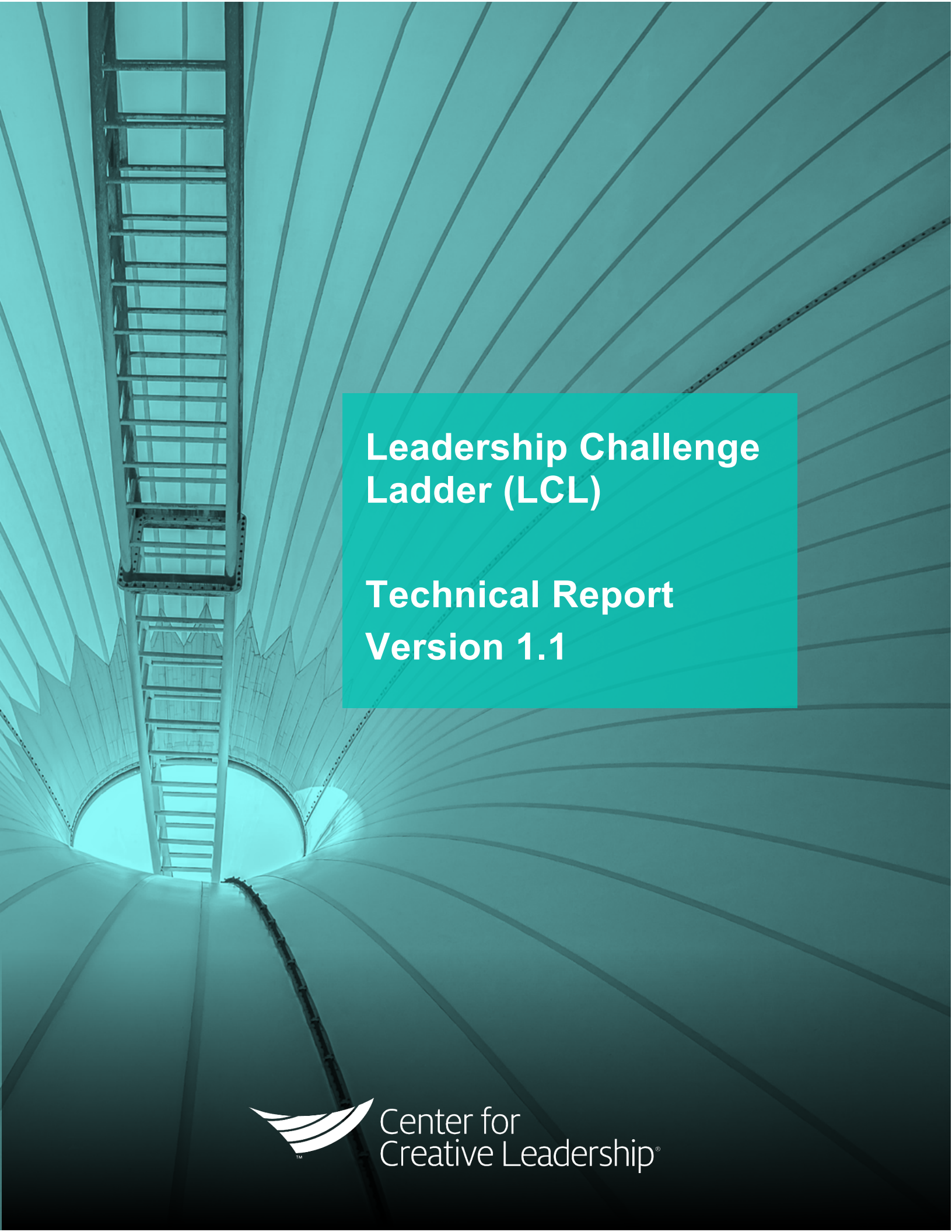

Leadership Challenge Ladder (LCL)

Technical Report
Version 1.1

Center for Creative Leadership®

Acknowledgment

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1. Purpose of This Report

This report outlines the research methodology underlying CCL's creation of the Leadership Challenge Ladder. The report presents a comprehensive account of the process used to develop five different leadership challenge topic models across various leader levels, ranging from the individual contributor level to the C-suite. An explanation for how the Leadership Challenge Ladder predicts a distribution of unscored challenge data against our various challenge topic models is presented. To further understand the nature of these topics and how they manifest, we analyzed topic challenge proportions with respect to Gender, Sector, Industry, Job Function, and Year of Challenge. We conclude with our approach to comparing an organization's aggregate challenge data against industry benchmarking norms. The report is written for the scientific autodidact, data scientists, or anyone who values the application of science in novel ways.

2. Overview of the Leadership Challenge Ladder

The Leadership Challenge Ladder is a framework of leadership challenges developed using recent advances in machine learning. To create the evidence-based framework, we conducted a research study using 11 years (2010-2021) of data collected from over 37,000 multi-level leaders working across more than 6,000 organizations. The leaders responded to the question, "What are the three most critical leadership challenges you are currently facing?" Using a machine learning algorithm called topic modeling, we built 5 different topic models based on 5 leader levels. Across all 5 levels, there were a total of 42 challenges that persist over time and across different industries and sectors. Subject matter experts in the leadership development domain then qualitatively categorized the 42 challenges into a thematic framework that shows leaders routinely face 3 overarching types of challenges across their careers: Personal Growth (personal shortcomings and aspirations for a better self), People and Task Demands (managing people and getting work done) and Working within a Larger System (managing dynamics across the organizational and environmental systems).

We developed the LCL framework to improve the ROI of leadership development at all leader levels and to give organizations a scalable approach to diagnosing challenges within their organizations. Scores from a 10-minute survey, that asks leaders to describe the challenges they are facing, is used to compare their challenges to LCL. With these data, organizations can focus their leadership development strategy by understanding and placing leaders' top challenges at the center of development. The LCL is a one-of-a-kind product in the leadership development industry.

3. LCL Background

Leadership development can be improved by seeking a data-driven answer to the following fundamental question: What leader pain points should we address through our leadership development strategies? Asking and answering this key question will increase the probability that executives, CHROs, and line managers focus their efforts on what matters most and align on the leadership development initiatives that will enable their organizations to thrive in a post-pandemic (COVID-19) world (Young, Leslie, Balakrishnan, Winn, 2021).

Estimates of annual corporate expenditures on leader development are as high as $50 billion with costs ranging between $4,000 and $10,000 per person (Prokopeak, 2018). Still, it seems to be just as difficult to develop leaders now than it ever has been. Three gaps explain the leadership development problem: (1) a gap in motivation between organizations and individual participants; (2) a gap between the skills programs build and what organizations actually want; and (3) a gap in transferring what is learned in the classroom to one's job (Moldoveanu & Narayandas, 2019). Theoretically, the more leader development is framed around the actual needs of participants of development initiatives, the better the outcomes for participants and organizations (Collins & Holton, 2004). Past research has stressed the need to understand participants' expectations with regard to training prior to their attendance (Bouloutian, 2009; Tannenbaum, Mathieu, Salas & Cannon-Bowers, 1991). When leaders receive training that does not address their specific leadership challenges, they are likely to view the experience as irrelevant and a waste of precious time. Consequently, determining the challenges leaders face is important for aiding in the design and delivery of training content (Tonidandel, Summerville, Gentry, Young, unpublished).

Prior to this study, Gentry et al. (2014) investigated the leadership challenges of 763 middle-to-senior-level leaders from seven different countries. Responses were analyzed using traditional qualitative thematic analysis (Boyatzis, 1998). First, the researchers used a sample of N = 100 to generate a codebook consisting of 34 leadership challenges. Then, they applied that rubric to classify the challenges faced by the remaining leaders in the sample. Although Gentry et al. (2014) found 34 possible challenges, it was derived from a small sample of leaders (N = 100). When they applied this rubric to the full sample of leaders, they only found 6 challenges that appeared with high frequency.

Although various methodologies exist for imposing structure on text data (e.g. grounded theory or content analysis), those methodologies do not scale well (Campion, Campion, Campion & Reider, 2016). Machine learning techniques have been shown to be particularly helpful in analyzing new sources of "big data" that previously have been underutilized for research, such as large textual archives (Antweiler & Frank, 2004). Though leadership challenge is not in the millions or billions, it is still impossible to manually code thousands of responses. Latent Dirichlet Allocation (LDA) is a machine learning algorithm that allows us to address this issue directly given its ability to examine a large amount of unstructured text and derive the underlying topics.

Furthermore, LDA quantifies the likelihood of a given set of challenges across leaders, allowing for direct examination of the relationship between self-reported challenges and leader characteristics such as gender, sector, industry, job function, and year of challenge. Such quantification also becomes important when organizations want to compare the challenge likelihood in their organization relative to industry norms.

4. Developing the LCS

4.1. Sample

To provide personalized products and services, CCL collects and processes individual leader background data. These data are used by course instructors and coaches to provide a highly personalized experience and for norming purposes. One background question regularly asked is, “What are your three most critical leadership challenges you are currently facing?" Leaders are provided three text boxes to capture their digital responses. These data are collected prior to the leader attending the program.

