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Invited Paper
Survey of Technology and Skills in Demand: The 2022 Update

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ABSTRACT

Faculty in the information systems (IS) and information technology (IT) fields are faced with the challenge to keep their curriculum relevant and current. What was taught two years ago will often be outdated and faculty must constantly update their curriculum on which courses should be taught as well as what should be taught within a particular course. This research continues a fifteen-year effort to help understand employer needs in terms of the skills they desire new hires to possess upon employment. This is the sixth version of this employer survey. The survey continues to report the responses of over 500 IS/IT professionals and was expanded to ask additional questions related to salary information. In addition, based on feedback from open-ended questions in a prior survey, new categories were added to the survey. Several key results and changes from prior surveys include that VR/AR (virtual reality/augmented reality) platforms showed the highest anticipated growth rate for all operating platforms in the next two years, analytics tools such as Apache Spark showed high growth rate, and JavaScript maintained the first position for programming languages.

Keywords: IT skills, Technologies, Curriculum, Employment, IT certifications

1. INTRODUCTION

A challenge for all Information Systems (IS) and Information Technology (IT) instructors is to ensure that the course offerings in our curriculums stay relevant and current to employers. On the positive side, the demand for IS and IT graduates continues to be in high demand. From the U. S. Bureau of Labor Statistics, employment in information technology occupations is projected to grow 13 percent in the 2020 to 2030 period, much higher than the average (7% to 9%) for all occupations. Likewise, the Bureau of Labor Statistics details that this growth is being driven from greater emphasis on cloud computing, collection/storage of big data, and data security (Bureau of Labor Statistics, retrieved on August 9, 2022, https://www.bls.gov/ooh/computer-and-information-technology/home.htm).

The Bureau of Labor Statistics indicates a variety of technology occupations will continue to be in high demand for the next 8-10 years. The ten-year projections include Information Security Analyst (+33%), Software Developers (+22%), Web Developers (+13%), Database Analyst (+8%), and System Analyst (+7%). Interestingly, employment for computer programmers is projected to drop by 10% in the next ten years (Bureau Labor Statistics, retrieved on August 9, 2022, https://www.bls.gov/ooh/computer-and-information-technology/home.htm).

One approach to keeping IS/IT curriculum relevant is to use the recommendations from the ACM/AIS IS Model Curriculum (ACM/AIS, 2020) that are updated on a periodic basis. A limitation of the IS Model Curriculum is that it is only updated on a periodic basis and there is a need to supplement its recommendations between its periodic reports. Legier et al. (2013) call for additional research in this area. They reported that there are several problem areas for developers of IS/IT curriculums that need to evolve as industry needs change. These challenge areas include:

- How to meet employer needs in the changing IS and IT professions,
- How to determine what knowledge should be included in basic Information Systems courses,
- How to balance training and certification desires of students with providing a foundational knowledge of a topic area, and
- How to incorporate frequent advances in technology into the same total number of courses.

This research reflects a continuing effort over 15 years to survey and understand the industry needs in terms of not only the specific technologies being utilized by organizations and that college students should acquire a working knowledge prior to graduation, but also the business skills that will enhance their employment possibilities. It also attempts to provide guidance

to students in these disciplines on the skills they should attempt to acquire to be desirable to employers. We are hopeful that this research may be used to provide input to curriculum development between IS model curriculum releases.

2. LITERATURE REVIEW

Prior studies have evaluated the knowledge and technical needs within the industry using various approaches. These approaches can be generally grouped around: a) searching the job skills desired in IS/IT job postings, b) surveying recent IS/IT graduates on their current jobs and requirements, c) investigating the current course offerings in the IS/IT curriculums, and d) surveying employers and employees in IS/IT to identify the skills they indicate are important. Interestingly, most of the research also reflects the needs for IS/IT employees to have a working knowledge of business and communication skills. Table 1 provides a summary of similar research and the approaches taken.

Authors	Approach
Zaheer et al. (2020)	Surveyed employers of their recent graduates
Dong & Triche (2020)	Text mining for job postings related to data analyst positions
Rhew et al. (2019)	Reviewed job postings and compared to AACSB standards
Leonard et al. (2019)	Reviewed gaps between model curriculum and employer desires
Burns et al, (2018)	Reviewed the tech related job listings over a four-month period

Table 1. IS/IT Skill and Technology Related Research

The current research aims to survey a wide range of working IS/IT professionals with varying levels of experience and identify their current and future technology skills. In addition to these skills, we also evaluate the knowledge required for success in the IS/IT field. This paper is part of a continuing project that surveys IS/IT professionals biennially, with the last survey completed in 2022. In more detail, we consider the current technology needs in the areas of cloud computing, security, data analytics, databases, programming languages, networking, and operating systems platforms, as well as the anticipated changes in the near future.

3. METHODOLOGY

The survey was developed to examine the technologies IS/IT professionals are currently using and expected to use in the future. This is the sixth version of an ongoing study to understand the changing landscape of IS/IT professionals. The current version of the survey will be compared to the results found in the previous study (Cummings & Janicki, 2021). As with previous studies, the goal of the study was to answer the following questions:

- What organizational technologies are currently in use and projected to be used in the future?
- What IT and non-IT knowledge and skills are required/needed by all IS/IT professionals?
- What is the importance of certifications in the technology field and which ones are most prevalent?
- How have these changed from the prior survey?

The survey was developed using a multi-phase process involving an advisory board of IS/IT professionals and faculty. As this is a biennial survey and the process remains consistent from prior surveys, we have included more details concerning the survey development process in the Appendix.

There were some changes from the prior survey that are worth noting here. During the roundtable discussion process with the advisory board, they suggested removing the Management/Strategy job role to encourage more management to answer specific questions about the area they are managing. Additionally, while previously it was suggested that Data Analyst and Database Admin should be combined, the board suggested these are better represented by two different roles. Also, the networking and security analyst were separated to focus on more specific skills surrounding each role. This resulted in the following categories:

- Analytics
- Business/Systems Analyst
- Database Admin
- Networking
- Project Manager
- Security
- Software Developer

Once the survey was developed and finalized, a pilot test was conducted to ensure that (a) the survey questions were clear to participants, (b) all areas were appropriately covered, and (c) average completion time was 10 minutes or less. A preliminary survey was emailed to industry professionals which directed them to complete the online survey and provide feedback. Thirty-four participants completed the survey during the pilot test with an average completion time of 7.5 minutes. Minor changes were made to the survey instrument based on participant feedback before it was deemed ready for distribution.

