In [1]:
```
#Importing relevant libraries
from pdfminer.high_level import extract_text
import PyPDF2
from PyPDF2 import PdfReader
import re
import string
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
from nltk.stem import PorterStemmer
from nltk import download
from gensim import corpora, models
from gensim.models import CoherenceModel
import os
import statistics
import pandas as pd
import numpy as np
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
from scipy.stats import pearsonr
import matplotlib.pyplot
import seaborn as sns
from wordcloud import WordCloud
import matplotlib.pyplot as plt
from gensim.models.coherencemodel import CoherenceModel
import tensorflow as tf
import os
import pdfplumber
from gensim.corpora import Dictionary
from gensim.models import HdpModel
from gensim.models.ldamodel import LdaModel
from sklearn.model_selection import KFold
import pyLDAvis.gensim



# Download other resources
download('stopwords')
download('punkt')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     /Users/cdlacey/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package punkt to /Users/cdlacey/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[1]:
```
True
```

In [2]:
```
#Initial stats - file count

def count_files_in_folder(folder_path):
    # Initialize a counter for files
    file_count = 0

    # Walk through the directory and count files
    for _, _, files in os.walk(folder_path):
        file_count += len(files)

    return file_count

folder_path = '/Users/cdlacey/TMU_DataScience/CIND820/Dataset_Sample'
total_files = count_files_in_folder(folder_path)
print("Total files in datasource: ", total_files)
```

```
Total files in datasource:  25
```

In [3]:
```
#Initial stats - page count

def count_pages_and_stats(folder_path):
    total_pages = 0
    page_counts = []

    for filename in os.listdir(folder_path):
        if filename.endswith('.pdf'):
            file_path = os.path.join(folder_path, filename)
            with open(file_path, 'rb') as file:
                pdf_reader = PdfReader(file)
```

```
                num_pages = len(pdf_reader.pages)
                total_pages += num_pages
                page_counts.append(num_pages)

    mean_page_count = statistics.mean(page_counts)
    median_page_count = statistics.median(page_counts)

    return total_pages, mean_page_count, median_page_count

folder_path = '/Users/cdlacey/TMU_DataScience/CIND820/Dataset_Sample'
total_pages, mean_page_count, median_page_count = count_pages_and_stats(folder_path)

print("Total pages in all PDF files:", total_pages)
print("Mean page count per file:", mean_page_count)
print("Median page count per file:", median_page_count)
```

```
Total pages in all PDF files: 2113
Mean page count per file: 84.52
Median page count per file: 82
```

In [4]:

```
# Function for preprocessing text
def preprocess_text(text):
    # Tokenize
    tokens = word_tokenize(text)
    # Remove punctuation and convert to lowercase
    tokens = [token.lower() for token in tokens if token.isalpha()]
    # Remove stopwords
    stop_words = set(stopwords.words('english'))
    french_stopwords = set(stopwords.words('french'))
    stop_words.update(french_stopwords)
    tokens = [token for token in tokens if token not in stop_words]
    # Remove numbers, symbols, and certain words
    tokens = [re.sub(r'[^a-zA-Z]', '', token) for token in tokens]
    # Remove specific words or letters which are not useful
    additional_stopwords = {
        'mr.', 'mr', 'mrs.', 'ms.', 'speaker', 'bill', 'debate', 'hon', 'cpc', 'lib', 'bq', 'canadian',
        'act', 'amend', 'amendment', 'canada', 'house', 'public', 'honour', 'minister', 'ministry', 'gover
        'member', 'program', 'primeminister', 'would', 'people', 'chair', 'committe', 'liber', 'polici', '
        'ndp', 'government', 'conserv', 'parties', 'partisan', 's', 'b', 'c', 'e', 'f', 'g', 'h', 'j', 'k'
        'q', 'r', 't', 'u', 'v', 'w', 'x', 'y', 'z', 'am', 'pm','year','time','motion','go', 'canadians',
        'also', 'members', 'madam', 'committee', 'prime', 'senate', 'senator', 'hous',
        'one', 'govern', 'liberal', 'conservative', 'liberals', 'conservatives', 'speech', 'parliamentaria
        'secretariat', 'ii', 'iii', 'iv', 'v', 'vi', 'vii', 'viii', 'ix', 'x', 'xi', '000', '1', '3', '5',
        '15', '22', '25', '2007', '2008', '2009', '2010', '2011',
        '2012', '2013', '2014', '2015', '2016', '2017', '2018', '2019', '2020', '2021', '2022', '2023', ',
        ',Äú', ',Äù', "’",'..................',' ................................................',
        '.......',"'s"}
    tokens = [token for token in tokens if token not in additional_stopwords]
    # Stemming
    stemmer = PorterStemmer()
    tokens = [stemmer.stem(token) for token in tokens]
    return tokens