Data are securely stored in CCL databases and may be used, as in this case, for research purposes. Data collected from 5 different CCL leadership development programs were used to develop LCL.

- The first dataset includes leaders who attended “Leadership at the Peak (LAP)” program and custom leadership development programs for C-level & senior executives in the top three tiers of an organization.
- The second dataset includes leaders who attended “Leadership for Organizational Impact (LOI)” program and custom leadership development programs for executive and senior leaders in charge of functions, divisions, or business units in large organizations.
- The third dataset includes leaders who attended “Leadership Development Program (LDP)®” and other custom leadership development programs for mid-to-senior level leaders who lead other managers; operational, group or department managers; or leaders who work up, down and across the organization.
- The fourth dataset includes leaders who attended “Maximizing Your Leadership Potential (MLP)” program and other custom leadership development programs for new or experienced managers of people and projects; supervisors of individual contributors, and/or high potentials who are preparing to advance to the next level.
- The fifth dataset is a combination of leaders who attended CCL programs and a market research sample of individuals who self-reported having no supervisory responsibility (i.e., no direct reports). We collected a sample of individual contributors from a market research sample in order to have an adequate number of individuals to generate a model of leadership challenges at this level.

Data used in modeling were grouped based on an individual's admission to a specific program – not based on their self-reported organizational level. CCL programs are designed and marketed to leaders based primarily on their scope of responsibilities and secondarily based on organizational level. Hierarchical structures and terminology differ across organizations depending on organizational size, design, and culture. The Leadership at the Peak and equivalent custom programs, for example, enrolled leaders at the very top of organizations as well as self-identified middle-and-upper-middle level managers (see Table 1). Very large organizations can have individuals with the "Director" title and annual budgets that exceed that of CEOs in medium and small organizations. In another example, individuals with no supervisory responsibilities (individual contributors) self-reported as first-level and up to the executive level. Grouping data based on program attended (with programs differentiated by key steps in the management hierarchy) should yield samples at similar levels of responsibility in an organization and who face similar leadership challenges.

Table 1
Sample Across Leader Levels

Dataset	Leader Level by Responsibility	N	Self-Reported Organizational Level	
LAP Program and custom programs designed for top executives leading the enterprise	Leading the Organization	3,102	Top	21%
			Executive	54%
			Middle & Upper	20%
			First Level	1%
			Hourly	0%
			Not Relevant/Other	4%
LOI Program and custom designed programs for senior leaders of organization functions or divisions	Leading the Function	3,588	Top	4%
			Executive	48%
			Middle & Upper	42%
			First Level	4%
			Hourly	0%
			Not Relevant/Other	2%

Dataset	Leader Level by Responsibility	N	Self-Reported Organizational Level	
LDP Program and custom designed programs for Experienced leaders who lead other managers or senior professional staff	Leading Managers	13,458	Top	3%
			Executive	24%
			Middle & Upper	58%
			First Level	10%
			Hourly	1%
			Not Relevant/Other	4%
MLP Program and custom designed programs for new or experienced leaders of people and projects; supervisors of individual contributors, and/or high potentials	Leading Others	6,411	Top	1%
			Executive	5%
			Middle & Upper	63%
			First Level	26%
			Hourly	2%
			Not Relevant/Other	3%
Participants from CCL programs (51%) and a market research sample (49%)	Individual Contributors	3,163	Top	0%
			Executive	2%
			Middle & Upper	26%
			First Level	26%
			Hourly	39%
			Not Relevant/Other	6%

Sixty-four percent of the overall sample were men, thirty-five percent were women, and the remaining one percent did not specify their gender. The detailed sample distribution for the five subsets of data based on Leader Level, Gender, and Sector is provided in the Table 2.

Table 2
Sample Across Leader Level, Gender and Sector

Leader Level	Overall Count	Population by Gender		Population by Sector	
Leading the Organization	3,102	Male	74%	Business Sector	53%
		Female	26%	Public Sector	37%
		Not Specified	0%	Private Non-Profit Sector	10%
Leading the Function	3,588	Male	69%	Business Sector	64%
		Female	31%	Public Sector	24%
		Not Specified	0%	Private Non-Profit Sector	12%
Leading Managers	13,458	Male	63%	Business Sector	62%
		Female	37%	Public Sector	24%
		Not Specified	0%	Private Non-Profit Sector	14%
Leading Others	6,411	Male	60%	Business Sector	72%
		Female	40%	Public Sector	14%
		Not Specified	0%	Private Non-Profit Sector	14%
Individual Contributors	3,163	Male	49%	Business Sector	60%
		Female	50%	Public Sector	23%
		Not Specified	1%	Private Non-Profit Sector	17%

Twenty-four different industries were represented. The percentage of leaders from each industry is specified in Table 3.

Table 3
Leaders Across Each Industry

Industry	Population %
Aerospace and Defense	5%
Automotive and Transport Equipment	3%
Banking	1%
Chemicals	2%
Computer Hardware and Software Services	2%
Consumer Products	3%
Education	5%
Energy	4%
Financial Services	4%
Food, Beverage & Tobacco	3%
Government	14%
Health Products & Services	5%
Insurance	3%
Manufacturing	8%
Materials & Construction	1%
Media	2%
Non-Profit	7%
Other	16%
Pharmaceuticals	3%
Real Estate	1%
Retail	3%
Telecommunications	2%
Transportation	2%
Utilities	2%

4.2. Introduction to Topic Models

We used a machine learning algorithm to automate the classification of leader challenge data, namely topic modeling. Topic modeling is capable of scanning a set of documents, detecting word and phrase patterns within them, and automatically clustering word groups and similar expressions that best characterize a set of text responses (or documents) to a given question.

To date, LDA is the most popular topic modeling algorithms. The LDA model is able to address other models' limitations, such as latent semantic indexing (LSI) (Deerwester, Dumais, Furnas, Landauer, & Harshman, 1990) and probabilistic latent semantic indexing (PLSI; Hofmann, 2001). LDA (Blei, Ng, & Jordan, 2003) is an unsupervised probabilistic model that generates mixtures of latent topics from a collection of documents, where each mixture of topics produces words from the collection's vocabulary with certain probabilities. We used LDA to derive the underlying topics from the leadership challenge text data. Each leader's challenge text data is considered a single document that is made up of various topics. Each topic has various words belonging to it. In other words, a document response from Leader A, for example, will contain several different challenge topics. If a word *w* has high probability of being in a topic *t*, all the documents having word *w* will be more strongly associated with topic *t* as well. Similarly, if *w* does not have a high probability of being in *t* , the documents which contain the *w* will have a very low probability of being in *t*.

4.3. Processes Involved in LDA Topic Modeling

1) Text Preprocessing

Topic models do not have any actual semantic knowledge of the words. Instead, topic models use math. The words that tend to co-occur are statistically likely to be related to one another. Since every topic model is susceptible to noise, the raw text data must be preprocessed to increase the accuracy of the topics. To this end, punctuation marks, extra spaces, numerical and special cases were removed from the raw text. We also removed stop words such as *the*, *a*, *in*, *you*, *their*, *an*, etc., from the raw text data. Stop words are common words in a language that do not add much meaning to a sentence. Because stop words appear frequently in text, yet convey little meaning, their removal improves the performance of language classification algorithms like LDA. In addition to the conventional stop word list, three custom stop words were added to the stop word library: leadership, challenge, and challenges. These words were part of the prompt, many participants began their responses with something like "One leadership challenge I have is…". As a result, we removed this source of noise from the documents. We used the stemming technique to get rid of plurals. This technique helps in avoiding semantic duplicates of the same word which also increases the accuracy of the topics (May et al., 2019). Finally, we only used the following word types: noun, adjective, adverb, and verb.

Topic models use “bag of words” approach, which means each word is considered as a separate entity during model training. Therefore, bigram modeling was also implemented to avoid noise. Bigrams are two words frequently occurring together in the document. The decision to use bigrams reflects the need to strike a balance between sufficiently capturing meaning without unnecessarily increasing model complexity (Nokel & Loukachevitch, 2015). If bigram modeling is not implemented, words like “direct report” will be considered as two different words “direct” and “report”, changing the context of the actual text. To increase accuracy, we used bigram models by setting a minimum frequency co-occurrence threshold to be greater than 5. If two words occurred next to each other more than 5 times in the entire text corpus, then it was considered a single word (e.g., direct_report) In addition to the bigram words, the single word instances (e.g., direct, report) were also retained with their respective meanings if they occurred individually.

2) Exploratory Data Analysis

Exploratory data analysis (EDA) is the first step in analyzing any form of data. In the context of leadership challenge data, it was very important to analyze if there are any challenges specific to an industry, sector, leader level, job function or gender (e.g., Medicare-related challenges in healthcare domain). This knowledge informs the number of models that may be needed to classify topics accurately. Thus, we conducted EDA with different subsets of data and analyzed word-clouds and the top 100 most frequent terms. Word clouds are graphical representations of word frequency that give greater prominence to words that appear more frequently in a source text. The bigger and bolder the word appears, the more often it is mentioned within a given text and the more important it is.