To ensure a wide spectrum of responses from IS/IT professionals, a nationwide survey company was employed and paid to distribute the survey. The survey was distributed in the second quarter of 2022 and resulted in a total of 566 respondents. In the following section, the summary statistics will be presented comparing the results from this year's survey to the 2020 results.

4. SUMMARY STATISTICS

For 2022, 566 IS/IT professionals completed the survey across various organizational types (Table 2) and sizes (Table 3). Again, corporations represented the most surveyed organizational type with 56% (down from 62% in the previous survey) with Sole Proprietor or Partnership saw the largest increase with 12% (up from 5%). The organization size of those surveyed was again primarily consisting of companies over 500 employees which accounted for 70% of responses (up from 62%). Additionally, responses came from across the United States with New York (22%), California (16%), Florida (7%), Texas (7%), and Pennsylvania (4%) representing the largest number of responses.

Organization Type	2022	2020
Corporation	56%	62%
LLC	10%	7%
Education	6%	5%
Healthcare	4%	7%
Government	6%	7%
Non or Not for Profit	7%	7%
Sole Proprietor or Partnership	12%	5%

Table 2. Organization Type

Number of Employees	2022	2020
< 20	3%	8%
21-100	8%	8%
101-499	18%	22%
500-999	29%	22%
1000-9999	34%	28%
10000+	7%	12%

Table 3. Organization Size

Participant gender changed slightly from previous years with females accounting for 28% (up from 24%) and males representing 72% of participants (down from 76%). Educational background of participants remained similar with a majority of participants holding a post-secondary degree including an Associate's degree (5%), Bachelor's degree (IT related at 28% and non-IT related at 10%), Master's degree (IT related at 35% and non-IT related at 13%), and Ph.D. (6%). Additionally, the average tenure of the participant in their given field remained consistent at 11 years, with the average years at their current employer also remaining the same to the prior study at 9 years.

As mentioned in the previous sections, additional organizational roles were included in this year's survey. Table 4 includes a comparison of participants responding to the survey based on their roles. The role seeing the largest decline in participants was Business/Systems Analyst which fell from 16% in 2020 to 7% in 2022. We did see increases, however, in both the analytics (3%) and database administrator roles (9%), which were previously combined at only 6% of participants in 2020. Finally, the software developer role saw the largest increase in participants, going from 30% in 2020 to 46% in 2022.

Organizational Role	2022	2020
Business/Systems Analysis	7%	16%
Analytics	3%	6%
Database Admin	9%	
Management/Strategy	-	9%
Networking	8%	15%
Security	5%	
Project Manager	20%	18%
Software Developer	46%	30%
Other IT	2%	7%

Table 4. Organizational Role

New to the 2022 version of our survey was the inclusion of salary information. Gathering this information will allow comparisons to be made across time as we collect data in the future as well as across the various categories that are already included in the survey. Table 5 summarizes the salary categories from our survey respondents. The largest salary range is $150,000 or more (21%), followed by $100,000 to $109,999 (11%), $140,000 to $149,999 (10%), and $70,000 to $79,999 (9%). Interestingly, 18% of the participants identified their salary as being below $70,000. We believe these lower salary responses may be due to the varying nature of employment statuses; that is, the employee may be full-time, part-time, or a freelancer. This finding has prompted us to also include questions about employment status in future iterations of the survey. This finding does not affect the intentions of our data collection or the insights that our survey affords.

Salary Range	2022
Less than $10,000	1%
$10,000 to $29,999	3%
$30,000 to $49,999	7%
$50,000 to $69,999	8%
$70,000 to $89,999	15%
$90,000 to $99,999	8%
$100,000 to $109,999	11%
$110,000 to $119,999	5%
$120,000 to $129,999	6%
$130,000 to $139,999	3%
$140,000 to $149,999	10%
$150,000 or more	21%

Table 5. Salary Range

5. RESULTS

The remaining sections are organized as follows: first, an examination of the current and future importance of various technologies is discussed. This is followed by a closer look at the specific skills required for professionals in their given fields. Finally, the impacts of certifications are evaluated in the IS/IT profession.

5.1 Current and Future Technology Importance

Similar to prior surveys, this section asked participants to respond to questions concerning technologies currently used within their organization and the expected importance to the field over the next two years. There were two areas that were asked to all participants: platform and cloud technologies. These will be discussed first, followed by the responses to specific roles and importance of technology in those roles. As with past surveys, a comparison of the 2020 results is included. All technology importance questions were evaluated on a Likert 4-point scale, which was calculated as follows: 4 - more important, 3 - same importance, 2 - less important, and 1 - not at all important.

5.1.1 Operating System (OS) Platform Expectations. All survey participants responded to the questions concerning OS platforms including the addition of Virtual Reality/Augmented Reality to the 2022 survey. Windows again remained the OS with the highest expected importance moving forward.

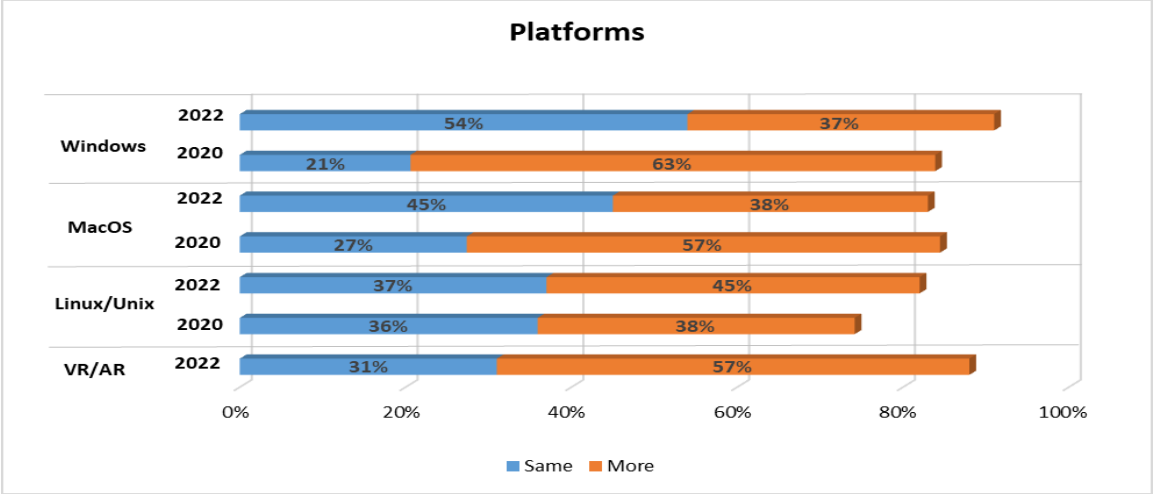

Figure 1. Platform Expected Importance in Two Years

However, the newest category, VR/AR, had the highest rating for more importance over the next 2 years at 57%, suggesting a shift in the environment organizations are choosing to focus on moving forward. Linux/Unix also saw an increase in importance from 38% finding it more important moving forward in 2020 to increasing to 45% in 2022. Finally, the only platform seeing a decrease in importance moving forward was MacOS.