# Directory path containing PDF files
pdf_directory = '/Users/cdlacey/TMU_DataScience/CIND820/Dataset_Sample'

# List all PDF files in the directory
pdf_files = [os.path.join(pdf_directory, file) for file in os.listdir(pdf_directory) if file.endswith('.pd

texts = []

# Loop through each PDF file and extract text
for pdf_file in pdf_files:
    with pdfplumber.open(pdf_file) as pdf:
        text = ""
        for page in pdf.pages:
            text += page.extract_text()
        texts.append(text)

# Preprocess text
preprocessed_texts = [preprocess_text(text) for text in texts]

# Create a dictionary from the preprocessed text
dictionary = Dictionary(preprocessed_texts)

# Create a corpus
corpus = [dictionary.doc2bow(text) for text in preprocessed_texts]
```

In [5]:
```
#spliting data for cross validation
from sklearn.model_selection import train_test_split

train_corpus, test_corpus = train_test_split(corpus, test_size=0.2, random_state=42)
```

In [22]:
```
# Train the HDP model
hdp_model = HdpModel(train_corpus, id2word=dictionary)
```

In [23]:
```
#First evaluation of HDP model and number of topics identified per document)
rows = []

# Iterate through each document in the corpus
for i, doc in enumerate(corpus):
    doc_topics = hdp_model[doc]
    # Extract topic numbers and their probabilities
    topic_numbers = [topic[0] for topic in doc_topics]
    topic_probs = [topic[1] for topic in doc_topics]
    # Append the document's topics to the rows list
    rows.append([i, topic_numbers, topic_probs])

# Create a DataFrame from the list of rows
doc_topics_df = pd.DataFrame(rows, columns=['Document_Index', 'Topic_Numbers', 'Topic_Probabilities'])

# Display the DataFrame
doc_topics_df.head(10)
```

Out[23]:

	Document_Index	Topic_Numbers	Topic_Probabilities
0	0	[0, 2, 3, 4, 5, 6, 10, 11, 13, 41, 48, 54, 71, 88, 107, 133, 137]	[0.047155762038943436, 0.01745641223716107, 0.021935941002908074, 0.08173593366511456, 0.3656592...
1	1	[14]	[0.9960326922549173]
2	2	[0, 4]	[0.9826620155469378, 0.016204768081790315]
3	3	[0]	[0.9999601737264474]
4	4	[1]	[0.9999840119261535]
5	5	[8]	[0.9999438441800745]
6	6	[7]	[0.9999496279042555]
7	7	[10]	[0.9999406441139107]
8	8	[0, 2, 4, 8, 10, 13, 14, 60, 66, 83]	[0.3406484096690997, 0.037426905142720464, 0.2210325621217866, 0.12818298433928554, 0.0114204199...
9	9	[11]	[0.9999365625262497]

In [24]:
```
# To find an approximate number of total topics identified within the HDP model, I found it easiest to tra
#LDA model on the HDP model.
# Here we'll train an LDA model using the HDP model as a training mechanism
lda_model_t = hdp_model.suggested_lda_model()

