBERSECURITY PROFESSIONAL JOB TRANSITION MAP
Expected Contributions

We can possibly answer following questions.
• What are the most common entry-level jobs in cybersecurity?
• What types of knowledge, skills, and educational credentials are needed to start a cybersecurity career?
• What types of knowledge, skills, and certifications are needed for a specific cybersecurity role?
• What cybersecurity certifications are most in demand in mid-level and advanced-level roles?
• What critical elements (e.g., education levels, certifications, experiences, etc.) do require to be executive-level cybersecurity professionals?
Relevant Literature