- First, we compared challenge data word-clouds of men leaders to women leaders to check if there are specific keywords unique to either of the gender. Although there was a slight frequency change for the keywords among men versus women, the majority of keywords remained constant across both the genders (Figure 1).

Figure 1

Word-clouds for Male and Female Challenges

The same process was iterated with leaders across different sectors and job functions. There were no major differences in the type of challenges when comparing different sectors and job functions.

Next, we analyzed word-clouds for different industries. For example, we found domain related keywords like “physician”, “hospital” etc., in the healthcare word-clouds. We then manually examined the healthcare domain data only to verify if leaders were talking about healthcare related challenges (vs. leadership challenges). We confirmed that the healthcare leaders were referring to generic leadership challenges and it was not specific to healthcare. One such example text from a healthcare leader was, “Our Company is going through a merger, bringing two hospital organizations together is a challenge.” The above example is related to “Guiding Change,” a generic leadership challenge that is common in other industries as well. Because leaders are asked about their leadership challenges (vs. healthcare-specific challenges), it made sense that the resulting challenges were shared across industries.

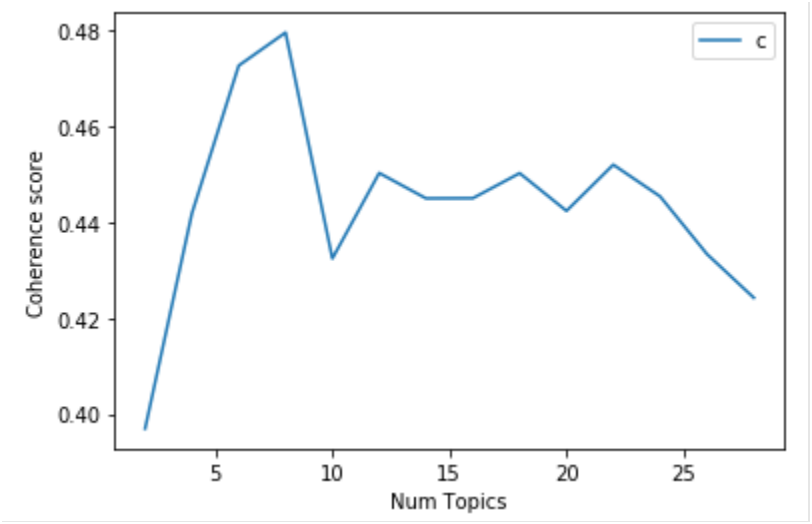
Our final step in EDA was to compare the word-clouds of individuals who attended different development programs based on leader level (Leading the Organization, Leading the Function, Leading Managers, Leading Others, and Individual Contributors). There was a drastic change observed when comparing word-clouds of different leader levels. For example, keywords like “strategy”, “mission”, “vision”, “board” were unique to the “Executives” subset when compared to other leader levels. We observed the nature of challenge to be significantly different for each leader level. This finding also aligns with past leadership research which has found that leadership skill requirements also vary by level (Mumford, Campion, & Morgeson, 2007). Hence topic models were implemented for each leader level separately to capture the challenge topics most accurately at each level. However, previous analyses suggested separate topic models were not needed by gender, industry, and sector.

3) Implementing LDA

- LDA is a powerful probabilistic model that identifies abstract topics within documents. Five different topic models were performed based on the results of EDA for each of the five leader levels. We used the python genism library to implement the LDA topic model across the five levels. The LDA algorithm does not compute the number of topics automatically. The number of topics must be determined and specified as an input prior to executing the algorithm. To determine a suitable number of topics, we compared the goodness-of-fit for LDA models by varying the number of topics. We evaluated the goodness-of-fit of each LDA model by calculating the perplexity and coherence score. Coherence score refers to the degree of semantic similarity between high scoring words in the topic. It ranges from 0-1. Perplexity is a statistical measure of how well a probability (pre-trained) model predicts unseen data. A lower perplexity and high coherence score suggest a better fit. A detailed process of LDA topic model implementation for the Leading the Organization data is described below. This same process was used to create topic models for every other leader level.

The first step was to determine the baseline k value range (number of topics) for our text corpus. Baseline k value is established by iterating the LDA model by incrementing k value by one for every iteration until it reaches a steady state of constant decrease of coherence score. The other parameters of the LDA model have been maintained at default values during this process. The coherence score is calculated for each iteration and from figure 2, it is clear that there is steep drop after k=9. Thus, optimum k value range should be between 4 and 9. The maximum coherence score obtained for our baseline LDA model was around 0.49.

Figure 2
Coherence Vs Number of Topics

- 

For the next step, we used hyper parameter tuning to evaluate the topic models, ranging from 4 to 9, based on coherence score to increase the model's efficiency., We performed a series of sensitivity tests to determine the optimal model via hyper parameters such as Number of Topics (K), Dirichlet hyperparameter for Document-Topic Density (alpha) and Dirichlet hyperparameter for Word-Topic Density (beta). The consolidated hyperparameter values used for the Leading the Organization model is given in Table 4.

Table 4
Hyperparameter Range for Leading the Organization Model

K- value (From the baseline LDA model)	{4,5,6,7,8,9}
Alpha	{0,0.3,0.6,0.9}
Beta	{0,0.3,0.6,0.9}

We chose the values which gave us the maximum coherence score and low perplexity for the final LDA model (K=6, alpha & beta =0.61). Although, perplexity is the most typical evaluation metric of LDA models (Bao & Datta, 2014), it is not strongly correlated to human judgement (Chang, Boyd-Graber, Gerrish, Wang & Blei, 2009). Therefore, a strong preference was given to a higher coherence score than a low perplexity score when choosing the final model. The final Leading the Organization model approximately yielded 7% improvement over the baseline score.

Table 5
Hyperparameter Tuning Results for Leading the Organization Model

Inputs to LDA model			**Performance Output**	
K	Alpha	Beta	Coherence	Perplexity
6	0.61	0.61	0.521	-7.22
7	0.31	0.91	0.507	-7.2
6	0.61	0.91	0.505	-7.17
7	0.91	0.61	0.505	-7.18
6	0.91	0.91	0.504	-7.18

We also compared Mallet-LDA model metrics with LDA to choose the best model. Mallet (**MA**chine **L**earning for **L**anguag**E** **T**oolkit) is a Java-based package developed by UMASS Amherst. The difference between Mallet and Gensim's standard LDA is that Gensim uses a variational Bayes sampling method which is faster but less precise than Mallet's Gibbs Sampling. Mallet LDA model gave us a lower coherence score of 0.51 compared to the standard LDA. Hence, we chose the standard LDA to be our final model because it characterized the data better.

We also created a visual (Figure 3) for the final Leading the Organization model for topic interpretability, assisting domain experts in the naming of each topic. The areas of the circles represent the prevalence of each topic over the entire corpus. The distances between the centers of circles indicate the similarity between topics. For each topic, the histogram on the right side listed the top 30 most relevant terms. The blue bars represent the overall term frequency. The red bar represents the estimated term frequency within the selected topic. In addition to the evaluation parameters like coherence score and perplexity, the LDA topic exclusivity also played a vital role in choosing our final model. Topic exclusivity measures the extent to which the top words of a particular topic do not appear as top words in other topics. In other words, it determines the extent to which its top words are 'exclusive'. We chose our model in such a way that it has good coherence score and mutually exclusive topics with few overlapping words with other topics. The same process was repeated for the other four datasets and the consolidated results are provided below in Table 5.

