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The Academic Discipline of Information Technology: A Systematic Literature Review

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Abstract

Aim/Purpose	This paper aims to answer the research question, "What are the development phases of the academic discipline of information technology in the United States?" This is important to understand the reason for the growing talent gap in the information technology (IT) industry by reviewing the evolution of information technology across time, how the discipline was formed, evolved, and gained independence from other information and computing disciplines.
Background	The COVID-19 pandemic has increased the shortage of IT professionals in the workplace. The root reason for this talent shortage requires understanding from both industry and academic perspectives in order to implement effective initiatives to prepare, recruit, and retain diverse IT professionals at an early stage.
Methodology	This paper used a systematic literature review methodology and retrieved 143 primary studies from the ACM and IEEE Xplore digital libraries to review the development phases of the IT discipline as a contributing factor in understanding why, when, and how the population of professionals in IT and other relevant computing disciplines has changed and continues to fluctuate. Thematic analysis was applied to the abstracts of the primary studies, which spanned the period of 1982 to 2021.
Contribution	This paper contributes to the understanding of the discipline of IT in the US and contributes foundations to researchers and educators who are working on strategies to fill the talent gap.
Findings	Based on the thematic analysis in this paper, the academic discipline of IT has evolved over four phases across a timeline from 1982 to 2021. These phases

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	were: Phase 1 (1982-1991) – Advent of Information Technology; Phase 2 (1992-2001) – Industry IT & DevOps; Phase 3 (2002-2011) – Information Technology and Management in Evolving Industry, Academia, and Research Areas; and Phase 4 (2011-2021) – Information Technology Research & Education.
Recommendations for Practitioners	IT occupies an independent disciplinary space from computer science, computer engineering, and information systems. The paper suggests that practitioners seeking to fill the talent gap in IT invest in enabling its academic programs.
Recommendations for Researchers	The depth of the IT disciplinary space and its continued evolution over time is ready for exploration. Continued research in this area may yield a better understanding of its role in society, the skills needed to succeed, and how to build programs to empower students with these skills.
Impact on Society	Examining the discipline of IT and understanding its independence and interrelated connection with other computing disciplines will help address the shortfalls in academia across the nation by identifying the distinction between each discipline and creating comprehensive programs, degrees, and curricula suitable for various students and professionals across all educational levels.
Future Research	Future research will integrate papers' introductions and conclusions in addition to abstracts, increase the number of databases and reviewers, as well as incorporate papers that focus on other information and computing disciplines such as computer science and information systems to explore the possibility that IT as a discipline was initially practiced in an existing information or computing discipline before it gained independence.
Keywords	information technology, discipline of information technology, systematic literature review

INTRODUCTION AND BACKGROUND

The COVID-19 pandemic started in 2019 and impacted the social, economic, and mental lives of people across the globe, including in the United States (Ma & Zhang, 2021). In many organizations, the Information Technology (IT) division bore great burdens to adopt interventions and solutions to transit and maintain organizations in remote workplaces, especially due to the talent shortage in IT (Muraski et al., 2021; Ramos et al., 2021). The *2021-2023 Emerging Technology Roadmap for Large Enterprises* report from Gartner Inc. reported that 64% of IT executives cited talent shortages as the most significant barrier to emerging technology adoption, up from 4% in 2020 (Ramos et al., 2021). Furthermore, the report indicated that most technologies now work outside of IT departments, encompassing technology or analytics capabilities for work known as "Business Technologies" (Ramos et al., 2021). An important factor neglected in the report is the segmentation of business technologies from information technology through being part of the IT umbrella itself. It is also reflected in the December 2017 draft of the ACM/IEEE *Computing Curricula: Information Technology*, which provided the following definition of IT:

> Information Technology is the study of systemic approaches to select, develop, apply, integrate, and administer secure computing technologies to enable users to accomplish their personal, organizational, and societal goals (Task Group on Information Technology Curricula, 2017).

Based on this definition, business technologies are computing technologies that enable users to accomplish their organizational goals (Task Group on Information Technology Curricula, 2017) while supporting innovations that continue to evolve (Task Group on Information Technology Curricula, 2017), thus fitting under the general IT discipline. Following the ACM/IEEE definition, the University of Cincinnati has also articulated a definition for the IT discipline as the study of solutions and needs that connects people, information, and the technology of the time (Said et al., 2021). The authors also argued that this definition can be achieved if IT practitioners and professionals possess the right knowledge, tools, and skills to understand and synergize the right stakeholders, information, and technologies to develop the right solutions (Said et al., 2021). Thereby, education serves as a crucial venue to equip students/future professionals. Alas, academia itself has been a contributing factor in the creation of the talent gap.

Insufficient college degrees at all levels focused on IT can impact the number of professionals with sufficient IT knowledge and technical skills needed in the market (CC2020 Task Force, 2020). According to a research survey conducted across over 1,000 business executives in the United States, "75% of organizations believe that the skills shortage is the primary cause for the difficulty in hiring," and "51% believe that the education system is doing little or nothing to solve the problem" (Watts & Reza, 2019). In complement, another article stated that "technology has been impacting the workforce at all levels requiring a more highly skilled worker – even for many entry-level jobs. When the needed educational response did not happen, the skills gap was born" (Lyons, 2019). Additionally, based on the research team's observation, some higher education institutes and colleges define information technology differently, and some do not consider information and computer science degrees and disciplines independent due to their origin.

During the 1990s, and even the early 2000s, information technology programs were created out of CS, IS, MIS, and Engineering (Lunt et al., 2002; Reichgelt et al., 2004). Naturally, the design and content of these programs equally influenced the design and content of information technology curriculums, focusing heavily on computing rather than technical applications (Lunt et al., 2002). It is worth mentioning that the Computer Science discipline itself underwent a similar process during the 1970s and 1980s due to its origins in mathematics and engineering (Lunt et al., 2002). Thereby, "some CS programs are in departments of Mathematics, others are in Engineering schools, and many others have become freestanding programs within newly emerging colleges of computing" (Lunt et al., 2002). The same is true for information technology programs that are housed in different colleges or departments rather than one under its own independent name. The colleges of computer science and engineering, colleges of arts and applied sciences, and social or applied science departments are a few examples where IT programs lie. Furthermore, some may welcome the development of baccalaureate degrees in IT that are distinct from other computing disciplines, while others may be "less accommodating and argue that there is nothing that would make a baccalaureate program in IT sufficiently distinct from a baccalaureate program in an existing computing discipline to warrant a separate degree program" (Reichgelt et al., 2004).