# Get the topic distributions for each document
doc_topics = [lda_model_t.get_document_topics(doc) for doc in corpus]

# Count the number of unique topics
unique_topics = set()
for doc_topics in doc_topics:
    unique_topics.update([topic[0] for topic in doc_topics])

num_topics_identified = len(unique_topics)
print(f"Number of topics identified by HDP model: {num_topics_identified}")
```

```
Number of topics identified by HDP model: 19
```

In [9]:
```
#From the Literature Review, the ideal topics for LDA was found to be 7.
from gensim.models import LdaModel

# Train the LDA model
lda_model = LdaModel(train_corpus, id2word=dictionary, num_topics=7, update_every=1, chunksize=10, passes=
```

In [10]:
```
#Evaluating LDA topic coherance values.

# Calculate coherence values for each topic
coherence_values = {}
for topic_num in range(lda_model.num_topics):
```

```python
    topic_terms = lda_model.show_topic(topic_num)
    topic_words = [term for term, _ in topic_terms]
    coherence_model = CoherenceModel(topics=[topic_words], texts=preprocessed_texts, dictionary=dictionary
    coherence_values[topic_num] = coherence_model.get_coherence()

# Create a table of coherence values
print("Topic\tCoherence Value")
for topic_num, coherence_value in coherence_values.items():
    print(f"{topic_num}\t{coherence_value}")
```

```
Topic   Coherence Value
0       0.45736087529776065
1       0.874373060072404
2       0.3963513104929659
3       0.660325208683177
4       0.3978611926676396
5       0.5498209228613706
6       0.40954532370489627
```

In [11]:
```python
# Finding the overall LDA model coherance value
topics = lda_model.show_topics(num_topics=-1, formatted=False)

# Calculate coherence values for each topic
coherence_model_lda = CoherenceModel(model=lda_model, texts=preprocessed_texts, dictionary=dictionary, coh
coherence_lda = coherence_model_lda.get_coherence()

print("Coherence Score for LDA model:", coherence_lda)
```

```
Coherence Score for LDA model: 0.410306025057182
```

In [25]:
```python
#Evaluating HDP topic coherance values, which were found to have a range below as well as above the LDA mo

hdp_topics = hdp_model.show_topics(num_topics=19, formatted=False)  # Get the top topics

# Extract topic words for each topic
topic_words = [[word for word, _ in topic] for topic_id, topic in hdp_topics]

# Calculate coherence values for each topic
coherence_values = {}
for topic_num, words in enumerate(topic_words):
    coherence_model = CoherenceModel(topics=[words], texts=preprocessed_texts, dictionary=dictionary, cohe
    coherence_values[topic_num] = coherence_model.get_coherence()

# Create a table of coherence values
print("Topic\tCoherence Value")
for topic_num, coherence_value in coherence_values.items():
    print(f"{topic_num}\t{coherence_value}")
```

```
Topic   Coherence Value
0       0.35378889730765517
1       0.5815620435360508
2       0.46758620014278823
3       0.3644140581503076
4       0.409021556616043
5       0.23868174880719942
6       0.3441902705045204
7       0.35631095661923473
8       0.4597742834083295
9       0.40607332438045696
10      0.2690057186740486
11      0.4200206196641586
12      0.4300083454633025
13      0.32838358757375779
14      0.3461376859783381
15      0.7456783408159909
16      0.7116339792674294
17      0.7325777676665787
18      0.7453307669425714
```

In [26]:
```python
# Finding the overall coherhance value for HDP model
hdp_topics = hdp_model.show_topics(num_topics=19, formatted=False)  # Get the top topics