Figure 3

LDA Topic Visualization for Leading the Organization Model

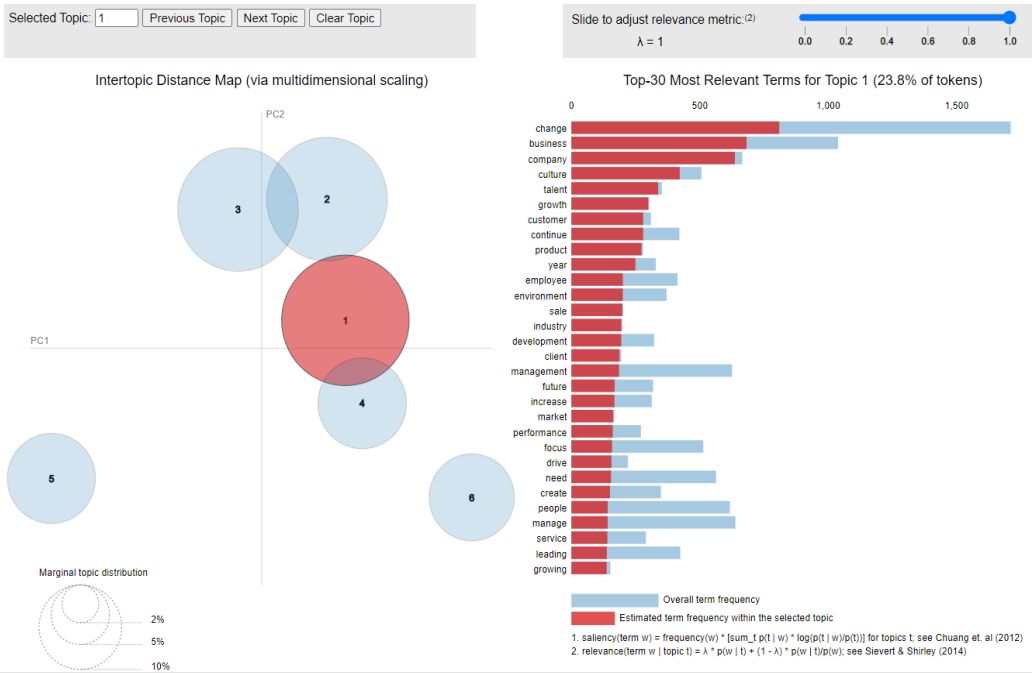


Table 6
Topic Models with Number of Topics by Leader Level

Leadership Level	No. of Topics
Leading the Organization	6
Leading the Function	10
Leading Managers	10
Leading Others	11
Individual Contributors	5

4) Naming of the Topics by CCL Expert Research Team

- We identified 42 distinct challenges across all leader levels through LDA topic models. However, LDA modeling does not provide topic names; thus, human expertise is required to interpret each topic. Four Ph.D.-level researchers with extensive leadership development domain expertise named the topics. First, conventions in naming topics (Schmiedel, Müller, & vom Brocke, 2019), a pair of researchers were asked to independently label the topics for a single dataset based on the top ten highest probable keywords, LDA topic visualization graph, and top 10 highest rated challenge responses belonging to each topic. Two subject matter experts then exchanged labels and discussed discrepancies until both subject matter experts were able to agree on a consensus label for each of the topics in the dataset. After completing labels for all 6 leader levels, the SMEs categorized the 42 challenge labels into a new thematic framework that suggests leaders routinely face 3 overarching types of challenges across their careers: personal growth, people and task demands, and working within a larger system. Finally, the SMEs developed rich and detailed descriptions (Table 11 in Appendix) for each of the topics identified using quote exemplars and keywords. The leadership challenge thematic framework is provided in Table 7. Following client feedback, the labels were edited by two SMEs for better precision.

Table 7

Leadership Challenges Matrix by Theme

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributors
Personal Growth The challenge of personal shortcomings and aspirations for a better self	Interpersonal Rigidity	Limited Self-Awareness Credibility Gaps	Personal Limitations Ineffective Interpersonal Style	Personal Improvement Frustrations with People and Time	Frustrations with Others
People and Task Demands The challenge of managing people and getting work accomplished	Strategic Responsibilities Lack of Cooperation Organizational Talent Issues	Transition into a New Role Talent Pipeline Issues	New or Ambiguous Responsibilities Accountability for Others' Work Competing People and Project Priorities Development Gaps: Yours & Others Staffing Issues	First Time Managing People New to Positional Authority Peers as Team Members Limited Influence Team Performance Employee Engagement Competing Priorities	Limited Influence Workforce Constraints

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributors
Working within a Larger System The challenge of managing across the organization and within a dynamic external environment	Dynamic Business Environment Organizational Readiness Amid Uncertainly	Process Improvement across Groups Tense and Complex Situations Problems with Upper Management Limited Market/Sales Growth Changing Internal/External Environment Resource Constraints and Financial Instability	Cross-Functional Influence Adverse Work Environment Challenging Business Context	Deficient Operational Processes Change and Instability	Support for Change Strategic Alignment

5) Understanding Topic Proportions Across All Leader Levels

A key output of LDA topic modeling is the "Document to Topic" matrix which displays the probability distribution of the topics across all leaders in the CCL database. In other words, the Document-Topic matrix shows how popular each topic is across the entire corpus. The summary of the average topic proportion for all the 5 leader levels is provided in the Table 8.

Table 8

Challenge Labels with Average Proportion by Leader Level

Leader Level	Challenge	Average Challenge proportion
Leading the Organization	Dynamic Business Environment	22.30%
	Strategic Responsibilities	21.90%
	Interpersonal Rigidity	19.60%
	Organizational Readiness Amid Uncertainty	12.90%
	Staffing Issues	12.10%
	Lack of Cooperation	11.40%
Leading the Function	Limited Self-Awareness	12.40%
	Credibility Gaps	10.80%
	Process Improvement across Groups	10.60%
	Tense and Complex Situations	10.10%
	Transition into a new role	9.90%
	Changing Internal/External Environment	9.80%
	Limited Market/Sales Growth	9.70%
	Problems with Upper Management	9.40%
	Talent Pipeline Issues	9.30%
	Resource Constraints and Financial Instability	8.10%
Leading Managers	Personal Limitations	10.70%
	Ineffective Interpersonal Style	10.60%
	Challenging Business Context	10.30%

Leader Level	Challenge	Average Challenge proportion
	Development Gaps: Yours & Others	10.20%
	New or Ambiguous Responsibilities	10.10%
	Competing People and Project Priorities	9.90%
	Adverse Work Environment	9.80%
	Accountability for Other's Work	9.70%
	Cross-Functional Influence	9.50%
	Staffing Issues	9.50%
Leading Others	First Time Managing People	10.60%
	Frustrations with People and Time	9.70%
	Team Performance	9.70%
	Process Management	9.40%
	Personal Improvement	9.30%
	Peers as Team Members	8.90%
	New to Positional Authority	8.70%
	Limited Influence	8.70%
	Employee Engagement	8.60%
	Competing Priorities	8.60%
	Change and Instability	8.10%
Individual Contributors	Frustrations with Others	23.14%
	Workforce Constraints	22.56%
	Limited Influence	20.45%
	Support for Change	17.57%
	Strategic Alignment	16.29%

6) Challenges Across Demographic Factors

Leader demographic information can also be used to understand the likelihood of leadership challenges present among different leader segments. Challenges by leader level were explored for: (1) men and women, (2) public, private, business, and nonprofit sectors, (3) industry, (4) job function, and (5) year.

i. Gender

Past research has demonstrated that gender affects leadership processes and outcomes (e.g., Doldor, Wyatt, & Silvester, 2019; Gentry, Clark, Young, Cullen, & Zimmerman, 2015). Thus, it is critical to examine how gender affects self-reported leadership challenges.

- At the Leading the Organizational level, women (22%) were more likely to report challenges with respect to "Interpersonal Rigidity" than men (18%). Men (23%) were more likely to report "Dynamic Business Environment" than women (19%).
- At the Leading Managers level, women (13%) were more likely to report "Personal Limitations" challenge than men (10%). Men (11%) were more likely to report "Challenging Business Context" than women (8%).
- At the Leading the Function level, Men (14%) were more likely to report "Limited Self-Awareness" challenge than women (11%).
- At the Individual Contributors level, women (24%) were more likely to report "Frustration with Others" challenge than men (21%). Men (19%) were more likely to report "Support for Change" challenge than women (16%).

ii. Sector

Leadership in any sector involves leading people who, regardless of sector, concomitantly share both universal human traits and unique individual differences. CCL's past work in public vs. private sectors reveals that more nuanced differences do exist. The environment of government, especially the constitutional structure and financially constrained context of the US federal government, does appear to impact some of the challenges faced by those leaders (Ferguson, Ronayne, & Rybacki, 2016). The challenge proportion in the Leading the Organization level were very similar for Business and Private Non-Profit sector leaders, but the challenge proportion was different with respect to public sector leaders.

- At the Leading the Organization level, leaders in Public sector (23%) were more likely to report "Organizational Readiness Amid Uncertainty" when compared to Business (6%) and Non-Profit sector (7%). Likewise, Business (30%) and Non-Profit sector (25%) leaders were more likely to report "Dynamic Business Environment" challenge when compared to Public sector leaders (11%).

- At the Leading the Function level, Public sector leaders (14%) were more likely to report challenges related to “Resource Constraints and Financial Instability” than Non-Profit (9%) and Business (6%) leaders. Business sector leaders (11%) were more likely to report challenges related to “Limited Market/Sales Growth” when compared to Public (7%) and Non-Profit sector leaders (8%). Likewise, Business sector leaders (12%) were more likely to report challenges related to “Credibility Gaps” in comparison to Non-Profit (8%) sector leaders.
- At the Leading Managers level, Business sector leaders (11%) were more likely to report challenges related to “Challenging Business Context” when compared to Public (9%) and Non-Profit leaders (8%).Middle managers from Public (12%) and Non-Profit (12%) sectors were more likely to report “Staffing Issues” when compared to Business sector (7%).
- At the Individual Contributors level, Business Sector leaders (18%) were more likely to report challenges related to “Support for Change” than Public sector leaders and Non-Profit sector leaders (16%). Business sector leaders (19%) were more likely to report challenges related to “Strategic Alignment” when compared to Public (17%) and Non-Profit leaders (15%).

iii. Industry

Leadership development has long been interested in how competencies vary across industries in terms of importance and effectiveness (Leslie & Palmisano, 2014; Young, Gentry, & Bendixen, 2017). Thus, we decided to explore this question in the context of self-reported leadership challenges.