While the origin of information and computing programs in education can be estimated, it is not clear why information technology as a discipline took so long to form itself and gain independence. The research space has been occupied by researchers from multiple disciplines, but the space itself is not identified as an information technology discipline with a mature set of undergraduate and graduate programs and a clear research agenda. Examining the discipline of information technology and understanding its independence and interrelated connection with other computing disciplines will help address the shortfalls in academia across the nation by identifying the distinction between each discipline and creating comprehensive programs, degrees, and curricula suitable for various students and professionals across all educational levels. Thereby, the research gap that this paper examines is a comprehensive review using a systematic literature review methodology for the discipline of information technology. The exploratory study presented in this paper aims to answer the question:

What are the development phases of the academic discipline of information technology in the United States?

METHODOLOGY

This paper uses a systematic literature review by adapting Kitchenham and Charters' (2007) proposed guidelines. It involves the following components:

1. The research question
2. Inclusion and exclusion criteria
3. The search process
4. Filtering and quality assessment
5. Thematic analysis

RESEARCH QUESTION

To address the research question, this systematist literature seeks to investigate publications on the history of information technology in the United States through the lenses of education, workforce, and computing disciplines across time to assist in identifying the country's development phases of the academic discipline of information technology.

INCLUSION AND EXCLUSION CRITERIA

Table 1 lists the inclusion and exclusion criteria used in this study to support the research question.

Table 1. Inclusion and exclusion criteria

Inclusion	Exclusion
Papers focusing on the evolution of computing or information	Papers focusing on courses and not full discipline
Papers focusing on the history of computing or information	Papers focusing on the history of IT application outside the U.S.
Papers addressing academic elements of computing or information	Papers focusing on non-IT and non-computing disciplines
Papers addressing industry elements of computing or information	Papers that are non-English
Papers that are full research publications	Books
Open access papers	Newsletters
Papers that are surveys	Magazines
	Encyclopedias
	Videos
	Posters

SEARCH PROCESS

To conduct the systematic literature review for this paper, publications from the ACM Digital Library and the IEEE Xplore Digital Library were accessed. The ACM and IEEE Xplore online libraries have a large reservoir of information technology, computer science, and other relevant computing discipline publications that were deemed suitable for this review. Selecting search terms reflecting an inclusive range of literature pertaining to the history and evolution of IT was challenging. Based on the inclusion and exclusion criteria, followed by several trials and errors, the following research terms were selected: "Information Technology" in the title, and "History" and "Development" or "Development Phase" in all metadata. Utilizing ACM and IEEE Xplore Advanced Search features, the final query strings were as followed:

- **ACM:** Title: ("Information Technology") AND AllField:(development) AND AllField:(History)

- **IEEE Xplore**: ("All Metadata":"information technology") AND ("All Metadata":development) AND ("All Metadata":history)

Filtering and Quality Assessment

A combination of automatic and manual processes was used on the ACM and IEEE Xplore publications to ensure selected papers were within the range restricted by the inclusion and exclusion criteria as shown in Table 1. The queried results in ACM were filtered to show "Research Articles", "Proceedings," and "Journals" respectively. The queried results in IEEE Xplore were also filtered to reflect "Journals" and "Conferences" and excluded non-IT and non-computing topics. In both cases, the filtering panes available on the left side of the databases' APIs were used. Thereby, the first phase of applying the inclusion and exclusion criteria automatically was completed during the "Search Process" by integrating inclusive and exhaustive search terms and utilizing filters available in the ACM and IEEE Xplore filter panes. Utilizing the queries and the databases' available filters helped with the automatic application of the inclusion and exclusion criteria.

The second phase of applying the exclusion and inclusion criteria was done manually. One team member read through the titles and abstracts of articles retrieved from ACM, and another member did the same for retrieved IEEE Xplore articles. If the article directly stated the use, history, and/or development of "information technology" in the academic, industrial, or business environment, the article met the criteria. To ensure articles focused on IT and computing disciplines in the United States, the research team reviewed the authors' names, their email addresses, their affiliated universities, and the publication location. Papers published outside the United States were excluded.

As a result, 143 out of a total of 1,019 papers met the defined criteria. A quality assessment was performed, as indicated in Kitchenham and Charters' (2007) guidelines, to assess the quality of the retrieved research articles. One team member read the articles' abstracts while referring to the quality assessment questions stated in Table 2. The degree to which each article focused on or addressed the questions was determined by the team member and how explicitly or implicitly they were able to discern from the papers' abstracts. Table 2 shows the quality assessment form and assessment results.

Table 2. Quality assessment questions and results

Question	1=Not Focused	2=Semi-Focused	3=Fully Focused
What is the degree to which the article focuses on the discipline of information technology?	49.7%	21.7%	23.1%
What is the degree to which the article describes history relevant to computing?	46.9%	18.2%	8.4%
What is the degree to which the article addresses academic element of computing or information?	42.7%	10.5%	25.2%
What is the degree to which the article addresses industry element of computing or information?	6.3%	8.4%	11.9%

Based on the quality assessment and combining the semi-focused and full-focused categories, 44.8% of articles focused on the discipline of IT; 26.6% of articles described history relevant to computing to some degree; 35.7% of articles had some degree in which they addressed academic elements; and 20.3% had some degree in addressing industry elements. Therefore, the focus on academic elements was greater than on industry. Another interesting factor was the high percentage of articles not focusing on IT as a discipline (49.7%). Those articles focused on IT more as a tool or functionality rather than a discipline.

THEMATIC ANALYSIS

Thematic analysis was conducted to analyze the articles' abstracts and draw conclusions based on common themes or patterns identified in each phase to answer the research question. Thematic analysis is generally defined as "a method for identifying, analyzing, and reporting patterns (themes) within data" (Purssell & Gould, 2021). The thematic analysis consists of the following three stages that were adhered to during this paper (Thomas & Harden, 2008):

1. Line-by-line coding of the text in the papers, which in this case were the abstracts.
2. Generating descriptive themes that were linked closely to the articles.
3. Developing final analytical themes to create new explanations or hypotheses.

As outlined in Appendix B, a script was generated using RStudio version 2022.07.01 for the first step of the thematic analysis. The software scanned through the texts line-by-line, identified repeating words through a matching algorithm, and listed them and their wordcount both in a table and bar charts. The words extracted by RStudio in each phase became the initial code.

Appendix A illustrates all the coded words with a total wordcount of 5 or above. For wordcounts of less than 5, the resulting diagrams became illegible to be included. The team reviewed, discussed, and compared them, merged those with similar names or meanings, and deleted irrelevant ones. The team observed that words with a total count of 15 or more were representative of the codes generated by R. Thereby, the research team agreed on a threshold of n >= 15 where n is the frequency of the word being listed.

To answer the research question, the factor of time was important. The metadata for 143 papers (e.g., title, author, publication year, etc.) was transferred into an Excel spreadsheet and ordered chronologically by publication year. The retrieved publications' years showed a timeline from 1982 to 2021, as such 1982 was based on the earliest publication that met the search criteria.