# Extract topic words for each topic
topic_words = [[word for word, _ in topic] for topic_id, topic in hdp_topics]

# Calculate coherence values for each topic
coherence_values = {}
for topic_num, words in enumerate(topic_words):
    coherence_model = CoherenceModel(topics=[words], texts=preprocessed_texts, dictionary=dictionary, cohe
```

```
    coherence_values[topic_num] = coherence_model.get_coherence()

# Compute the average coherence value
avg_coherence_value = sum(coherence_values.values()) / len(coherence_values)

print("Overall Coherence Value for HDP model:", avg_coherence_value)
```

```
Overall Coherence Value for HDP model: 0.4584305342904611
```

In [14]:
```
#Generate df with dominant topics, the topic contribution and topic keywords for LDA model

def format_topics(ldamodel=None, corpus=None, texts=None):
    # Initialize an empty list to store rows
    rows = []

    # Iterate through each document in the corpus
    for i, row_list in enumerate(ldamodel[corpus]):
        row = row_list[0] if ldamodel.per_word_topics else row_list
        row = sorted(row, key=lambda x: (x[1]), reverse=True)

        # Extract dominant topic, its contribution, and keywords
        for j, (topic_num, prop_topic) in enumerate(row):
            if j == 0:  # Dominant topic
                wp = ldamodel.show_topic(topic_num)
                topic_keywords = ", ".join([word for word, prop in wp])
                row_data = [int(topic_num), round(prop_topic, 4), topic_keywords, texts[i]]
                rows.append(row_data)
                break

    # Create df
    topics_df = pd.DataFrame(rows, columns=['Dominant_Topic', 'Perc_Contribution', 'Topic_Keywords', 'Text

    return topics_df


df_topic_keywords = format_topics(ldamodel=lda_model, corpus=corpus, texts=preprocessed_texts)

df_topic_keywords.head(10)
```

Out[14]:

	Dominant_Topic	Perc_Contribution	Topic_Keywords	Text
0	0	0.9961	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
1	0	0.9056	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
2	0	0.5588	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
3	0	1.0000	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
4	5	0.9952	tax, carbon, yea, agre, commonsdeb, mass, nay,...	[common, debat, volum, number, session, parlia...
5	0	1.0000	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
6	0	1.0000	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
7	0	0.9999	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
8	0	0.9937	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...
9	0	0.6940	right, work, want, make, need, know, order, li...	[common, debat, volum, number, session, parlia...

In [15]:
```
#Generate df of represtative text for dominant topics for LDA model

pd.options.display.max_colwidth = 100

topics_sorteddf_mallet = pd.DataFrame()
topics_outdf_grpd = df_topic_keywords.groupby('Dominant_Topic')

for i, grp in topics_outdf_grpd:
    topics_sorteddf_mallet = pd.concat([topics_sorteddf_mallet,
                                         grp.sort_values(['Perc_Contribution'], ascending=False).head(
```

```
                                                    axis=0)

# Reset Index
topics_sorteddf_mallet.reset_index(drop=True, inplace=True)

# Format DF
topics_sorteddf_mallet.columns = ['Topic_Num', "Topic_Perc_Contrib", "Keywords", "Representative Text"]


topics_sorteddf_mallet.head(10)
```

Out[15]:

	Topic_Num	Topic_Perc_Contrib	Keywords	Representative Text
0	0	1.0000	right, work, want, make, need, know, order, like, support, import	[common, debat, volum, number, session, parliament, offici, report, hansard, monday, novemb, hon...
1	5	0.9952	tax, carbon, yea, agre, commonsdeb, mass, nay, sidhu, brison, fraser	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, june, hon...

In [20]:

```
#Generate df with dominant topics, the topic contribution and topic keywords for HDP model

def topics_sentences(ldamodel=None, corpus=None, texts=None):
    # Initialize an empty list to store rows
    rows = []

    # Iterate through each document in the corpus
    for i, topics in enumerate(ldamodel[corpus]):
        # Sort topics by contribution
        topics = sorted(topics, key=lambda x: (x[1]), reverse=True)