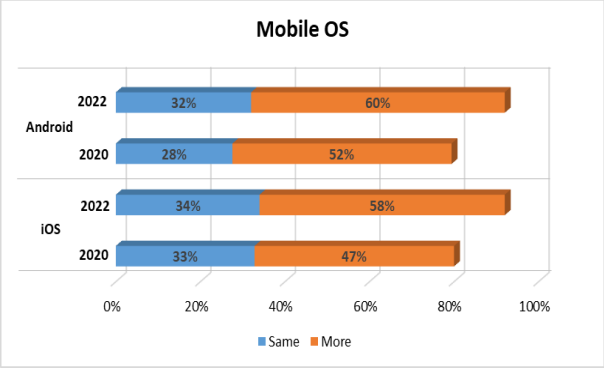

Figure 2. iOS and Android Expected Importance

It was a slight decrease overall but those stating MacOS will be more important in the next 2 years fell dramatically from 57% in 2020 to 38% in 2022. This may suggest MacOS peaked in 2020. A comparison of the ratings by platform for same/more importance can be found in Figure 1.

In addition to the platforms, mobile operation systems were also evaluated. The results continue to suggest an increased importance on mobile OS. Both Android and iOS saw increases in both the same importance and more important in the next 2 years. For a comparison of mobile operating systems expected importance over the next 2 years, see Figure 2.

The final analysis of operating systems examines the average importance rating across all operating systems compared to the prior survey (see Table 6).

	2022	2020
Platform		
Windows	3.44	3.33
VR/AR	3.44	-
Mac OS	3.24	3.31
Linux/Unix	3.17	2.96
Mobile		
Android	3.49	3.16
iOS	3.48	3.12

Table 6. Summary of OS Platform Expectations

In 2022, there was an increase in all platforms (including mobile) except for Mac OS where there was a slight decline from 2020 at 3.31 to 3.24 in 2022. While Windows remained the highest rated platform, the newest category in the survey (VR/AR) had the same rating as Windows. Finally, we see a significant gain in importance rankings for both mobile platforms surveyed. Each platform ranked higher than any of the other non-mobile platforms suggesting the continued importance in mobile devices compared to others.

5.1.2 Cloud Platform Expectations. In addition to the platforms evaluated in the previous survey, two additional categories were included in 2022: containers and service frameworks. This was a suggestion from both the advisory board and participants from the 2020 survey who recommended to capture not only the technology organizations use but also how they are being utilized.

Cloud Platform	2022	2020
AWS	3.64	3.33
Google	3.51	3.29
Azure	3.50	3.28
Service Frameworks (e.g., SaaS, IaaS, etc.)	3.37	-
Salesforce	3.30	2.87
Containers	3.12	-