- At the Leading the Organization level, we identified that the challenges related to “Dynamic Business Environment” were more likely reported in Manufacturing (36%), Health Products and Services (30%) and Finance (30%) industries when compared to all other industries (22%). Health Products and Services (29%) leaders were more likely to report challenges related to “Strategic Responsibilities” compared to all other industries (21%). Aerospace & Defense (24%) and Government (25%) industries were more likely to report challenges related to “Organizational Readiness amid Uncertainty” compared to other industries (8%).
- At the Leading the Function level, we observed that Government (13%), Education (13%) and Aerospace & Defense (12%) industries were more likely to report challenges related to “Resource Constraints and Financial Instability” than other industries (8%). Likewise, Automotive & Transport equipment (13%) and Food, Beverage & Tobacco (13%) industries were more likely to report challenges related to “Limited Market/Sales Growth” than other industries (10%).
- At the Leading Managers level, “Education” industry leaders were more likely to report challenges related to “Staffing Issues” (15%) than other industries (9%).
- At the Leading Others level, “Insurance” industry leaders (12%) were more likely to report challenges related to “Engaging & Motivating Employees” than others (8%).

- At the Individual Contributors level, “Energy” and “Non-Profit” (31%) industry leaders were more likely to report challenges related to “Limited Influence” than others (21%). “Health Products and Services” industry leaders (29%) were more likely to report challenges related to “Workforce Constraints” than others (19%). “Telecommunications” industry leaders (22%) were more likely to report challenges related to “Support for Change” than others (17%).

iv. Job Function

Although most organizations tend to apply the same leadership competencies across all job functions (Campion et al., 2011), some consulting firms (e.g., CEB) do offer specialty competency models for certain high-impact functions like Sales. Thus, we decided to explore how challenges vary by job function. These differences do not necessarily mean that organizations must start developing new competency or challenge models for each function.

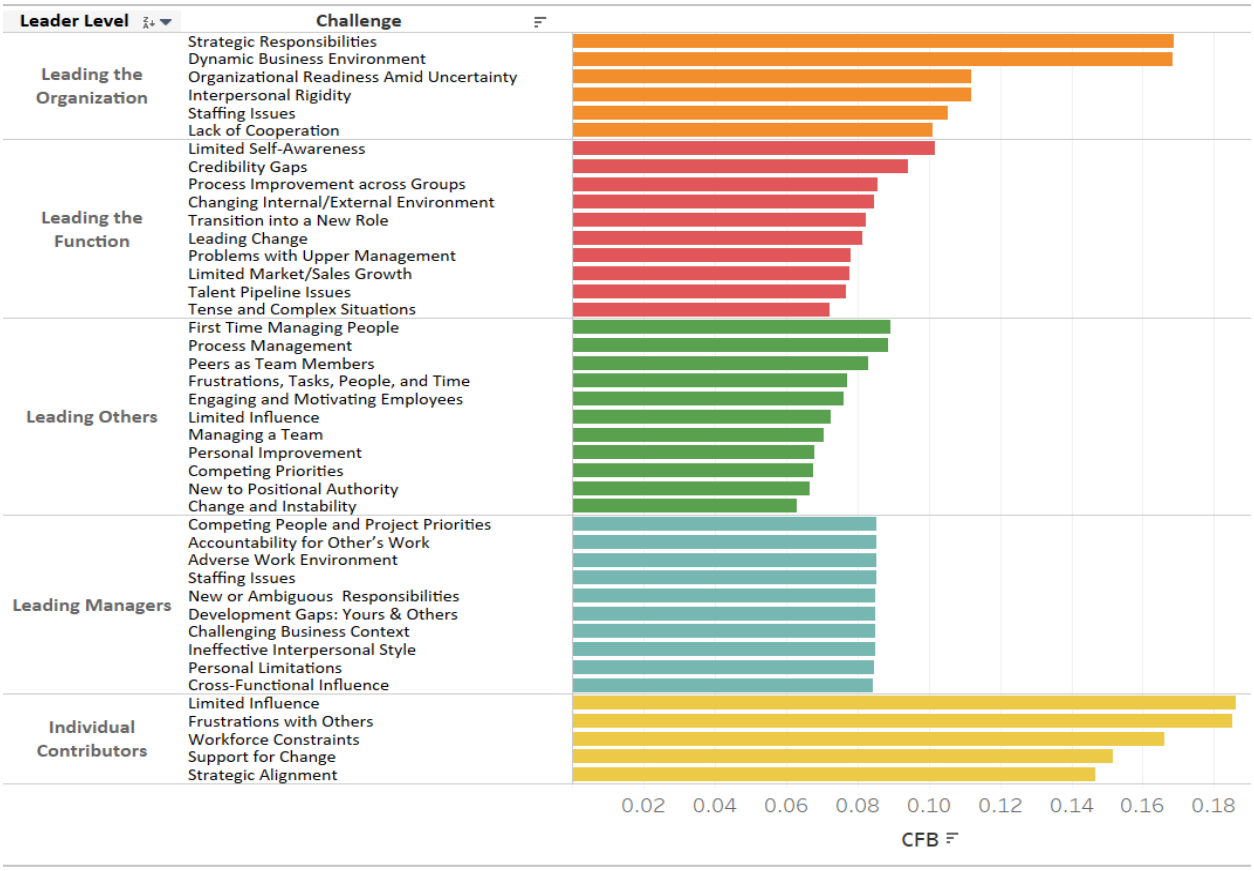
- At the Leading the Organization level, “Marketing and Sales” leaders (30%) were more likely to report challenges related to “Dynamic Business Environment” when compared to all other job functions (22%).
- At the Leading the Function level, “Limited Market/Sales Growth” related challenges were reported more often in “Marketing and sales” department (15%) than other all other job functions (10%). Similarly, “Human Resources” (13%) and “Health care” (12%) leaders were more likely to report challenges related to “Credibility Gaps” than other job functions (10%).
- At the Leading Managers level, “General executives” (13%) were more likely to report challenges related to “Challenging Business Context” than other job functions (10%). Likewise, Middle-level managers from “Production/Processing” job function (13%) were more likely to report challenges related to “Adverse Work Environment” than other job functions (10%).
- At the Leading Others level, managers from “Production/Processing” (12%) and “Facilities operations and services” (11%) department were more likely to report challenges related to “Engaging & Motivating Employees” than other job functions (8%). Managers from “Engineering Architecture and Design” function (12%) were more likely to report challenges related to “Process Management” than other job functions (9%).
- At the Individual Contributors level, “Project Management” (31%) leaders were more likely to report challenges related to “Limited Influence” than others (21%). “Healthcare” leaders (31%) were more likely to report challenges related to “Workforce Constraints” than others (20%). “Production/Processing” leaders (31%) were more likely to report challenges related to “Frustration with Others” than others (23%).

v. *Timeline*

Coffey, Feingold and Bromberg (CFB) (1988) developed a measure of variability for a weighted set of proportions. The measure of variability for a set of proportions is the square root of the ratio of the actual weighted variance over the maximal weighted variance. The measure ranges from 0 to 1, with higher values indicating higher variability. We used this measure to analyze the variability of challenge topics over the last decade (2010-2020). Overall, these challenges were consistent over time. Challenges from the Leading the Organization and Individual Contributors level had higher CFB than others. Figure 6 represents the CFB measure for challenges from 2010-2020.