        # Extract dominant topic, its contribution, and keywords
        for j, (topic_num, prop_topic) in enumerate(topics):
            if j == 0:  # Dominant topic
                topic_keywords = ", ".join([word for word, prop in ldamodel.show_topic(topic_num)])
                row_data = [int(topic_num), round(prop_topic, 4), topic_keywords, texts[i]]
                rows.append(row_data)
                break

    # Create df
    topics_df = pd.DataFrame(rows, columns=['Dominant_Topic', 'Perc_Contribution', 'Topic_Keywords', 'Text

    return topics_df

df_topic_keywords = topics_sentences(ldamodel=hdp_model, corpus=corpus, texts=preprocessed_texts)

df_topic_keywords.head(10)
```

Out[20]:

	Dominant_Topic	Perc_Contribution	Topic_Keywords	Text
0	6	0.3377	elect, ontario, qubec, offic, elector, vote, parliamentari, make, chief, voter, young, britishco...	[common, debat, volum, number, session, parliament, offici, report, hansard, friday, februari, h...
1	8	0.9960	thedeputyspeak, pension, plan, chambr, thursday, follow, tabl, excel, messagefromthesen, permiss...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, decemb, h...
2	7	0.9999	vessel, amend, work, translat, english, abandon, commonsdeb, make, commun, issu, protect, like, ...	[common, debat, volum, number, session, parliament, offici, report, hansard, friday, februari, h...
3	2	1.0000	first, nation, commonsdeb, commun, make, right, work, issu, know, order, want, develop, question...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, novemb, h...
4	0	1.0000	tax, need, know, want, work, carbon, make, like, commonsdeb, go, say, agre, get, english, budget...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, june, hon...
5	4	0.9999	trade, agreement, hondura, privileg, right, countri, import, work, question, want, commonsdeb, f...	[common, debat, volum, number, session, parliament, offici, report, hansard, monday, march, hono...
6	1	1.0000	commonsdeb, work, order, want, countri, make, need, develop, right, support, say, english, impor...	[common, debat, volum, number, session, parliament, offici, report, hansard, tuesday, octob, hon...
7	3	0.6305	right, want, need, issu, make, care, medic, work, commun, import, decis, know, indigen, court, l...	[common, debat, volum, number, session, parliament, offici, report, hansard, friday, januari, ho...
8	2	0.3875	first, nation, commonsdeb, commun, make, right, work, issu, know, order, want, develop, question...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, octob, ho...
9	2	0.9999	first, nation, commonsdeb, commun, make, right, work, issu, know, order, want, develop, question...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, june, hon...

In [27]:

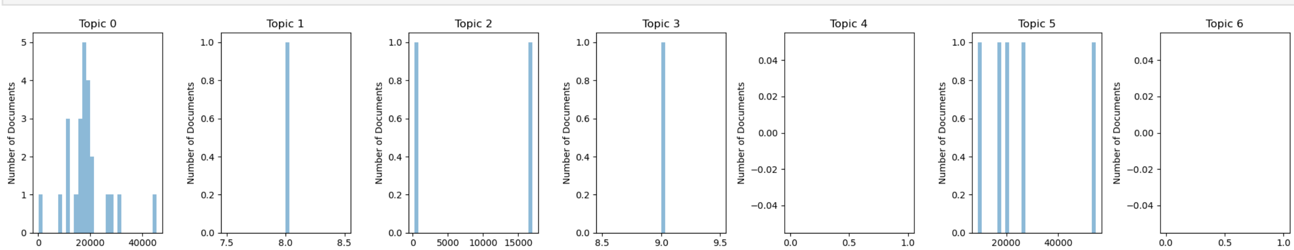
```
#Generate df of represtative text for dominant topics for HDP model

pd.options.display.max_colwidth = 100

topics_sorteddf_mallet = pd.DataFrame()
topics_outdf_grpd = df_topic_keywords.groupby('Dominant_Topic')

for i, grp in topics_outdf_grpd:
    topics_sorteddf_mallet = pd.concat([topics_sorteddf_mallet,
                                         grp.sort_values(['Perc_Contribution'], ascending=False).head(
                                        axis=0)