Table 7. Summary of Cloud Platform Expectations

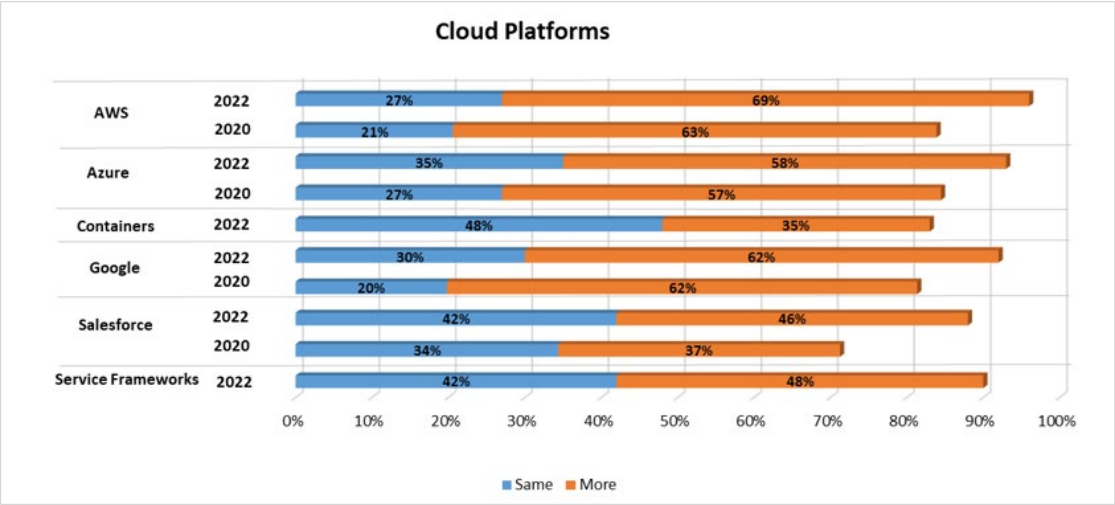

Figure 3. Cloud Platform Rankings of Importance in Two Years

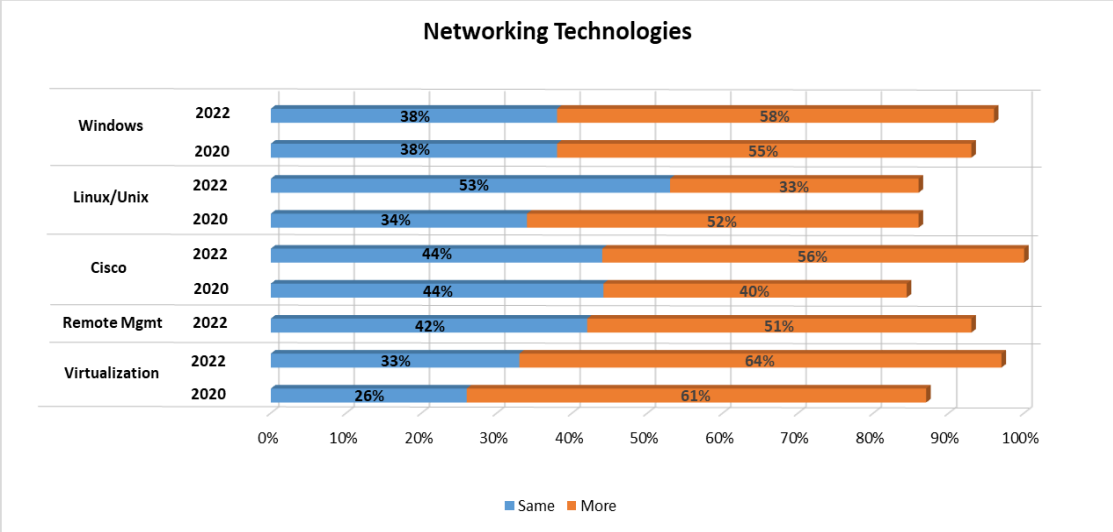

Figure 4. Networking Technologies Expected Importance in Two Years

Consistent with 2020, results (see Figure 3) show an increase across all platforms in 2022. AWS was ranked highest with importance at 96% of participants responding that AWS will remain the same or more important in the next 2 years. This was followed by Azure at 93%, Google at 92% and Salesforce at 88%. The two additions to this year's survey were also considered to be important moving forward, with Containers at 83% and Service Frameworks at 90%.

When evaluating the average scores across platforms (see Table 7), Salesforce saw the largest increase from 2.87 in 2020 to 3.30 in 2022 (an average gain of 0.43). The next largest increase was AWS with an average gain of 0.31 from 2020 to 2022. All other platforms saw an increase as well. One possible reason for the larger increase in AWS compared to other platforms could be a result of developers consistently using AWS more than other providers (Desai, 2022).

Similar to 2020, an additional, open response question was included that asked about technologies not captured in the survey. The only additional technology that was suggested to be important in this area was IBM Cloud. There were, however, only four participants who made this suggestion. Based on this feedback and changes in the cloud provider field moving forward, IBM Cloud and other potential technologies will be considered in the next survey.

5.1.3 Networking Technology Expectations. In the previous sections, all participants answered the questions regarding platform and cloud technologies. All the subsequent sections were answered by those self-selecting into a specific organizational role. The first role we are going to discuss is Networking, which was separated from security technologies for the 2022 survey. A total of 45 participants responded as working in the networking role at their organization. Both software (e.g., Windows networking) and hardware (e.g., Cisco) technologies were included in this category.

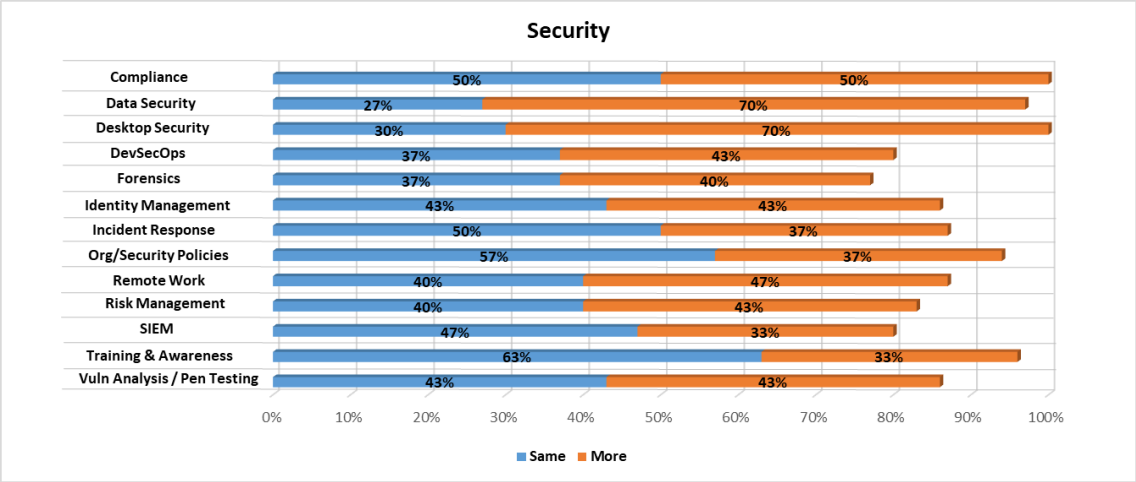

Figure 5. Security Expected Importance in Two Years

The 2022 survey saw Cisco technologies with the largest increase in importance. All participants stated Cisco technologies will either have the same or more importance in the next 2 years. The increase came from those stating Cisco will be "More Important" moving forward which increased from 40% in 2020 to 56% in 2022. The second highest-rated technology in 2022 was Virtualization at 99% importance in the next 2 years. Linux/Unix remained consistent with 86% for both 2020 and 2022. Finally, a new category, Remote Management Technologies, was included. It had 93% of respondents rate the importance as the same or higher moving forward. This category was included in response to results from the 2020 survey suggesting that remote management should be included in future surveys. The significant importance in these technologies may be in response to the increased move to remote work within many companies.

Compared to 2020, the averages across almost all technologies increased in overall importance (see Table 8 for average importance by technology). The one exception was Linux/Unix, which saw a slight decline in 2022. The largest gain was seen in Cisco technologies, which saw an increase in 0.36 in 2022.

Networking Technologies	2022	2020
Virtualization	3.62	3.42
Cisco	3.56	3.18
Windows	3.51	3.43
Remote Management	3.44	-
Linux/Unix	3.18	3.27

Table 8. Summary of Networking Expectations

As with other categories, participants had the opportunity to include additional technologies of importance for this category. Most participants responded with no additional technologies. One participant, however, did respond with cloud-based services.

5.1.4 Security Expectations. As previously mentioned, security was separated from networking with this year's survey. The security questions were broader compared to the other organizational roles. The goal was to capture the concepts/skills expected for those in a security role. Thirty participants selected security in 2022.

With the increased organizational focus on security, it was not surprising that most of the items surveyed came back with high ratings of importance moving forward. All participants rated both Compliance and Desktop Security as either being the same or more important in the next two years.

Data Security was not far behind with 97% of the participants stating this will remain the same or become more important in the next two years. An interesting result was the importance of both Policy and Training & Awareness, which were the fourth and fifth highest, respectively. These results suggest a balance of the expected importance of both technological approaches (Desktop and Data Security) with more managerial approaches (Compliance, Policy and Training & Awareness).