To construct a timeline for the themes, the research team organized the publications based on publication year. The team observed that information and technology were dominant keywords throughout. However, the associated keywords changed. For instance, there were no other dominant keywords up until the early 1990s. Furthermore, keyword education did not become dominant until the 2000s. Based on the literature review of the major educational and technological events, the team identified approximately four milestones at the beginning of the 1990s, 2000s, and 2010s. Table 3 is constructed to represent the team's proposition that, based on the primary studies, the information technology discipline has undergone four phases of development.

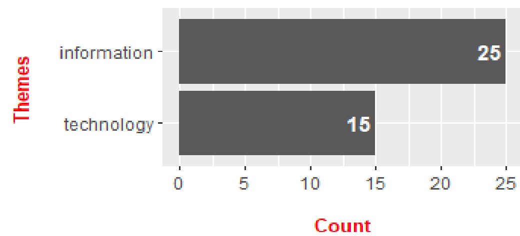
Table 3. IT discipline development phase timeline and total number of articles in each phase

Database	Phase 1: 1982-1991	Phase 2: 1992-2001	Phase 3: 2002-2011	Phase 4: 2012-2021	**Total**
ACM	6	15	25	13	**59**
IEEE Xplore	0	36	38	10	**84**
Total	**6**	**51**	**63**	**23**	**143**

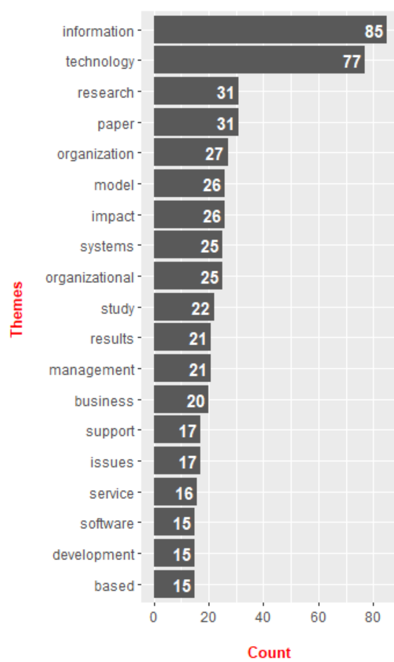
Overall, subthemes and main themes were developed based on: (1) the literature review; and (2) the repeated words encountered while reading the papers' abstracts.

RESULTS

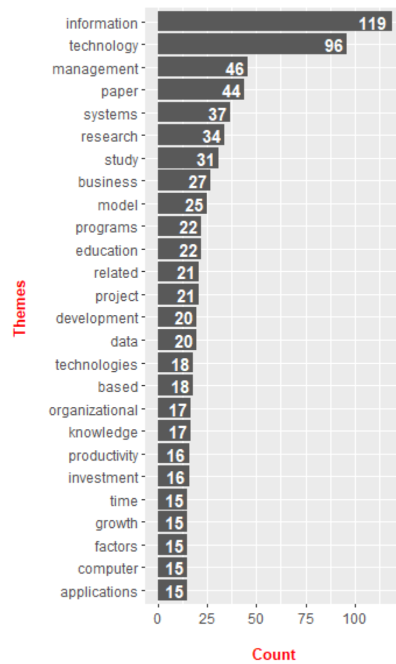
At the start of the analysis, the team wanted to get a sense of the top repeating words in all the study articles. A total of 2,994 words were coded by RStudio, representing the abstract of each of the 143 papers used as the primary studies for this project. Appendix A shows words repeated in all the primary studies with a total wordcount of 1 and above. Amidst them, "information", "technology", "paper", "research", "management", "systems", "model", "study", "business", and "results" were the top ten prevailing ones. However, to identify the themes in each of the phases and answer the research question, the research team realized that an analysis of only articles published within each phase is required. Using RStudio, the abstracts of articles categorized in each phase were coded. The components of Figure 1 illustrate words that were repeated fifteen times or more in each phase. These were considered the first-step codes.



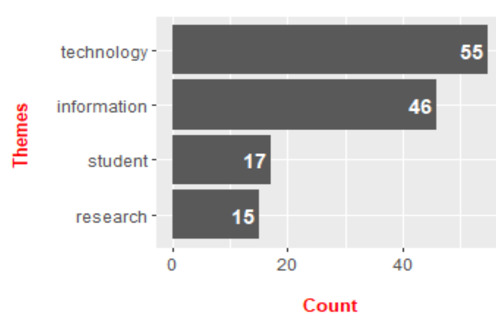
(a) Phase 1



(b) Phase 2



(c) Phase 3



(d) Phase 4

Figure 1. Repeated words with a wordcount of n >= 15 in each phase
Generated in RStudio Version 2022.07.01

Figure 1 demonstrates the codes extracted in each phase with a wordcount equal to or greater than fifteen. In Phase 1, the only qualifying words included “information” and “technology”. As such, the subtheme “Information Technology” was developed. The team reviewed the articles’ abstracts in this phase and, following the methodology described earlier, the team recognized that “Information Technology” was the prevailing theme. Therefore, the main theme for this phase was decided as the “Advent of Information Technology”. Themes for Phases 2, 3, and 4 were developed through a similar process. However, an additional step was added as certain words appeared to be the same due to their singular and plural appearance in the text, such as “system” and “systems”, “technology” and “technologies” and alike. These words were first combined before developing the sub-themes. While developing the sub-themes, the team also observed that grouping words such as “education”, “students”, “programs”, and “studies” can indicate an “Education” theme; grouping words such as “technology”, “systems”, “applications”, “programs”, “software”, and “computer” can indicate a “Technological” theme, and alike. The final codes for each phase, subthemes, and main themes are summarized in Tables 4, 5, 6, and 7.

Table 4. Thematic analysis results: Phase 1 (1982-1991)

CODE	GROUPS	SUB-THEME	MAIN THEME
information		Information Technology	Advent of Information Technology
technology			

Table 5. Thematic analysis results: Phase 2 (1992-2001)

CODE	GROUPS	SUB-THEME	MAIN THEME
information	information	Information Technology	Industry’s Growing IT Infrastructure & DevOps
technology	technology		
research	system	Information System	
organization/ organizational			
model	organization/ organizational	Industry	
impact	business		
systems	management		
management			
business	technology	Technologies and Systems	
support	software		
issues	systems		
service	service		
software			
development	issues	Problem-Solving & Solutions Support	
study	service		
	impact		
	support		

CODE	GROUPS	SUB-THEME	MAIN THEME
	development		
	research	Research & Development	
	development		
	study		

Table 6. Thematic analysis results: Phase 3 (2002-2011)