# Reset Index
topics_sorteddf_mallet.reset_index(drop=True, inplace=True)

# Format
topics_sorteddf_mallet.columns = ['Topic_Num', "Topic_Perc_Contrib", "Keywords", "Representative Text"]

# Show
topics_sorteddf_mallet.head(10)
```

Out[27]:

	Topic_Num	Topic_Perc_Contrib	Keywords	Representative Text
0	0	1.0000	tax, need, know, want, work, carbon, make, like, commonsdeb, go, say, agre, get, english, budget...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, june, hon...
1	1	1.0000	commonsdeb, work, order, want, countri, make, need, develop, right, support, say, english, impor...	[common, debat, volum, number, session, parliament, offici, report, hansard, tuesday, octob, hon...
2	2	1.0000	first, nation, commonsdeb, commun, make, right, work, issu, know, order, want, develop, question...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, novemb, h...
3	3	1.0000	right, want, need, issu, make, care, medic, work, commun, import, decis, know, indigen, court, l...	[parliament, session, common, debat, offici, report, hansard, volum, monday, octob, honour, anth...
4	4	0.9999	trade, agreement, hondura, privileg, right, countri, import, work, question, want, commonsdeb, f...	[common, debat, volum, number, session, parliament, offici, report, hansard, monday, march, hono...
5	5	0.9999	ontario, qubec, resourc, commun, crime, support, parliamentari, develop, project, children, firs...	[common, debat, volum, number, session, parliament, offici, report, hansard, friday, novemb, hon...
6	6	0.9999	elect, ontario, qubec, offic, elector, vote, parliamentari, make, chief, voter, young, britishco...	[common, debat, volum, number, session, parliament, offici, report, hansard, friday, februari, h...
7	7	0.9999	vessel, amend, work, translat, english, abandon, commonsdeb, make, commun, issu, protect, like, ...	[common, debat, volum, number, session, parliament, offici, report, hansard, friday, februari, h...
8	8	0.9960	thedeputyspeak, pension, plan, chambr, thursday, follow, tabl, excel, messagefromthesen, permiss...	[common, debat, volum, number, session, parliament, offici, report, hansard, thursday, decemb, h...

In [28]:

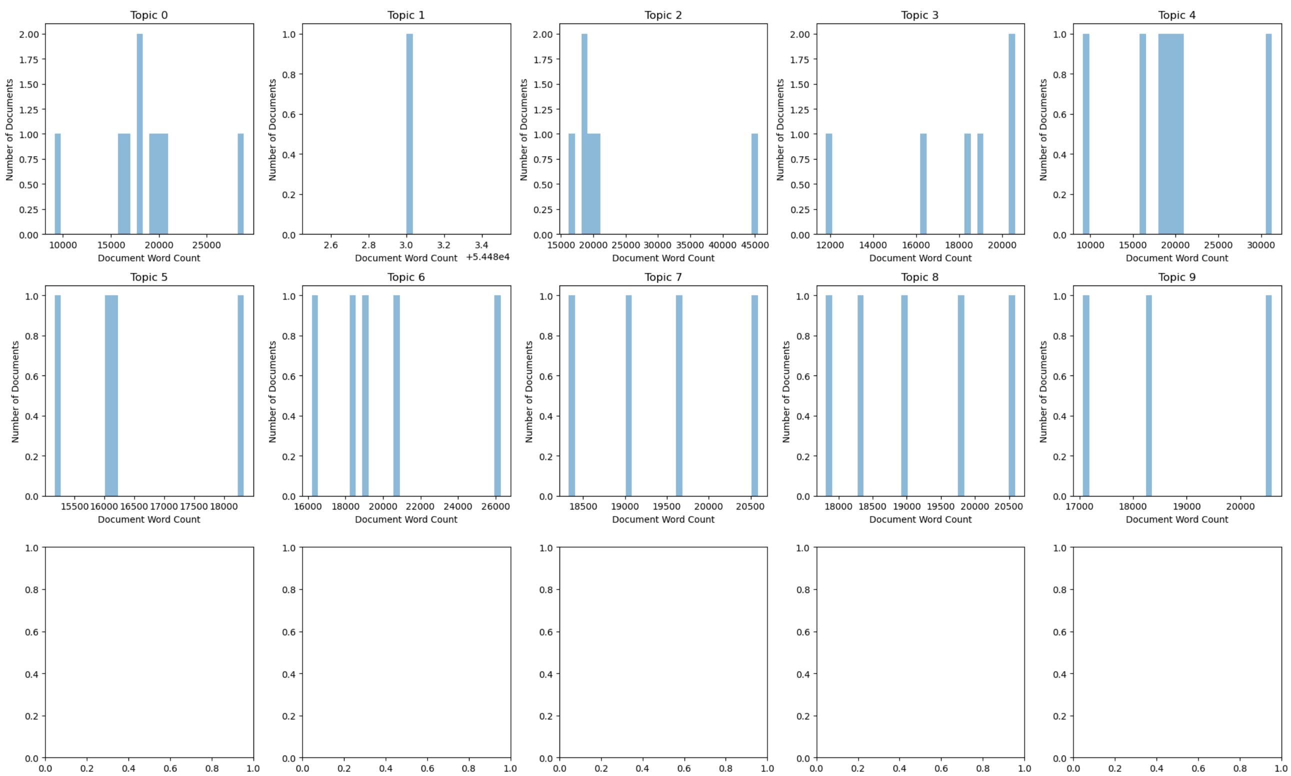
```
#Ploting document word count against nubmer of documents for LDA model