Security	2022
Desktop Security	3.70
Data Security	3.67
Compliance	3.50
Remote Work	3.33
Training and Awareness	3.30
Identity Management	3.27
Organization / Security Policies	3.27
Vulnerability Analysis / Pen Testing	3.27
DevSecOps	3.23
Risk Management	3.23
Incident Response	3.20
Forensics	3.13
SIEM	3.10

Table 9. Summary of Security Expectations

5.1.5 Database Expectations. For 2022, we saw an increase in those selecting the Database Admin role from 32 in 2020 to 52 in 2022. All participants responded that the importance of Oracle will remain the same or increase in the next two years. This represented both the highest rated technology as well as the largest increase from 2020. This was followed by IBM DB2 (98%), MS SQL (86%), and MySQL (86%). Previously,

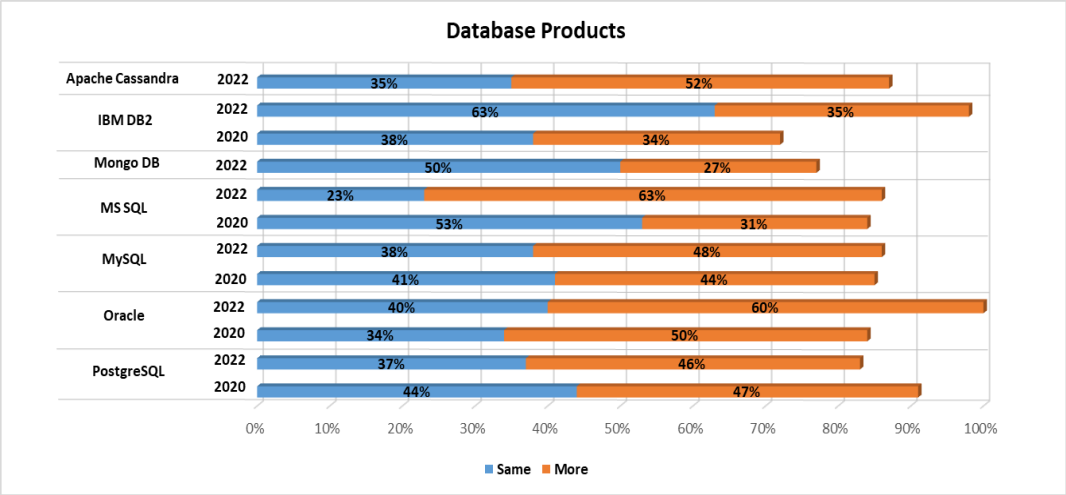

Figure 6. Database Expected Importance in Two Years

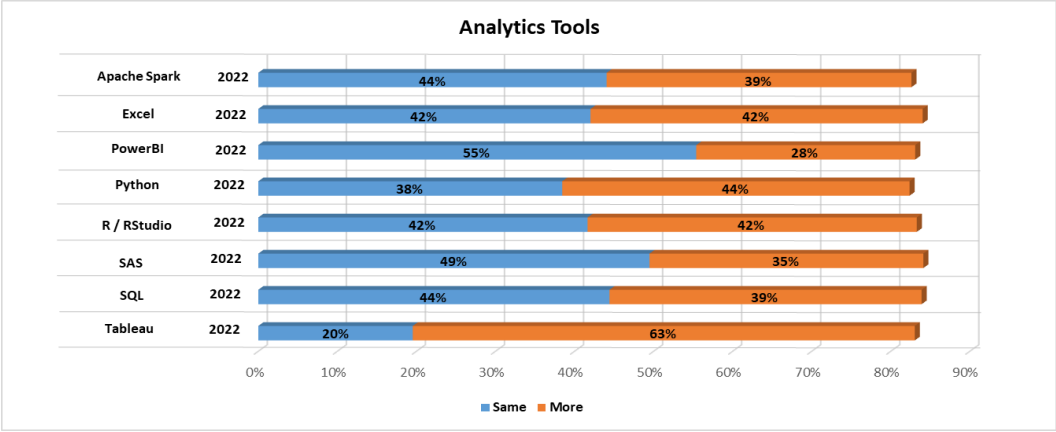

Figure 7. Analytics Tools Expected Importance in Two Years

PostgreSQL was the highest in 2020 but it fell by 8% in 2022. Additions to this year's survey include Apache Cassandra and MongoDB, with participants stating their importance will remain the same or become more important over the next two years at 87% and 77%, respectively (see Figure 6).

Database Product	2022	2020
Oracle	3.60	3.28
MS SQL	3.44	3.06
IBM DB2	3.33	2.97
Apache Cassandra	3.31	-
MySQL	3.29	3.19
PostgreSQL	3.25	3.31
Mongo DB	3.02	-

Table 10. Summary of Database Expectations

The results compared to previous surveys showed gains in each product with the exception of PostgreSQL seeing a 0.06 decline (see Table 10). During 2020, Oracle and PostgreSQL represented the two highest rated products for databases. While Oracle continued to gain importance in 2022, MS SQL is now rated as the second highest with PostgreSQL falling to one of the lowest-rated importance in 2022 (only higher that MongoDB).

5.1.6 Analytics Tools Expectations. An evaluation of importance of analytics tools was a new inclusion in this year's survey. Due to the increase in companies leveraging data, the suggestion of the advisory board as well as the previous survey participants was to separate database and analytics into two different organizational roles. This allowed us to include additional tools that may be used by those who view analytics as their primary role.

There were only 19 participants who selected the data analytics role in the 2022 survey. All of the tools in the survey were rated above 80% as having the same or more importance in the next two years. The highest rated tool as having the same importance moving forward was Power BI at 55%, while Tableau was rated highest for being more important moving forward at 63%. In general, with all the tools being ranked relatively high, it would appear that a variety of tools are

consistently utilized for the analytics field. Table 11 shows the average ratings across the tools surveyed. Tableau had the highest average rating at 3.47 while Excel was close behind at 3.42.

Analytics Tools	2022
Tableau	3.47
Excel	3.42
SQL	3.26
Python	3.21
R / RStudio	3.21
SAS	3.21
Apache Spark	3.16
PowerBI	3.05

Table 11. Summary of Analytics Tools Expectations

5.1.7 Development Languages. The software developer role again represented the largest number of participants (n = 260, 46%) in this year's survey. This was up from 151 participants (30%) in 2020. Software developers were asked to rate the level of knowledge needed by IS/IT professionals across 13 different products. For 2022, HTML5 and CSS3 were combined, and two additional languages (Angular and React) were added based on feedback from the advisory board and prior survey participants. The scale consisted of 1 - no experience, 2 - fundamental, 3 - working, and 4 - expert (see Table 12).