CODE	GROUPS	SUB-THEME	MAIN THEME
information	information	Information Technology	Information Technology and Management in Evolving Industry, Academia, and Research Areas
technology/ technologies	technology/ technologies		
management	system	Information System	
systems	technology/ technologies	Technology & Systems	
research	systems		
business	computer		
model	applications		
programs			
education	information	Information Management	
project	data		
development	management		
organizational			
knowledge	research	Education & Literacy	
productivity	study		
investment	education		
growth	programs		
computer	knowledge		
data			
	business	Industry Growth & Development	
	organizational		
	productivity		
	investment		
	growth		
	time		
	development		
	project		
	research	Research & Development	
	development		

CODE	GROUPS	SUB-THEME	MAIN THEME
	study		

Table 7. Thematic analysis results: Phase 4 (2012-2021)

CODE	GROUPS	SUB-THEME	MAIN THEME
information		Information Technology	Information Technology Education & Research
technology			
student		Education	
research		Research	

DISCUSSION AND CONCLUSION

The results show the discipline of Information Technology has evolved over four phases. The first phase is where the discipline was formed, which we called the "Advent of Information Technology" and it lasted 9 years. According to the articles found, that timeline was known as the "era of information revolution … characterized by explosive developments in electronic information technologies and by their integration into complex information systems that spanned the globe" (Office of Technology Assessment, 1982). It was the time when information technologies were infiltrating various aspects of society, including industries and educational institutions while impacting individuals, institutions, and the government and altering what they did. As a result, the constant challenge was the growing need to adapt, change, develop, and scale IT infrastructures across various levels in order to "thrive economically and socially in a world that will be shaped, to a large degree, by these technological developments" (Office of Technology Assessment, 1982). In fact, some of the most significant IT innovations during this decade include the release of Microsoft's Windows 1.0, Apple's Macintosh Computer, cell phones, the Linux system, and the Internet.

The second phase is where the industry grew its infrastructure. We suggest a theme of "Industry's Growing IT Infrastructure and DevOps," which scaled across from 1992 to 2001. The articles found for Phase 2 were primarily concerned with IT in the context of the industry. Following the advent of computers, the World Wide Web, and the expansion/inauguration of today's giant tech companies such as IBM, Microsoft, Apple, and Google during this decade, organizations continuously attempted to "expand the range of potential strategic applications of IT and to focus attention on IT applications that can improve an organization's capability for learning" (Mason, 1993); increasing productivity, workflow efficiency, creativity, and more (Reimers, 1997) through consistent implementation of organizational and managerial change (Cooper, 1995), research and development (e.g., technological, social, cultural, etc.) (Hoffman, 1998), automation and ad hoc methods (Chimera, 1995); and focusing on humans, computers, and the interactions between them, also known as HCI, to balance the work and knowledge delivered by both humans and computers, as well as improving users' experiences across diverse businesses and services that use technologies to retain customers and employees, as well as preserve their economies (Drury & Farhoomand, 1999; Orlikowski & Gash, 1994).

The main theme of the third phase, from 2002 to 2011, that we suggest is "Information Technology and Management in Evolving Industry, Academia, and Research Areas." For the first time, educational elements start to show alongside the continuous industrial elements, which are also reflected in the ACM/IEEE *Computing Curricula: Information Technology*. IT as an academic discipline was first recognized in the 2004 ACM/IEEE *Computing Curricula: Information Technology* published as the following:

> Information Technology (IT) in its broadest sense encompasses all aspects of computing technology. IT, as an academic discipline, focuses on meeting the needs of users within an organizational and societal context through the selection, creation, application, integration, and administration of computing technologies (CC2005 Task Force, 2005).

According to the articles found, the focus shifting to education started in the early 2000s due to the growing need to hire literate and skilled individuals in IT at every level (Bailey & Stefaniak, 2002), putting emphasis on colleges and educational institutes' programs and curricula that comprise sufficient technical and soft skills to develop future employees (Bailey & Stefaniak, 2002). Thereby, there grew a need to develop IT programs and to focus on student success, computer and IT literacy, and skill development to prepare and maintain student and future employee retention, which continued to 2021 (Chen & Fox, 2014; Zhang et al., 2008).

While education became prominent starting in Phase 3, IT remained a critical factor in industry and research, especially given the explosion of the internet and emerging e-services through various technologies, both mobile and computer, that began to increase the volume, velocity, variety, and veracity of data being entered, shared, and processed (Niu, 2020). As a result, some topics growing in importance during this time include cybersecurity; mobility networks, security, and management; data mining, data analysis, and information management; information systems, object-oriented programming, and software engineering; and e-businesses and e-learning (2007 International Conference on Convergence Information Technology – Title, 2007). All of these deliver solutions, support creativity and productivity, and foster a culture of continuous research, learning, and development. This became reflected in ACM/IEEE *Computing Curricula: Information Technology* published in 2017 and shared earlier in this paper, in which IT was redefined from an "academic discipline" into a broader definition that comprised people, information, solutions, and the technologies of the time:

> Information Technology is the study of systemic approaches to select, develop, apply, integrate, and administer secure computing technologies to enable users to accomplish their personal, organizational, and societal goals (Task Group on Information Technology Curricula, 2017).

The fourth phase, starting in 2012 and ending in 2021, was called "Information Technology Education & Research" due to Academia remaining a focal point. The research focused on increasing student success, enrollment, retention, and graduation rates as a few top measures of institutional performance that also impact students' professional future (Sabin et al., 2020).

In conclusion, the thematic analysis showed the advent of the academic discipline of information technology since 1982, which began in the industry and slowly shifted toward academia due to the growing need to prepare and develop the workforce needed across various IT levels. Research articles provided supported this claim and, given the data analyzed from the retrieved publications, the development phases of IT can be summarized as Phase 1 (1982-1991) – Advent of Information Technology; Phase 2 (1992-2001) – Industry IT & DevOps; Phase 3 (2002-2011) – Information Technology and Management in Evolving Industry, Academia, and Research Areas; and Phase 4 (2011-2021) – Information Technology Research & Education. However, it was not possible to pinpoint the exact time when IT gained independence as an academic discipline, whether it was during the timeline proposed in this paper or before the 1980s as illustrated in James Gleick's (2011) *The Information: A History, A Theory, A Flood*, or in the guise of another computing discipline that was not explicitly called IT. Additionally, research is required to identify when IT became an independent discipline in the industry.

The IT Talent Gap and the Role of Academia

According to the thematic analysis, information technology started initially in the industry and later shifted toward education. The shift started in the early 2000s, when information technology grew across all workplace sectors, demanding more skilled professionals, and information technology programs began to form out of CS, IS, MIS, and Engineering (Lunt et al., 2002; Reichgelt et al., 2004), as stated in the Introduction and Background section of this paper. However, creating the programs was insufficient because the "college completion rate continued to increase but at a slightly slower pace from 1980 forward" (Lyons, 2019), and the skill gap occurred when the industry's demand for skilled IT professionals did not match the pace of educational response (Lyons, 2019). To remedy this, first, both industry and academia must collaborate to create information and computing programs across all educational levels to "encourage students of all ages to learn more about technology to advance their careers while helping their employers advance their bottom line" (Lyons, 2019). For instance, at a college level, there are two critical areas that must be addressed by both the university and the industry to close the talent gap.