Figure 6

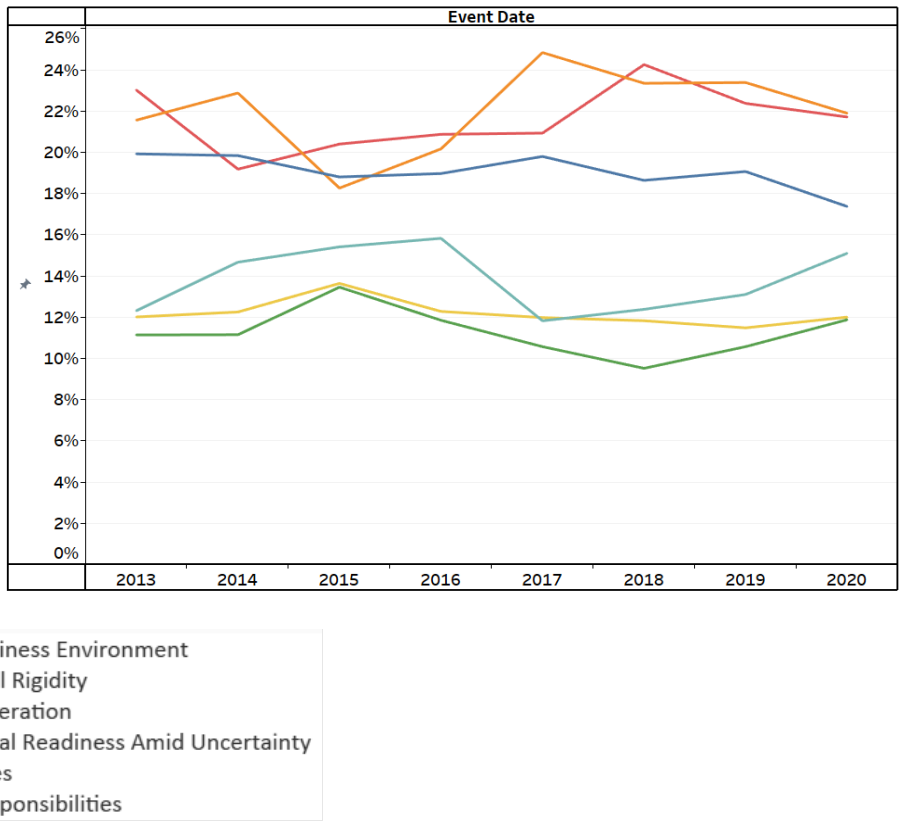
CFB for Challenges by Leader Level from 2010-2020



To better understand why CFB scores of Leading the Organization level and Individual Contributors level had were more varied, we examined challenges by year. At the Leading the Organization level, there was a slight fluctuation observed with respect to "Dynamic Business Environment" and "Strategic Responsibilities" challenge from 2014 – 2018. Although it is difficult to explain why this may have occurred, both challenges remain consistently high for leads leading their organizations.

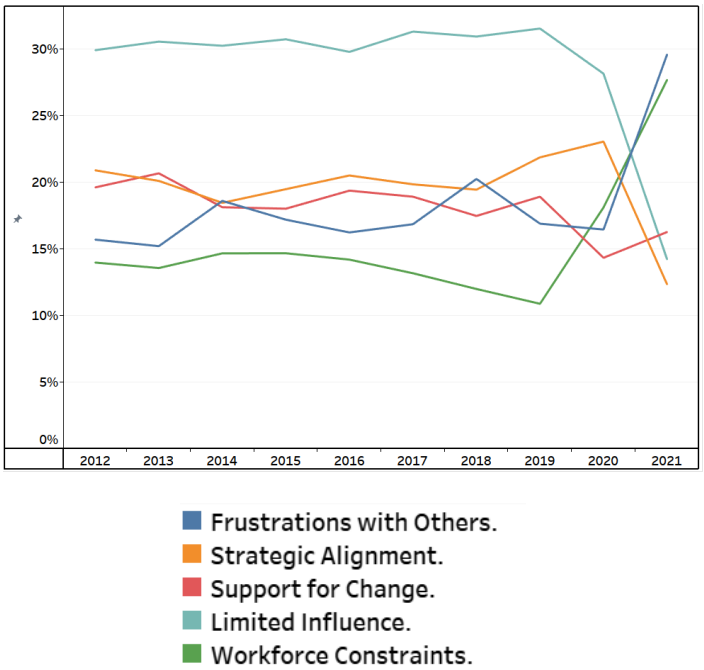
Figure 7

Average Challenge Proportion for Leading the Organization Model Over Time



At the Individual Contributor level, “Limited Influence”, “Frustration with Others”, and “Workforce Constraints” had relatively higher CFB scores than other Individual Contributor challenges. Prior to 2019, these challenges were fairly consistent. However, since 2019, “Limited Influence” has been reported at lower levels whereas “Frustration with Others” and “Workforce Constraints” have increased. Individual Contributors may be reporting more “Workforce Constraints” and “Frustration with Others” due to COVID-19. However, the 2021 sample included a large percentage of individuals who were not preparing to attend a formal leadership development program. Often, individual contributors who are about to attend a leadership development program are doing so in preparation for a higher level management role. Thus, it is possible that Limited Influence declined because individuals in the market research sample may not see themselves as “becoming formal leaders.”

Figure 8
Average Challenge Proportion for IC Model Over Time



It is important to note that these are average trends observed across all organizations with medium and large effect size in our database and may not represent the context in which any single organization operates or experiences.

5. Working with the LCL

1) Prediction of Challenge Distribution for New Data

Developing a topic model based on a set of open-ended text documents requires approximate inference techniques that are computationally expensive. With today's large-scale collection of data, data scientists can infer topic distributions for new text-based responses without training or developing a new model. In other words, the LCL product can predict the challenge distribution of a new set of data by scoring new challenge responses from leaders against the topic scoring weights developed for each respective leader level topic model.

Based on the "Efficient Methods for Topic Model Inference on Streaming Document Collections" study (Yao, Mimno, & McCallum, 2009), there are several methods to infer the topic distribution in a new sample of data including methods based on Gibbs sampling, variational inference, and a new method inspired by text classification. We use the genism python library package for a LDA model estimation from a training corpus for inference of topic distribution on new, unscored documents (Rehurek & Sojka, 2010). By applying this, we are able to predict the topic distribution for new challenge data we collect over time.

2) Working with the LCL – Making Normative Comparisons

Using norms to compare leaders is common. Having a tool to determine whether or not to take action is less commonplace. To create a simple guideline for what is both statistically and practically significant, we conducted an ad-hoc study by comparing a sub-set of individual organization scores against overall industry benchmark norms across all leader levels. To do this, we first created five new datasets based on the five leader levels. Each leader at every level could select one of 32 different industries. A single aggregate company score was chosen to represent each of these potential industries at each leader level. As a rule of thumb, we selected the company that had the largest number of leaders in a given industry. If there were less than 20 leaders from a company, the industry for that leader level was ignored. For example, we did not have an organization in Conglomerates industry from the Leading the Organization level with more than 20 leaders. Our Individual Contributors sample did not include any organizations with at least 20 or more leaders. This led to a final sample of 6,314 leaders representing 75 organizations across all leader levels.

Table 9
Subset Sample Distribution for Determining Statistical and Practical Significance

Leader Level	Average number of leaders per company	% of industries represented
Leading the Organization	77	28%
Leading the Function	81	28%
Leading Managers	92	68%
Leading Others	66	56%
Individual Contributors	0*	0%

*Though the Individual Contributors challenge model included more than 3,000 leaders, few came from the same organization.

Given available data, we were able to make 75 comparisons. We used the Mann Whitney test to conduct the comparisons; it is a non-parametric test that is used to compare two independent groups that do not have large normally distributed samples (Nachar, 2008). We sorted the comparisons for which the p value from the Mann Whitney test was significant. From this subset of data, we calculated the average percentage difference between the organization's challenge and its industry benchmark as shown in Table 10. Based on these findings, we recommend that organizations focus attention on those differences that are at least 2% or greater per standard effect size guidelines (Cohen, 1988; 1992).

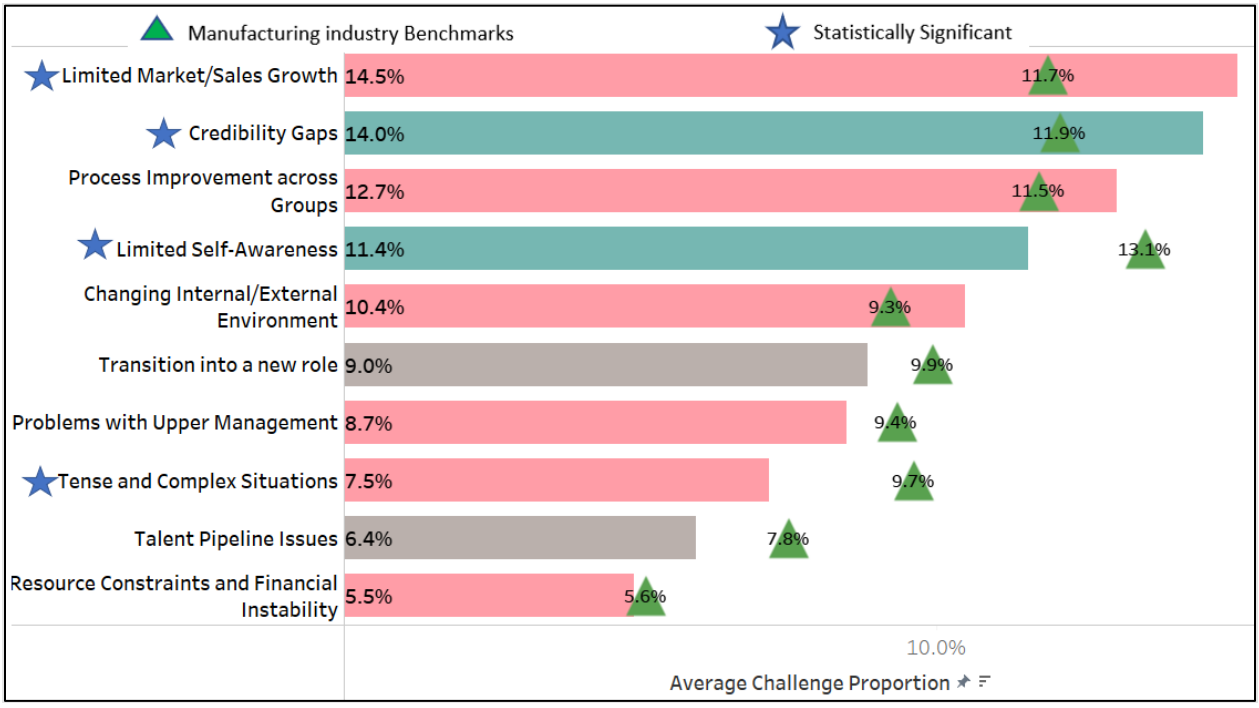
Table 10
Challenge Difference for Small, Medium and Large Effect Size