Development Language	Rating	2022 Rank	2020 Rank
JavaScript	3.48	1	1
Java	3.45	2	3
C++	3.41	3	4
HTML5/CSS3*	3.28	4	2 / 9
Python	3.24	5	6
C#	3.21	6	5
PHP	3.09	7	11
XML	3.05	8	8
jQuery	2.94	9	7
ASP.NET (Including MVC)	2.91	10	10
Angular	2.88	11	-
React	2.86	12	-
JSP	2.80	13	12

*HTML5 and CSS3 were separated in 2020

Table 12. Development Language Level of Knowledge Desired

The top development language for 2022 was JavaScript, which also took the top spot in 2020. In fact, the top six languages for 2022 remained consistent with Java, C++ and HTML5/CSS3 following JavaScript in experience. Python finished fifth this year, one step up from 2020, with C# in the sixth spot, moving down one position this year. These languages continue to dominate the Software Development role, which may be due to their extensive use in mobile app development (Aparna, 2022). For C++, many legacy systems are coded in this language, which is one of the reasons this language often appears at the top of historically-used languages (TIOBE, 2021). Python continues to grow in popularity with other research finding this to be the most popular language used today (Krill, 2022).

In addition to the languages surveyed, participants were able to suggest other important languages or skills that were not included in the list. The only languages suggested outside the ones surveyed were COBOL and Django, but these were only by one participant each. A number of developers suggested general skills that would be useful, including knowledge in AI/Machine Learning as well as good communication and customer relationship skills.

5.2 Skills by Role

While the previous sections focused on specific technologies, the survey also collected skills needed for those working in various roles (e.g., Business/Systems Analyst). The number of respondents per category will vary based on participant's job role selection at the beginning of the survey. This ensured that only those working in the field responded to the questions regarding knowledge areas in their role. As previously mentioned, the 2022 survey separated out two job roles (Data Analyst and Networking/Security) into four distinct roles (Database Admin, Analytics, Networking, and Security).

5.2.1 Business/Systems Analyst. Requirements Analysis was rated the top skill needed by this role, which was a jump up from second in 2020. This was followed by System Design, Process Analytics/Modeling, Project Management, and Data Modeling. Interestingly, Software as a Service (SaaS), which ranked as the most important knowledge area in 2020, did not appear in the top five skills in 2022. While cloud remains important, as evident by the results from the previous section, this skill may just be expected at this point, suggesting that the foundational skills of analysis and design should be the focus for this role. While the top five skills are listed in Table 13, Business/System Analysts still suggested SaaS knowledge was important as well as Quality Assurance and Prototyping/Mock Up (UX).

5.2.2 Project Management. Team Management remained as the most important skill in 2022. Also, all the other skills from 2020 remained within the top five except for Change Management, which fell out of the top five with Contract/Vendor Management moving into its place (see Table 13 for an ordered list of the top skills). While Change Management did not make the top five, it did finish immediately after Contract/Vendor Management.

5.2.3 Software Development. The results for 2022 were very similar to the 2020 results, with Cloud/Virtualization concepts, Data Structures, Object-Oriented Concepts and Version Control Management all remaining in the top skills needed for the software development role. It should be noted that Object-Oriented Concepts and Version Control tied for fifth. Design Patterns was the only skill to fall out of the top skills in 2022. Skills added to the top list for 2022 include API/Web Services and Mobile Device Development. Additional skills worth noting for software developers included Design Patterns, DevSecOps and Low Code/No Code solutions, which have recently become popular in many university programs. A comparison of 2020 and 2022 results can be found in Table 13.

Job Category	Knowledge Area*	
	2022 Results	2020 Results
Business/ Systems Analyst (n = 39)	Requirement Analysis	Software as a Service (SaaS)
	System Design	Requirement Analysis
	Process Analytics / Modeling	Process Analytics / Modeling
	Project Management	System Design
	Data Modeling	Data Modeling
Project Mgmt. (n = 112)	Team Management	Team Management
	Planning and Scheduling	Planning and Scheduling
	Resource Scheduling	Risk Management
	Risk Management	Resource Scheduling
	Contract/Vendor Mgmt	Change Management
Software Dev. (n = 260)	Cloud / Virtualization Concepts	Cloud / Virtualization Concepts
	API/Web Service Utilization	Data Structures
	Data Structures	Design Patterns
	Mobile Device Development	Object Oriented Programming
	OO Programming & Version Control Mgt (tied for 5th)	Version Control Mgt

* in order of importance

Table 13. Knowledge Skills by Job Role

5.2.4 Analytics. Skills related to Analytics is a new role for the 2022 survey. General Statistics (Regression, ANOVA, etc.) was listed as the top skill needed for those in the Analytics job role. This was followed by working with Big Data and then Predictive, Prescriptive, and Descriptive analysis. Finally, Data Visualization was also included, tied for fifth with Descriptive. Because this role was separated from database skills in 2022, the combined results from the previous 2020 survey are included in Table 14.

5.2.5 Database Admin. Virtualization was considered by the participants to be the most important skill needed for database administrators. The next two skills both dealt with data (Big Data Storage and Raw Unstructured Data), which relate to the importance of skills in the Analytics role. Finally, DB Programming and Analytic Tools were the other skills noted as the top skills for database administrators. The inclusion of Analytic Tools suggests that even DB administrators need to understand how to use these tools. Other knowledge areas considered to be important to database administrators include SQL Query / Reporting as well as NoSQL / Object Storage.

Job Category	Knowledge Area*	
	2022 Results	2020 Results
Analytics (n = 19)	General Statistics (e.g., Regression, ANOVA)	
	Big Data	
	Predictive (e.g., Forecasting)	Analytic Tools (SSIA/SSAS/SSRS)
	Prescriptive	DB Programming
	Descriptive & Data Visualization (tied)	NoSQL / Object Storage
Database Admin (n = 52)	Virtualization	Raw Unstructured Data
	Big Data Storage / Warehousing Concepts	SQL Query / Reporting
	Raw Unstructured Data	
	DB Programming	
	Analytic Tools (SSIA/SSAS/SSRS)	

* in order of importance

Table 14. Analytics/DB Admin Skills by Job Role

5.2.6 Networking. Based on the suggestion from previous surveys and the advisory board, Networking and Security were separated in 2022. Windows Admin was listed as the most important knowledge for this role. This was followed by Network Programming and Network Administration. Although security was separated this year, Firewall Admin/Security remained an important skill for those in the Networking role suggesting that these two roles are still intermingled. Interestingly, Linux Administration, which previously ranked higher, was considered to be the least important knowledge area for this role (see Table 15 for comparison to previous survey).