> The first is the successful preparation of graduates to meet the talent needs of the industry, and the second is the ability of the University to help the industry solve its current problems. Focusing on these two areas and emphasizing effort and success for both the University and the Industry are critical (Said, 2019).

A college institution, such as the University of Cincinnati, provides IT programs for all undergraduate and graduate levels. For instance, its doctoral program in Information Technology is designed to teach, train, and equip students with the skills needed to conduct applied research in evidence-based, human-centered, and secure IT practices; to educate future professionals at various academic levels; and to prepare them to serve as key leaders in organizations and enterprises to develop efficient IT solutions for consumers and/or businesses (University of Cincinnati, 2020). The program's curriculum is designed with an emphasis on the history and definition of IT as an independent discipline. In addition, the program has created a framework for IT that not only helps connect academia and industry but also promotes a curriculum development approach that is both reflective and iterative to help provide students with state-of-the-art knowledge and skills to prepare them for the workplace and meet the industry demand.

Framework for the Discipline of Information Technology

This research shows that information technology has evolved as an independent academic discipline that was driven by the needs of the industry. It shows that the level of complexity of information technology solutions continues to increase, which suggests more sophisticated and skilled talent. As with other academic disciplines, the discipline of information technology has already established graduate programs at the master's and doctoral levels at several institutions. This suggests a need for a comprehensive framework and definition for the discipline. The findings of this research align with the four elements of the discipline suggested by Said et al. (2021). Their framework suggests four independent components for the discipline of information technology: People, Information, Technology of the time, and the solutions or needs that connect them. Put together, a definition for the discipline can be articulated as:

> Information Technology is the study of solutions and needs that connect people, information, and the technology of the time.

This definition encompasses the elements articulated in the 2017 ACM/IEEE *Computing Curricula: Information Technology* definition. However, it expands beyond the ACM/IEEE definition in key areas. First, it presents IT as the study of solutions and needs instead of systematic approaches. Second, it utilizes the technology of the time instead of computing technologies. Finally, it focuses on people and information instead of users. In other words, the ACM/IEEE definition shows IT as a process and a function, whereas the proposed definition shows IT as a need and a solution.

Limitations

There are multiple sources of limitations in this exploratory study. First is the use of ACM and IEEE Xplore as the sources of data. Although both are prominent digital libraries for information technology and computing disciplines, a broader search including different databases has the potential to refine results (Chen & Fox, 2014). Thus, there might have been some degree of bias in the selection of databases. Another limitation is relevant to restricting publications to only research articles that were also available for free or were open access. Magazines, books, posters, and certain other publications were excluded. This may result in subjectivity and a lack of relevant information, such as historical content on the IT discipline's development phases.

Thematic analysis is a context analysis method that is prone to several potential limitations. According to Trochim et al. (2016), content analysis has the following potential limitations: "First, you are limited to the types of information available in text form," and "second, you have to be especially careful with sampling to avoid bias" (Trochim et al., 2016). It is impossible for the RStudio software to determine what is meant by a word or concept, and even compound words such as "Information Technology" were broken down into "information" and "technology." A significant disproportion existed in the number of publications fitting into each phase. Some phases, such as Phase 2 and Phase 3, had more articles compared to Phase 1 and Phase 2, which equally produced more codes. However, to maintain consistency, words with a wordcount of fifteen or more were chosen to be excluded from the very few extracted codes in Phase 1 and Phase 4, leaving out potentially relevant code for thematic analysis. Additionally, the review, analysis, and development of themes were done manually by the research team, so results are prone to subjectivity. Furthermore, the team consisted of two individuals, and the small number of reviewers involved potentially introduced systematic errors not only in the thematic analysis phase but also in the paper selection and quality analysis sections as well.

Another limitation includes the IT discipline development phase timeline. The publication years of retrieved articles showed a timeline from 1982 to 2021, which does not reflect an inclusive representation of the history of IT and its evolution. James Gleick's (2011) book, *The Information: A History, A Theory, A Flood*, describes historical events that indicate the history of IT dates before 1982. In addition, IT remains a consistently evolving discipline that will continue to grow in scale and complexity, especially given upcoming IT trends in 2023 (Groombridge, 2022). Finally, the main limitation was conducting analysis only on publications' abstracts.

Future Work

The study suggests that future work can continue along multiple dimensions. For instance, expanding the study by integrating papers' introductions and conclusions in addition to abstracts; increasing the number of databases, reviewers, and types of papers (e.g., books, magazines, posters, etc.); as well as incorporate papers that focus on other information and computing disciplines such as "computer science" and "information systems" to explore the possibility that IT as a discipline was initially practiced in an existing information or computing discipline before it gained independence. Additionally, future research may explore the development, interconnection, and independence of Information Technology as a discipline with other information and computing disciplines in other countries to not only suit the international audience but also learn from and integrate their best practices and initiatives towards improving national and international academic success of students in IT, IS, CS, and additional programs across all educational levels.