Effect Size	r	Average difference
Small	0.1	2%
Medium	0.3	3%
Large	0.5	5%

In this example (Figure 9), Acme's (manufacturing organization) challenge probabilities for 20 leaders at the Leading the Function level are represented in terms of percentages. The most likely challenge was "Limited Market/Sales Growth" (14.5%). The triangle (11.7%) represents the average challenge proportion across leaders from the Manufacturing industry (n=369). To test

whether the difference between the two groups (Acme vs. Manufacturing industry benchmark) is statistically significant, a Mann-Whitney U test should be conducted. To determine practical significance, the *r* effect size measure is also calculated. Stars appear next to each challenge where the difference is both statistically and practically significant. Practically significant is when the *r* effect size is at least .1 or higher according to Cohen's standards (Cohen, 1988; 1992). In this example, leaders in Acme corporation are significantly more likely to report "Limited Market/Sales Growth" as an example than the industry benchmark for manufacturing organizations. Leaders in Acme corporation are significantly less likely to report "Tense and Complex Situations" as an example than the industry benchmark for manufacturing organizations.

Figure 9
Challenge Probabilities for Acme Organization



6. Appendix

Table 11
Challenge Labels with Descriptions

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
Personal Growth The challenges of personal shortcomings and aspirations for a better self	**Interpersonal Rigidity** The challenge of changing the way you interact with others to be more interpersonally effective. This includes changing how you communicate, manage, or influence. It also includes adapting your style for different people and finding the right balance in your leadership approach.	**Limited Self-Awareness** The challenge of becoming more self-aware and understanding how others perceive you. This includes others' perceptions of your confidence, approachability, and the style in which you deliver difficult messages. **Credibility Gaps** The challenge of building credibility as an organizational leader. This includes gaining the trust of senior managers and other stakeholders, as well as enhancing your visibility in the organization.	**Personal Limitations** The challenge of overcoming a leadership inadequacy related to who you are as a person. These internal struggles are experienced as needing to work in ways that "go against your grain," to overcome your own doubts or those of others about your ability or readiness to lead, to better manage personal conflicts or dilemmas, or to have the courage to do the right thing. **Ineffective Interpersonal Style** The challenge of modifying your interpersonal style to be	**Personal Improvement** The challenge of learning to be more like your "ideal self." This includes developing confidence, being a better listener, improving flexibility, dealing more effectively with conflict, and being less reactive. **Frustrations with People and Time** The challenge of feeling frustrated with others and overwhelmed with inefficiencies. This includes providing considerable guidance to direct reports, overcoming resistant attitudes, and adjusting communication and feedback styles to work	**Frustrations with Others** Challenges related to working with others in respectful and productive ways. This includes being frustrated when others are not behaving in expected ways (e.g., not treating others fairly, emphasizing high-quality work, volunteering to help when workloads are uneven, or following the rules) and when one's own behaviors make working with others more difficult (e.g., not listening or being abrasive).

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
			more effective in leadership relationships. This includes being less dominant in interactions, being less directive and actively seeking input from others, being more open and approachable, managing your emotions, and being more assertive and self-confident.	with different people more effectively.	
People and Task Demands The challenge of managing people and getting work done	**Strategic Responsibilities** The challenge of developing strategy for an organization. This includes aligning priorities and initiatives across groups, as well as developing a team to support strategic efforts. **Lack of Cooperation** The challenge of influencing others to gain their cooperation. This challenge is experienced when new to a role, when managing former peers or more	**Transition into a New Role** The challenge of transitioning to a new role due to a promotion, a new position in a reorganization, a functional shift, or a geographic move. Challenges stem from changes in responsibilities, managing new people or former peers, or geographical separation from colleagues. **Talent Pipeline Issues**	**New or Ambiguous Responsibilities** Challenges related to the difficulties of your specific managerial role. These can stem from a recent promotion or reorganization that brings new or broader job responsibilities, or from occupying a role that is not clearly defined or has limited direct authority. **Accountability for Others' Work** Challenges related to transitioning from doing	**First Time Managing People** The challenge of managing people for the first time or in a new way. This may include managing employees older than you, former peers, or a large group. It requires learning how to juggle day-to-day and management responsibilities, filling the big shoes of a predecessor, and gaining respect as a new person in the role.	**Limited Influence** The challenge of influencing others when one has limited authority due to low positional power, lack of experience, or inadequate empowerment from above. These limitations make it difficult to be confident, set expectations, provide feedback, hold others accountable, manage peers, and display leadership qualities. **Workforce Constraints**

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
	experienced colleagues, when working with a new boss, when introducing significant change in your unit, when departments operate in silos, or when employees are in conflict or lack accountability. **Organizational Talent Issues** Challenges related to hiring, retaining, compensating, motivating, or reducing staff in the organization. These talent management issues are particularly challenging when the organization is facing financial challenges or an uncertain future.	The challenge of creating strategies and structures that facilitate hiring, development, and succession — both for divisions and for the organization as a whole. This includes transferring knowledge, simultaneously hiring younger employees and motivating senior employees, encouraging senior employees to train their replacements, developing career pathways for staff, creating developmental experiences, resource constraints on employee development, and remote workforce planning.	the work to creating the context in which work gets accomplished by others. Creating the context involves providing direction, plans, and prioritization — and then letting others do their jobs. This includes trusting others yet being available to them, having a process to monitor the work, and holding people accountable. Creating this context can be particularly challenging when there is unclear direction above you and a lack of talent or teamwork below you. **Competing People and Project Priorities** Challenges stemming from being responsible for both the motivation of individual employees and the completion of project-based work. Motivating people requires extra attention	**New to Positional Authority** The challenge of moving into a position of authority rather than influencing from the position of peer. This includes establishing credibility, communicating across levels, motivating direct reports, supporting problem-solving, managing push-back, connecting with others from a new position of authority, taking initiative on behalf of others, and managing up. **Peers as Team Members** The challenge of managing teammates who are peers. Issues include balancing friendship with authority, balancing assertiveness with responsiveness, communicating effectively, managing	The challenge of accomplishing one's work when the organization is understaffed, coworker performance is problematic, or staff are not working face-to-face. These situations create workload pressures, communication and coordination problems, and customer dissatisfaction.

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
			when they vary in personality, abilities, demographics, location, experience, or performance. Managing numerous projects that compete for importance and resources also demands attention. Balancing these competing priorities is difficult and often creates workload issues. **Development Gaps: Yours and Others** The challenge of expanding your own capabilities and developing direct reports to enhance the group's overall success. Developing others involves motivating them to improve, identifying stretch opportunities, and coaching and mentoring them. For your own professional growth, an emphasis is placed on communication skills,	relationships, creating a cohesive team, and delegating without micromanaging. **Limited Influence** The challenge of leading and influencing other people, often without authority. The issues include the need to make sense of different views and have your own understood by others; boundary spanning; working across functions, teams, and regions; working with people who are difficult or have different priorities; and leading others with different training/ experience. **Team Performance** The challenge of building and developing an effective team. It includes learning how to provide effective direction, giving feedback, coaching for	

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
			strategic thinking, and executive presence. **Staffing Issues** The challenge of attracting, hiring, training, motivating, and retaining a talented staff. These staffing issues are particularly challenging in startup, high growth, and turnaround situations; in tight labor markets; and when facing resource constraints or external pressures for change.	performance, and dealing with resistance from direct reports. **Employee Engagement** The challenge of keeping employees engaged and motivated by their work. This includes strengthening employee morale and commitment, encouraging innovation, motivating through difficult circumstances, supporting those who feel overworked, and retaining older employees who are looking to retire. **Competing Priorities** The challenge of accomplishing work while leading at the same time. This includes juggling multiple priorities, dealing with lack of consistent direction from higher-ups, having responsibility without	