Job Category	Knowledge Area*	
	2022 Results	2020 Results
Networking (n = 45)	Windows Admin	
	Network Design / Programming	
	Network Admin	
	Firewall Admin / Security	Desktop Security
	Virtualization	Data Security
Security (n = 30)	Desktop Security	Network Security
	Data Security	Network Admin
	Compliance	Windows Admin
	Remote Work	
	Training and Awareness	

* in order of importance

Table 15. Networking/Security Skills by Job Role

5.2.7 Security. Desktop Security was listed as the most important knowledge area for 2022, followed closely by Data Security. The next two knowledge areas show the increased importance of Compliance (third) and how Remote Work (fourth) has changed the security role. Finally, Training & Awareness was ranked fifth, suggesting that, along with Compliance, non-technical knowledge areas are important for those in the Security role in 2022. This was reinforced by the additional knowledge areas of Organizational/Security Policies and Identity Management ranking just below Training & Awareness.

5.3 Professional Certifications

Our survey continues to investigate the importance of certifications for IS/IT professionals. In 2022, 95% stated they had at least one certification, which grew from 89% in 2020. Consistent with the prior survey collection, Microsoft CSE ranked highest with 44% (n = 248) of participants reporting having this certification. The other important certifications were those offered from AWS and CompTIA. The largest drop occurred with CISCO CNA certification, which held the third position in 2020 but dropped to eighth in 2022 which may indicate a growing preference in the other networking certifications provided by CompTIA which ranked fourth and fifth. We should also note that Security+ and Professional Cloud Architect certifications were not included in the previous version of the survey and these were also ranked above the CISCO CCNA certification in 2022.

Certification	2022 Rank	2020 Rank
Microsoft CSE	1	1
AWS Cloud Practitioner	2	-
AWS Solutions Architect	3	5
CompTIA A+ Tech	4	2
CompTIA Network+	5	4
Security+	6	-
Professional Cloud Architect	7	-
CISCO CNA	8	3
CISM	9	7
Certified Risk IS Control	10	6
PMP	11	10
CISSP	12	8
CIS Auditor	13	9
Scrum Master	14	-

Table 16. Professional Certifications Held by Participants

In addition to the certifications reported, participants were given the opportunity to provide any other certification not listed. Out of the 566 responses received, only 7 reported other certifications and there was no pattern that indicated an important certification was missing from our listing. Based on this fact, we believe our list of certifications to be a comprehensive list of the most sought-after certifications by IS/IT professionals to date.

6. IMPLICATIONS FOR EDUCATORS

There are a number of implications for educators based on this year's results. First, educators should evaluate which technologies are emphasized within the curriculum. For platform technologies, Windows still dominated while MacOS dropped slightly in 2022. The inclusion of VR/AR, which ranked slightly higher than MacOS, suggests that inclusion of these technologies within the curriculum may be beneficial to students in the future. Additionally, the continued increase of importance on mobile OS (i.e., Android and iOS) suggests that educators should begin or continue to include app development courses within their curriculum.

The increase in importance of cloud, virtualization, and security suggests educators should take a closer look at traditional telecommunications courses. Telecommunication courses should expand to include security, virtualization, and cloud technologies within the topics covered in the course. The importance of these new areas warrants a re-evaluation of current topics covered in the course to meet the needs of industry.

Most degrees require a minimum of one database course in their current curriculum (Feinstein et al., 2014), which can be challenging to incorporate more than one database approach into a single course. As with previous surveys, the importance of databases seems to be very similar across technologies suggesting that faculty should select a database approach that best suits the university at which they are teaching. If they were to change their approach, they may consider Oracle or IBM DB2 as potential technologies to use.

Compared to previous surveys, there seemed to be a wider range in importance of various development languages participants suggest software developers understand. For 2022, JavaScript again rated as the highest, but Java, C++ and Python all increased in importance this year. The recent model curriculum emphasized that programming languages should be at least one core course. Results from this survey, however, suggest that students may benefit from learning additional languages as part of the curriculum.

Additionally, the survey also asked participants to evaluate the general IT Knowledge that professionals should possess (see Table 17). Software Development and Analytics remained in the top three from 2020 to 2022. However, Cloud/Virtualization Concepts dramatically increased in 2022 to being ranked second compared to 2020 where it ranked seventh. This provides further validation for the importance of incorporating these topics into the curriculum if it is not already present.

IT Knowledge	Rank of Importance	
	2022	2020
Software Development	1	2 (tie)
Cloud / Virtualization Concepts	2	7
Data Analytics	3	2 (tie)
Database Skills	4	6
Project Management	5	5
Networks	6	4
Business / Systems Analysis	7	1
Security	8	-
Artificial Intelligence	9	-
Blockchain	10	-
Systems Administration	-	8

Table 17. IT Knowledge Importance

The survey also asked about general Business Knowledge (see Table 18). The top ranked knowledge area for 2022 was again Management Skills. Data Analytics, however, moved up in importance from fourth in 2020 to second in 2022, suggesting the importance of analytics courses in the curriculum. Written and Oral Communication (combined in 2022) ranked third, which was the same as the previous survey. An interesting finding this year was the increased importance of Supply Chain Logistics, which ranked fifth in 2022, up from eight in 2020. This is most likely a direct result of the issues seen from the COVID-19 pandemic of recent years.

Business Knowledge	Rank of Importance	
	2022	2020
Management	1	1
Data Analytics	2	4
Communications – Written*	3	2
Communications – Oral*		3
Statistics	4	5
Supply Chain / Logistics	5	8
Finance	6	6
Marketing	7	9
Economics	8	7
Accounting	9	10

* Written and Oral Communication combined in 2022

Table 18. Business Knowledge Importance

Finally, another challenge we face as educators is deciding whether certifications should be included within the curriculum. The survey results found that over 95% of participants had at least one certification, which is up from 90% in 2020.This can be difficult to bring into a college environment, though, as many certifications require some years of experience. One consideration for educators would be to encourage students to sit for associate certifications that will allow them to be certified without the work experience. They could later get the full certification after they have achieved the experience. At a minimum, the pros and cons of certifications should be discussed in courses with the decision to sit for these certifications being left to the student.