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APPENDICES

Appendix A: Graphs of all keywords with counts of one and above

Figure A1. Repeated words with a wordcount of n >= 20 in all yielded articles

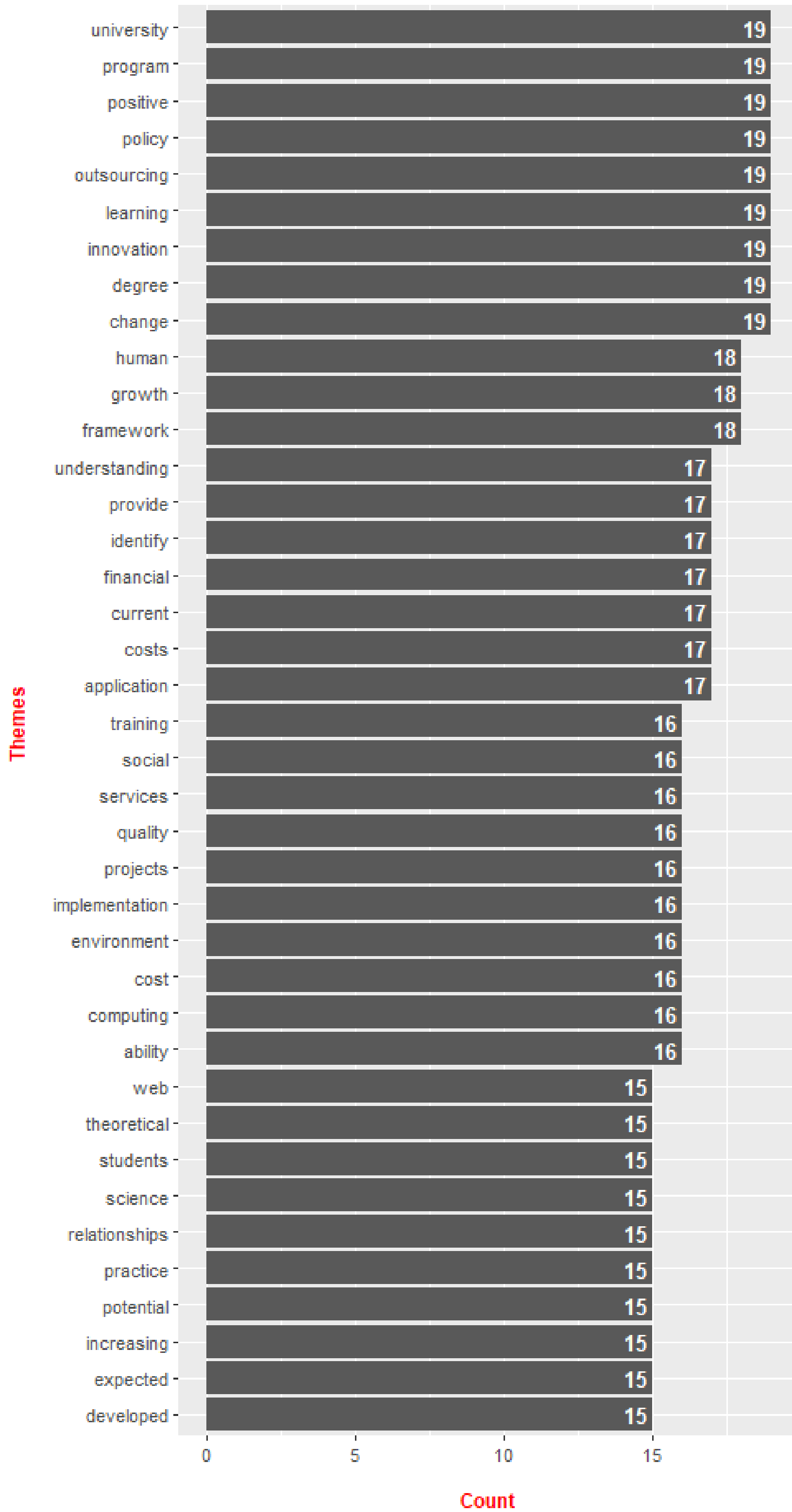

Figure A2. Repeated words with a wordcount of 20 > n >= 15 in all yielded articles

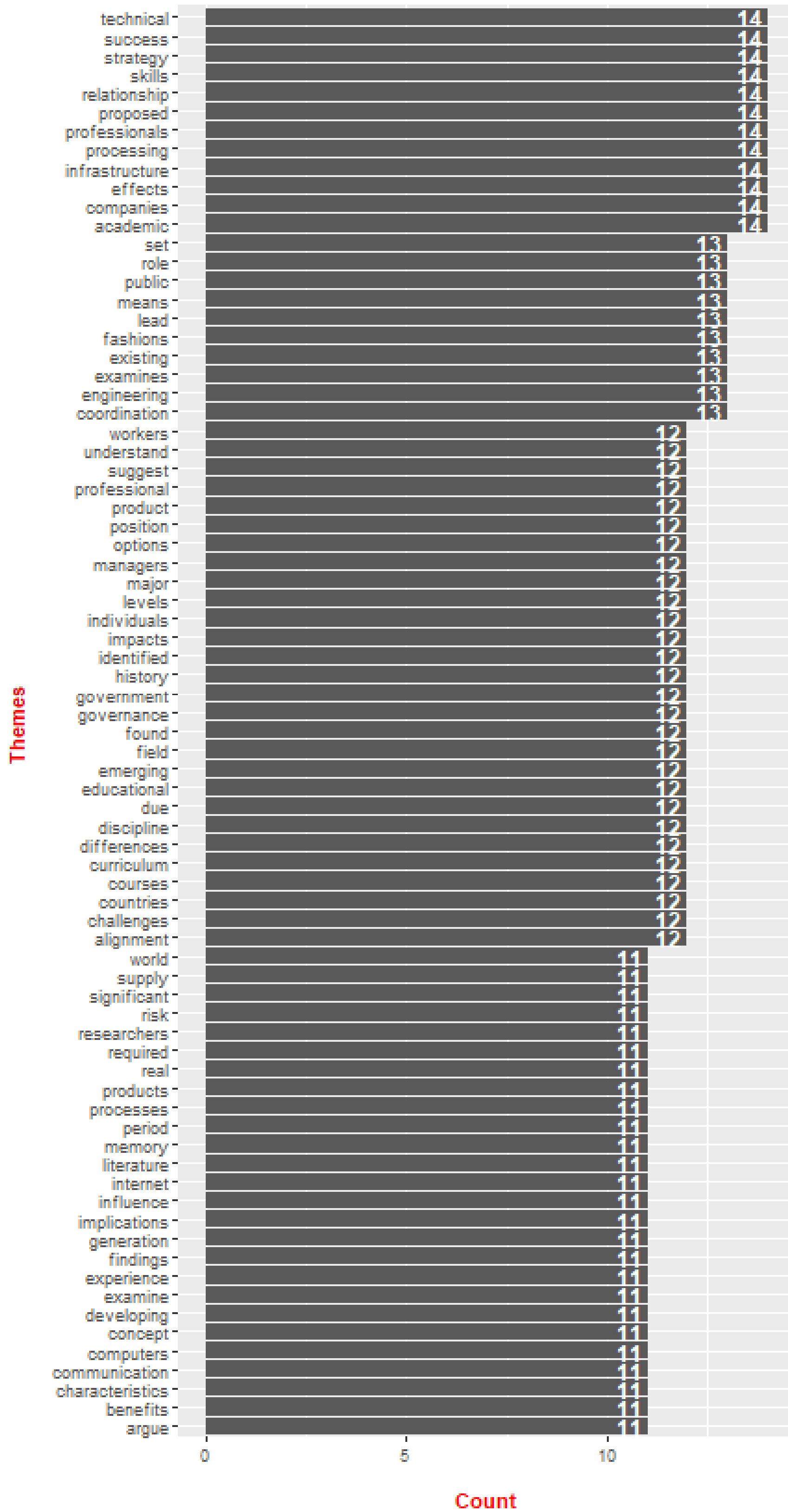

Figure A3. Repeated words with a wordcount of 15 > n >= 11 in all yielded articles