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
				authority, managing in a matrix, and coaching others to prioritize while managing own workload.	
Working within a Larger System The challenge of managing dynamics across the organizational and environmental systems	**Dynamic Business Environment** The challenge of leading an organization or business unit that must adapt to ever-changing circumstances. These changes may be brought about by new regulations, market and economic conditions, competition, and business growth. It requires developing and retaining the talent needed to support change, as well as revising business models and systems. **Organizational Readiness Amid Uncertainty** The challenge of being ready for an uncertain future. This challenge is experienced when there	**Process Improvement across Groups** The challenge of influencing the organization to improve and accept new processes. This requires strategic thinking, boundary spanning, developing a systemic view, and influencing others. **Tense and Complex Situations** The challenge of managing others during tense and complex situations. This includes developing trust among stakeholders, managing internal politics, dealing with different personalities, and effectively following up with others.	**Cross-Functional Influence** The challenge of influencing without formal authority in order to coordinate efforts or advance an initiative beyond your own group. This includes building presence and credibility as a leader, developing a cross-organizational network, partnering with others, and bridging functional boundaries. **Adverse Work Environment** The challenge of creating a more positive and efficient work environment. This includes both enhancing business processes and fostering healthy cultures where people adapt and thrive. The impetus for	**Deficient Operational Processes** The challenge of needing stronger operational processes to address a business problem. This includes process auditing, process improvement and development, managing interdependencies, and planning. **Change and Instability** The challenge of managing when conditions are changing and unstable. Issues include leading with incomplete information, managing ambiguity, developing agility in staff to adapt to changing conditions, and engaging employees with different	**Support for Change** The challenge of making process improvements and business practice changes in the organization. This requires educating others, sharing information, gaining buy-in and cooperation, and accessing resources across the organization. **Strategic Alignment** The challenge of working with others to achieve shared goals. This involves aligning around strategic goals and priorities; coordinating and collaborating across groups; and maintaining team cohesion.

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
	is a shifting organizational mission, significant resource constraints, changing technologies, or new ways of working.	**Problems with Upper Management** Challenges related to managing your bosses and other senior executives in the organizational hierarchy. These include lack of empowerment by upper management, lack of expertise on the part of decision-makers, inconsistent direction from senior management, shifting priorities, and limited ability to influence upward. **Limited Market/Sales Growth** The challenge of making strategic shifts to maximize market growth and sales. This may include expanding beyond core products, extending market reach, shifting to a market/customer	change may come from corporate initiatives, business system changes, changes in the external environment, or the desire for a more positive group climate. **Challenging Business Context** The challenge of delivering business results while operating in a difficult or changing business context. This includes improving business models and processes, keeping staff focused and motivated, and using limited resources effectively.	generational attitudes toward change.	

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
		orientation, and better alignment of sales. **Changing Internal/External Environment** The challenge of leading in the context of organizational, market, societal, political, and environmental changes. It may include changes in goals, expectations, organizational culture, or structure. It requires influencing, strategic thinking, driving innovation, and creating and modifying systems. **Resource Constraints and Financial Instability** The challenge of doing more with less. This includes engaging employees when promotion isn't an option, attracting and retaining employees while working within budget and			

Theme	Leading the Organization	Leading the Function	Leading Managers	Leading Others	Individual Contributor
		compensation constraints, managing organizational performance despite personnel reductions or inadequate facilities, and leading with agility.			

7. References

Antweiler, W., & Frank, M. Z. (2004). Is all that talk just noise? The information content of internet stock message boards. *The Journal of Finance, 59(3),* 1259-1294.

Bao, Y., & Datta, A. (2014). Simultaneously discovering and quantifying risk types from textual risk disclosures. *Management Science, 60*(6), 1371-1391.

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *The Journal of Machine Learning Research, 3*, 993-1022.

Bosco, F., Aguinis, H., Singh, K., Field, J., & Pierce, C. (2015). Correlational effect size benchmarks. *Journal of Applied Psychology, 100(2),* 431–449.

Bouloutian, A. (2009). There is a lot more to training than training. *T+D, 63(12),* 40-45.

Boyatzis, R. E. (1998). *Transforming qualitative information*. Thousand Oaks, CA: Sage.

Campion, M. C., Campion, M.A., Campion, E. D., & Reider, M. H. (2016). Initial investigation

into computer scoring of candidate essays for personnel selection. *The Journal of Applied Psychology, 101(7),* 958–975.

Claridge-Chang, A., Roorda, R. D., Vrontou, E., Sjulson, L., Li, H., Hirsh, J., & Miesenböck, G. (2009). Writing memories with light-addressable reinforcement circuitry. *Cell, 139*(2), 405-415.

Coffey, M. P., Feingold, M., & Bromberg, J. (1988). A normed measures of variability among proportions. *Computational Statistics & Data* Analysis, 7(2), 127-141.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Laurence Erlbaum Associates.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112(1),* 155-159.

Collins, D. B., & Holton, E. F. (2004). The effectiveness of managerial leadership development programs: A meta- analysis of studies from 1982 to 2001. *Human Resource Development Quarterly, 15(2)*, 217–248.

Deerwester, S., Dumais, S. T., Furnas, G. W., Landauer, T. K., & Harshman, R. (1990). Indexing by latent semantic analysis. *Journal of the American Society for Information Science, 41(6),* 391-407.

Doldor, E., Wyatt, M., & Silvester, J. (2019). Statesmen or cheerleaders? Using topic modeling to examine gendered messages in narrative developmental feedback for leaders. *The Leadership Quarterly, 30(5),* 101308.

Ferguson, J., Ronayne, P., & Rybacki, M. (2014). *Public sector leadership challenges: Are they different and does it matter?* Greensboro, NC: Center for Creative Leadership. Retrieved from: https://www.ccl.org/wp-content/uploads/2016/02/ComparingLeadershipChallenges.pdf

Gentry, W. A., Eckert, R., Munusamy, V. P., Stawiski, S. A., & Martin, J. (2014). The needs of

participants in leadership development programs: A qualitative and quantitative, cross-country investigation. *Journal of Leadership & Organizational Studies, 21(1),* 83-101.

Gentry, W. A., Clark, M. A., Young, S. F., Cullen, K. L., & Zimmerman, L. (2015). How displaying empathic concern may differentially predict career derailment potential for women and men leaders in Australia. *The Leadership Quarterly*, 26(4), 641-653.

Hofmann, T. (2001). Unsupervised learning by probabilistic latent semantic analysis. *Machine Learning, 42(1),* 177-196.

Leslie, J. B., & Palmisano, K. (2014). *The leadership challenge in the pharmaceutical sector*. Greensboro, NC: Center for Creative Leadership. Retrieved from: https://cclinnovation.org/wp-content/uploads/2020/03/leadership-challenge-pharmaceutical-center-for-creative-leadership.pdf

May, C., Wang, A., Bordia, S., Bowman, S. R., & Rudinger, R. (2019). On measuring social biases in sentence encoders. *arXiv preprint arXiv:1903.10561*.

Moldoveanu, M., & Narayandas, D. (2019, March-April). The future of leadership development. *Harvard Business Review, 97(4),* 40-48. https://vjholcomb.com/wp-content.

Mumford, T. V., Campion, M. A., & Morgeson, F. P. (2007). The leadership skills strataplex: Leadership skill requirements across organizational levels. *The Leadership Quarterly,18(2),* 154–166.

Nachar, N. (2008). The Mann-Whitney U: A test for assessing whether two independent samples come from the same distribution. *Tutorials in Quantitative Methods for Psychology, 4(1),* 13-20.

Nokel, M., & Loukachevitch, N. (2015, June). A method of accounting bigrams in topic models. *In Proceedings of the 11th Workshop on Multiword Expressions*, 1-9.

Prokopeak, M. (2018, March). Follow the leader(ship) development spending in business. *Chief Learning Officer.* Retrieved from: www.chieflearningofficer.com/2018/03/21/follow-the-leadership-spending/.

Schmiedel, T., Müller, O., & vom Brocke, J. (2019). Topic modeling as a strategy of inquiry in organizational research: A tutorial with an application example on organizational culture. *Organizational Research Methods, 22(4),* 941-968.

Tannenbaum, S. I., Mathieu, J. E., Salas, E., & Cannon-Bowers, J. A. (1991). Meeting trainees' expectations: The influence of training fulfillment on the development of commitment,

self-efficacy, and motivation. *Journal of Applied Psychology, 76(6),* 759-769.

Tonidandel, S., Summerville, K., Gentry, W., Young, S. Using Machine learning to gain insight

into the challenges faced by leaders: An application of structural topic modeling.

Yao, L., Mimno, D., & McCallum, A. (2009, June). Efficient methods for topic model inference on streaming document collections. *In Proceedings of the 15th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, 937-946.

Young, S., Gentry, W., & Bendixen, S. (2017). New reports capture the leadership challenges of 6 major industries. *Leading Effectively Blog*. Retrieved from: www.ccl.org/blog/new-reports-capture-leadership-challenges-6-major-industries/.

Young, S., Leslie, J., Balakrishnan, R., & Winn, B. (2021). The Leadership Development Imperative: Preparing Today's Leaders for Tomorrow's Challenges. *People + Strategy Journal*.