7. CONCLUSIONS

Compared to the 2020 survey, the results from this year's survey provide new insights for both educators and professionals. Students, as well as IS/IT professionals, need to adapt to a multiple-platform environment, including mobile platforms, which continue to gain importance. Security continues to be an area of focus, with an equally-important emphasis on both technical and managerial skills. Finally, as with past surveys, educators need to continue to go beyond the focus on technical skills alone and stress the importance for students to practice soft skills, such as management and written/oral communication.

8. FUTURE RESEARCH AND REMARKS

Based on the suggestions from the prior survey (Cummings & Janicki, 2021), changes were made to include additional questions and expand the pool of participants. This included the addition of new technologies and separating some job roles. In future surveys, we will continue to modify the survey based on suggestions from the current survey's participants and the input from the advisory board.

There were some limitations to the current study worth noting. While the survey reached many different professionals throughout the country, we were limited to the contacts at the survey company. While there are numerous emerging technologies, we limited the technologies in the survey to those identified by the advisory board but plan to expand based upon suggestions from this year's survey.

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APPENDIX

Survey Development Process

Initial Survey Development

During survey development, a roundtable discussion was conducted with a corporate advisory board at the university. The advisory board consisted of 25 members that represent regional and national organizations of varying sizes (10 employees to over 1000 employees). These members are primarily employees from their respective organization's IT department and interact with many of the technologies included in the survey. Additionally, people in IT management who manage and hire entry-level IT professionals were also members of the board and participated in the discussions. The roundtable goals were to understand what areas were important to IT professionals while identifying major technology areas. Faculty from the Information Systems and Information Technology department at a large, regional university led the roundtable discussions.

During the first roundtable discussions, a faculty representative worked with advisory board members to identify major trends or changes in technology in their respective fields. This included any suggestions from participants in the prior survey. Following this discussion, the group walked through previous surveys from the prior studies to evaluate relevancy in the current market as well as suggesting new areas to evaluate that were not covered in prior studies. Additionally, roundtable discussion included an evaluation of potential job categories that would fall under the technological areas identified.

Once the job categories were identified, the roundtable further discussed specific knowledge/skills needed for each of the jobs. This was done to provide a clear picture for educators of future IT professionals to incorporate specific skills into their courses that directly relate to the needs within industry. For example, under the Business/Systems Analyst job categories, the skills needed to perform effectively within the role were identified which included topics such as requirements analysis/gathering, process analysis, structured design and system design.

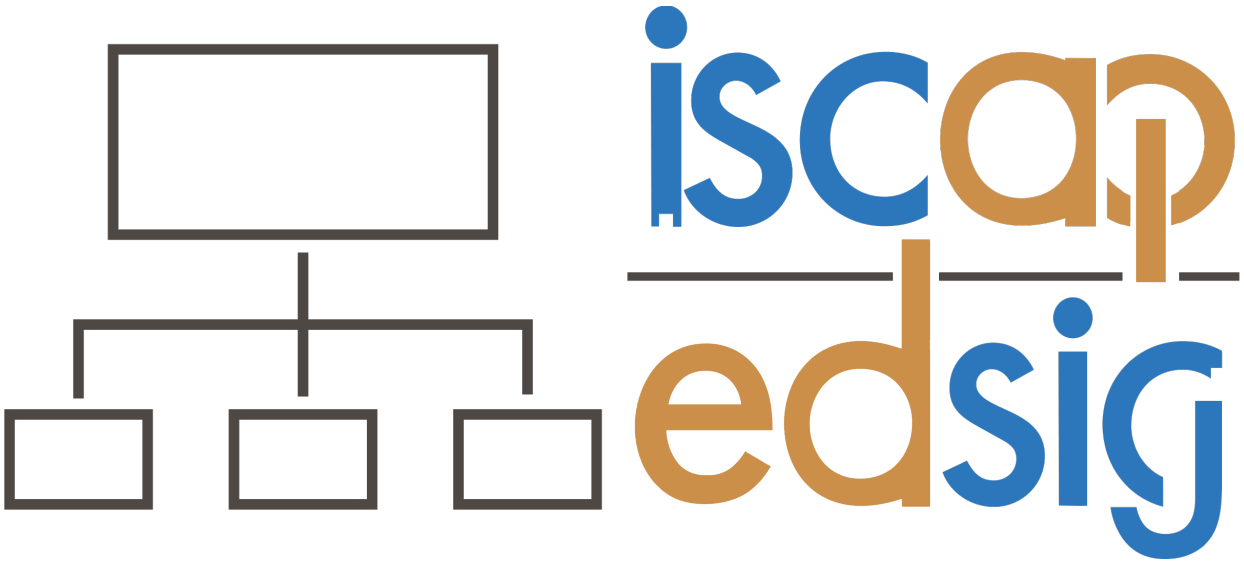
Final Survey Development

Adjustments were made based upon the suggestions from the advisory board as well as suggestions from prior survey participants during the initial survey development. Additional research was done to ensure all technologies and job categories were represented in the survey. The next step was to take the broad categories from the survey development phase and develop sub-categories of the technological areas. This discussion occurred during the following advisory board meeting in which specific technologies (including brand names) were identified within each category. The groups went through several iterations to make sure all possible sub-categories were captured and there was consistency across areas. The list of technologies/software was finalized based on the advisory board's experience and thoughts as well as ongoing importance. For example, professionals evaluated the networking category and specific technologies/brands (e.g., Cisco, Linux/Unix, etc.) were included as a subcategory.

In addition to the subcategories, questions centered on technologies used and future importance were developed to understand what industry professionals currently use now. Due to the evolving nature of the IT field, future importance was based on a two-year time horizon. After the subcategory selection was complete, the survey instrument was finalized and included general questions such as company size, organization type, employee functional area and general demographics (age, gender, location, company size, industry, job title).

Pilot Test

Once the survey was developed and finalized within the advisory board, a pilot test was conducted to ensure that the survey questions were clear to participants, all areas were appropriately covered, and average completion time was 10 minutes or less. A preliminary survey was emailed to industry professionals, which directed them to complete the online survey and provide feedback. The average completion time was below 10 minutes and based upon feedback, minor changes were made to the survey instrument, and it was deemed ready for distribution.



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