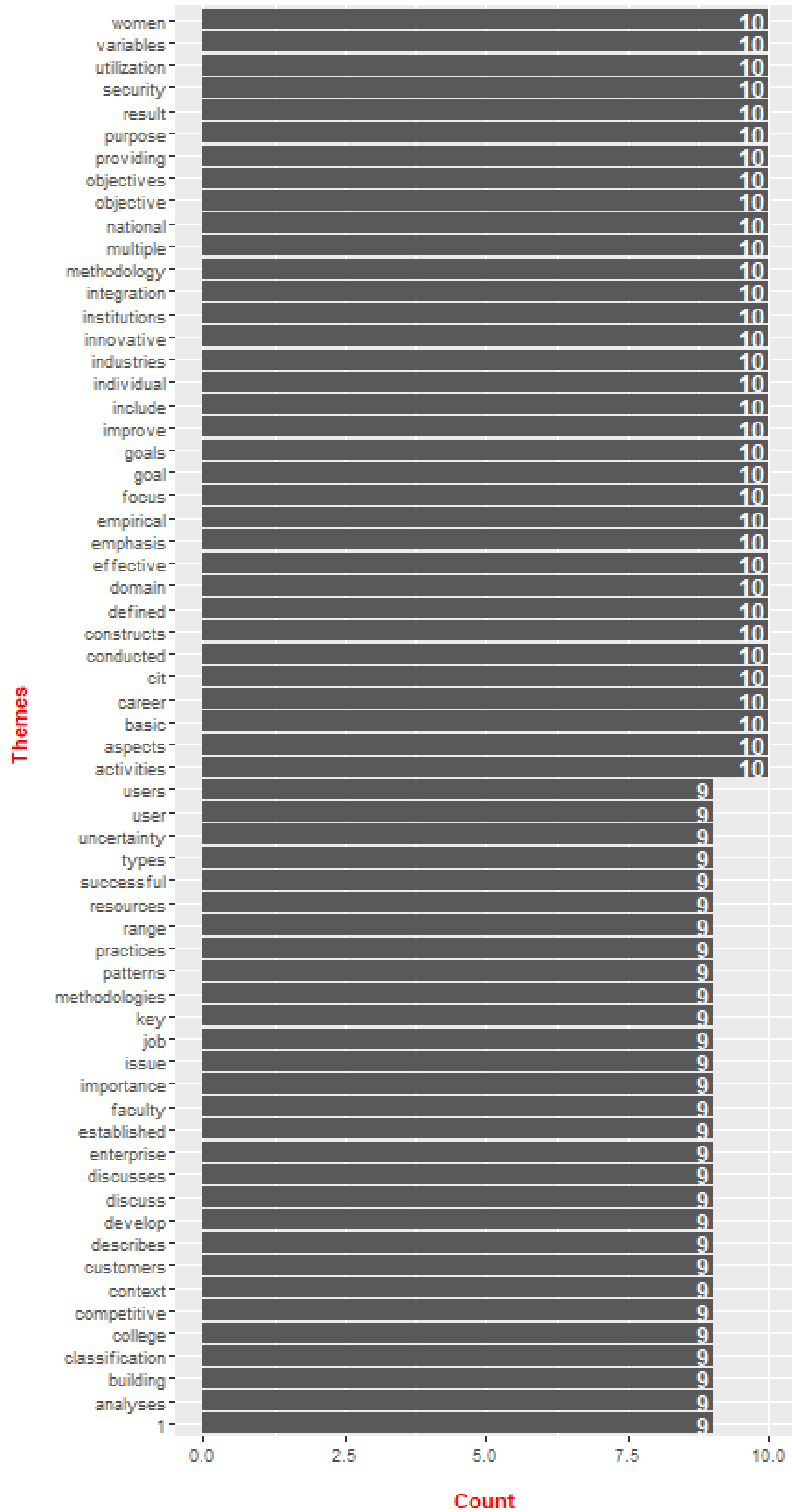

Figure A4. Repeated words with a wordcount of 11 > n >= 9 in all yielded articles

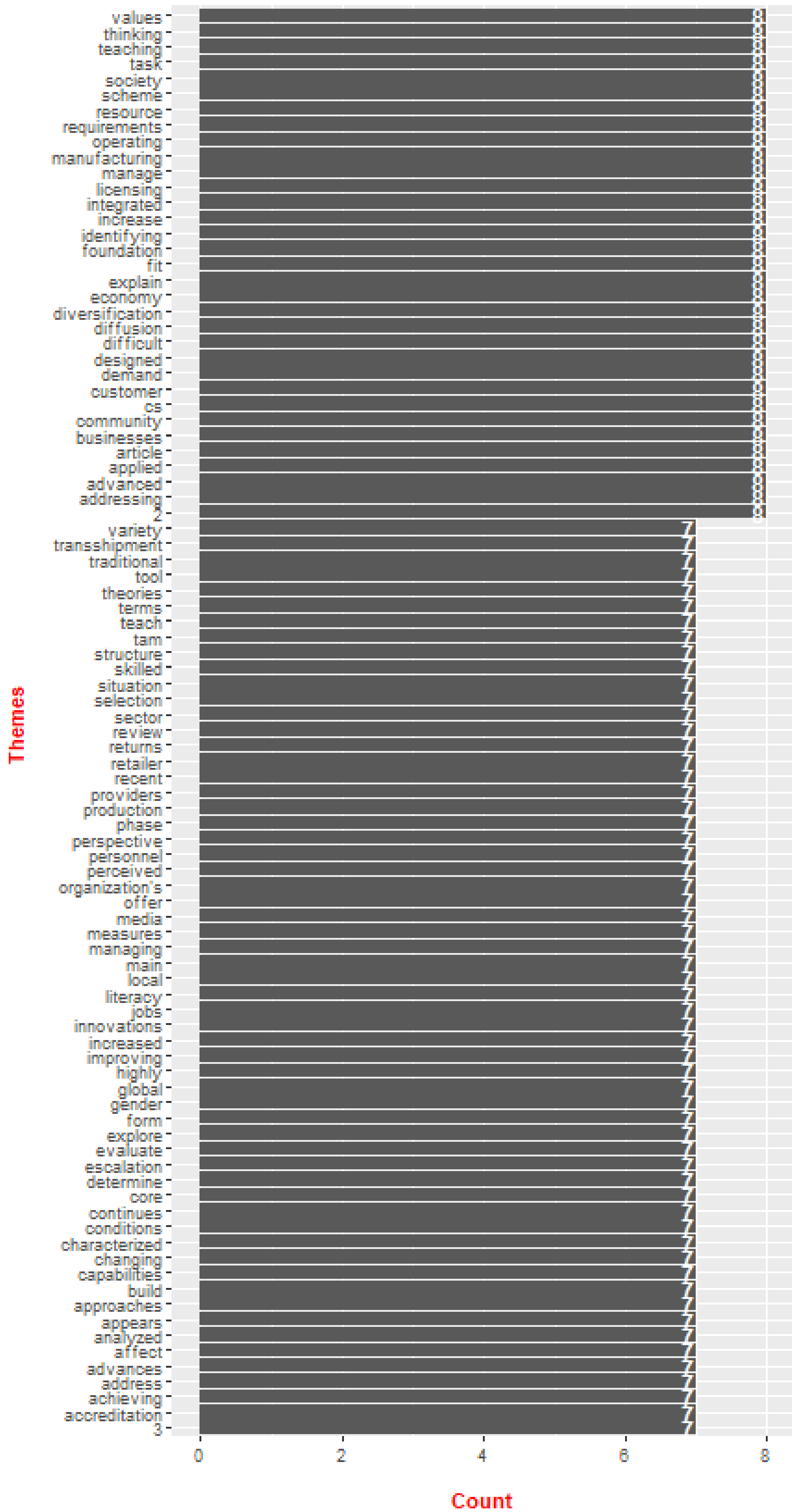

Figure A5. Repeated words with a wordcount of 9 > n >= 7 in all yielded articles

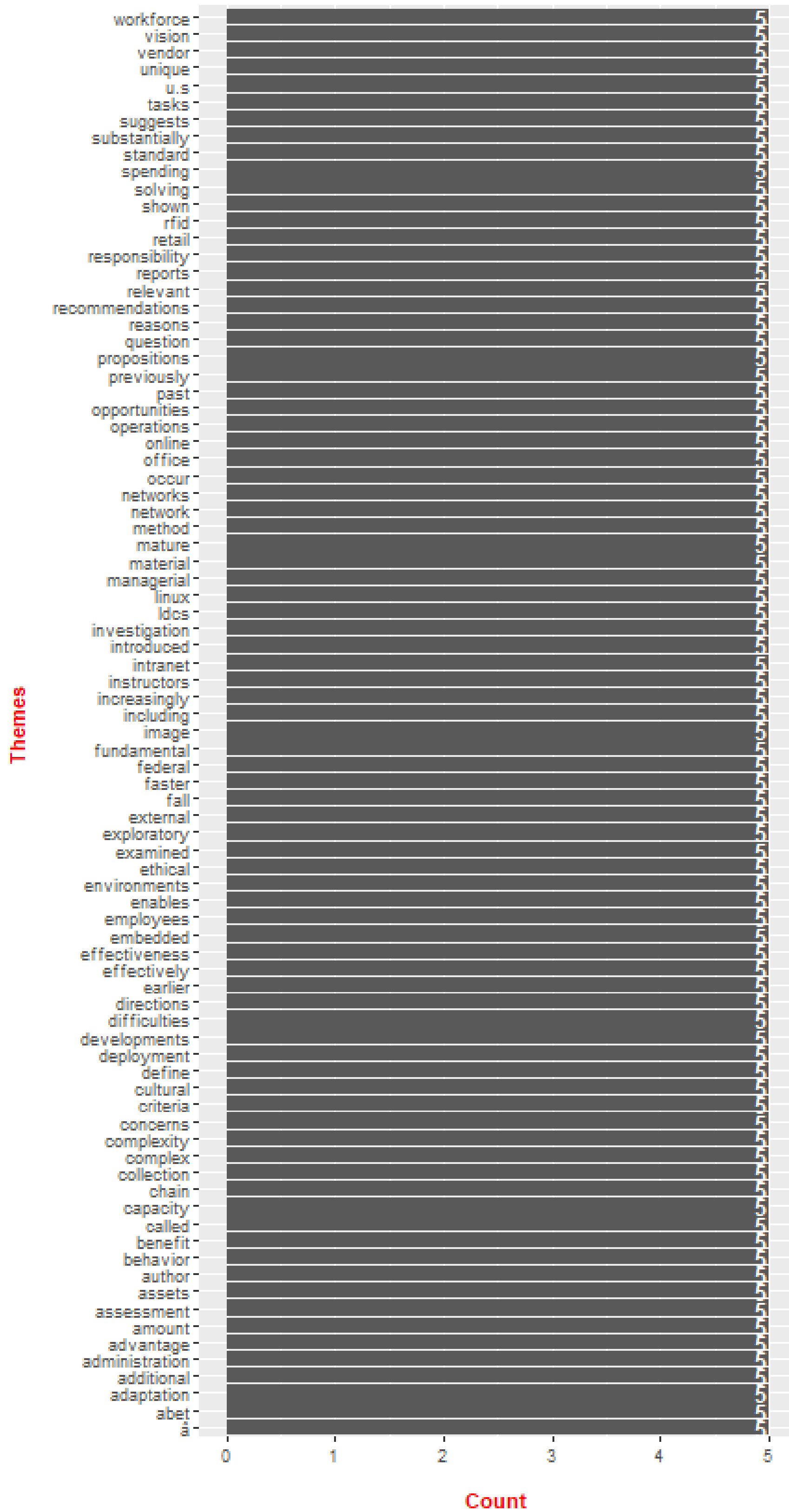

Figure A6. Repeated words with a wordcount of n = 5 in all yielded articles

Appendix B. Algorithm for Generating Keywords Using R Code

```
# Import libraries
library(dplyr)
library(tidytext)
library(ggplot2)

# Change the text file here
# Run each file individually by commenting the rest
data <- readLines("C:/User/Project/ThematicAnalysis/AllPapers.txt")
data <- readLines("C:/User/Project/ThematicAnalysis/Phase1.txt")
data <- readLines("C:/User/Project/ThematicAnalysis/Phase2.txt")
data <- readLines("C:/User/Project/ThematicAnalysis/Phase3.txt")
data <- readLines("C:/User/Project/ThematicAnalysis/Phase4.txt")

# Check
head(data, n = 20)

# Convert text to data
data1 <- tibble(Text = data)
head(data1, n = 20)
words <- data1 %>% unnest_tokens(output = word, input = Text)
words <- words %>% anti_join(stop_words)
wordcounts <- words %>% count(word, sort = TRUE)
head(wordcounts)

# ggplot2 Plot:
# filter (n) shows wordcount
wordcounts %>% filter(n >= 15) %>% mutate(word = reorder(word, n)) %>% ggplot(aes(word,
n)) + geom_col() +
  coord_flip() + labs(x = "Themes \n", y = "\n Count ") +
  geom_text(aes(label = n), hjust = 1.2, color = "white", fontface = "bold") +
  theme(plot.title = element_text(hjust = 0.5),
        axis.title.x = element_text(face="bold", colour="red", size = 10),
        axis.title.y = element_text(face="bold", colour="red", size = 10))
```

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