fig, axes = plt.subplots(nrows=1, ncols=7, figsize=(20, 4))

for i in range(7):
    word_counts = []


    for doc in corpus:
        # Get the topic distribution for the document
        doc_topics = lda_model.get_document_topics(doc)

        # Check if the current topic is the dominant topic for the document
        for topic, prob in doc_topics:
            if topic == i:
                # Calculate the word count of the document and add it to the list
                word_count = sum(count for _, count in doc)
                word_counts.append(word_count)
                break

    axes[i].hist(word_counts, bins=30, alpha=0.5)
    axes[i].set_title(f'Topic {i}')
    axes[i].set_xlabel('Document Word Count')
    axes[i].set_ylabel('Number of Documents')

plt.tight_layout()
plt.show()
```



In [29]:

```
#Ploting document word count against nubmer of documents for HDP model

fig, axes = plt.subplots(nrows=3, ncols=5, figsize=(20, 12))
```

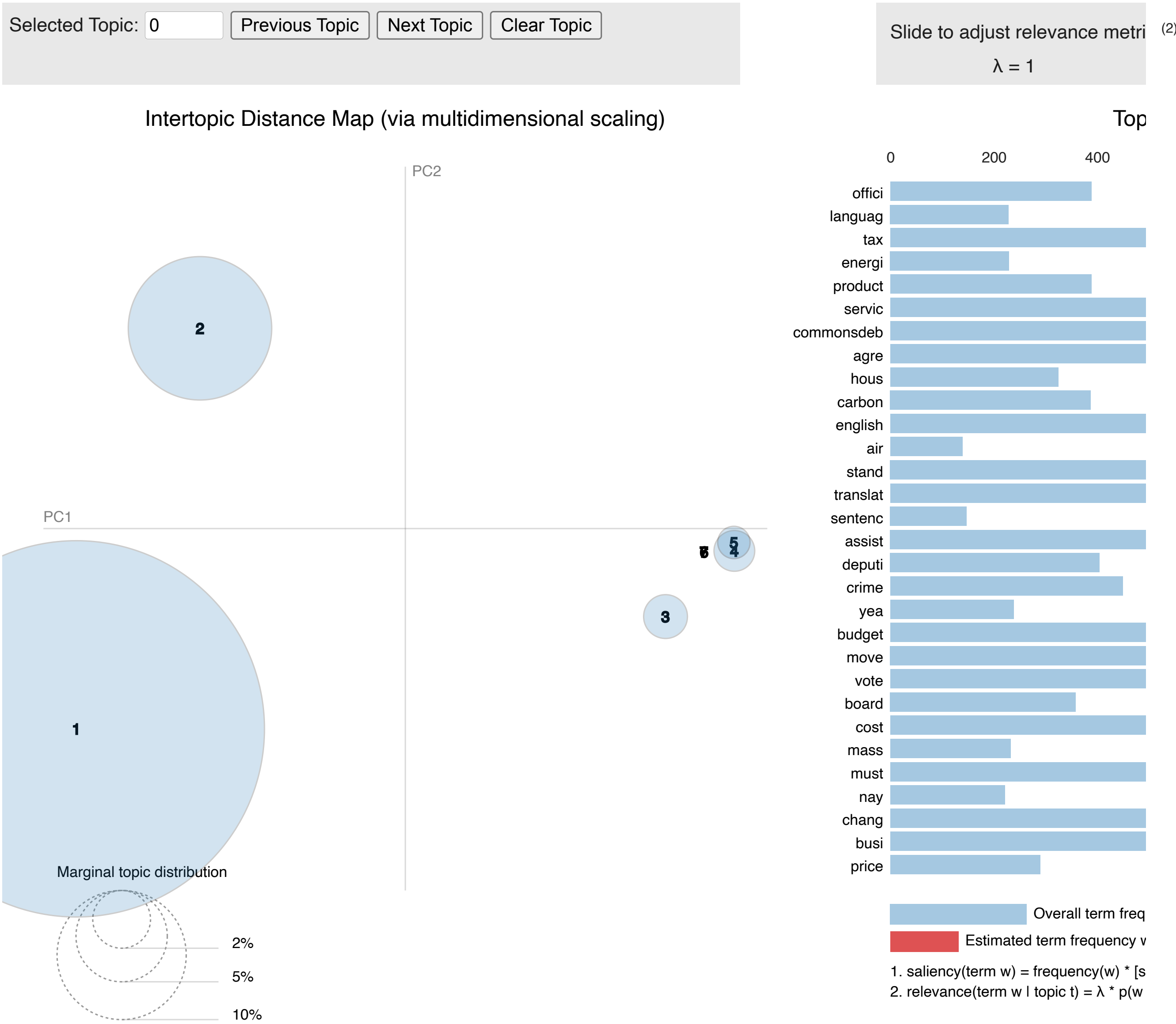
```
for i in range(10):
    word_counts = []

    for doc in corpus:
        doc_topics = hdp_model[doc]

        for topic, prob in doc_topics:
            if topic == i:
                word_count = sum(count for _, count in doc)
                word_counts.append(word_count)
                break

    # Determine the position of the subplot in the grid
    row_index = i // 5
    col_index = i % 5

    axes[row_index, col_index].hist(word_counts, bins=30, alpha=0.5)
    axes[row_index, col_index].set_title(f'Topic {i}')
    axes[row_index, col_index].set_xlabel('Document Word Count')
    axes[row_index, col_index].set_ylabel('Number of Documents')

plt.tight_layout()
plt.show()
```



In [30]:

```
#Exploring the relevant terms for each topic of the LDA Model

pyLDAvis.enable_notebook()
vis = pyLDAvis.gensim.prepare(lda_model, corpus, dictionary=dictionary)
vis
```

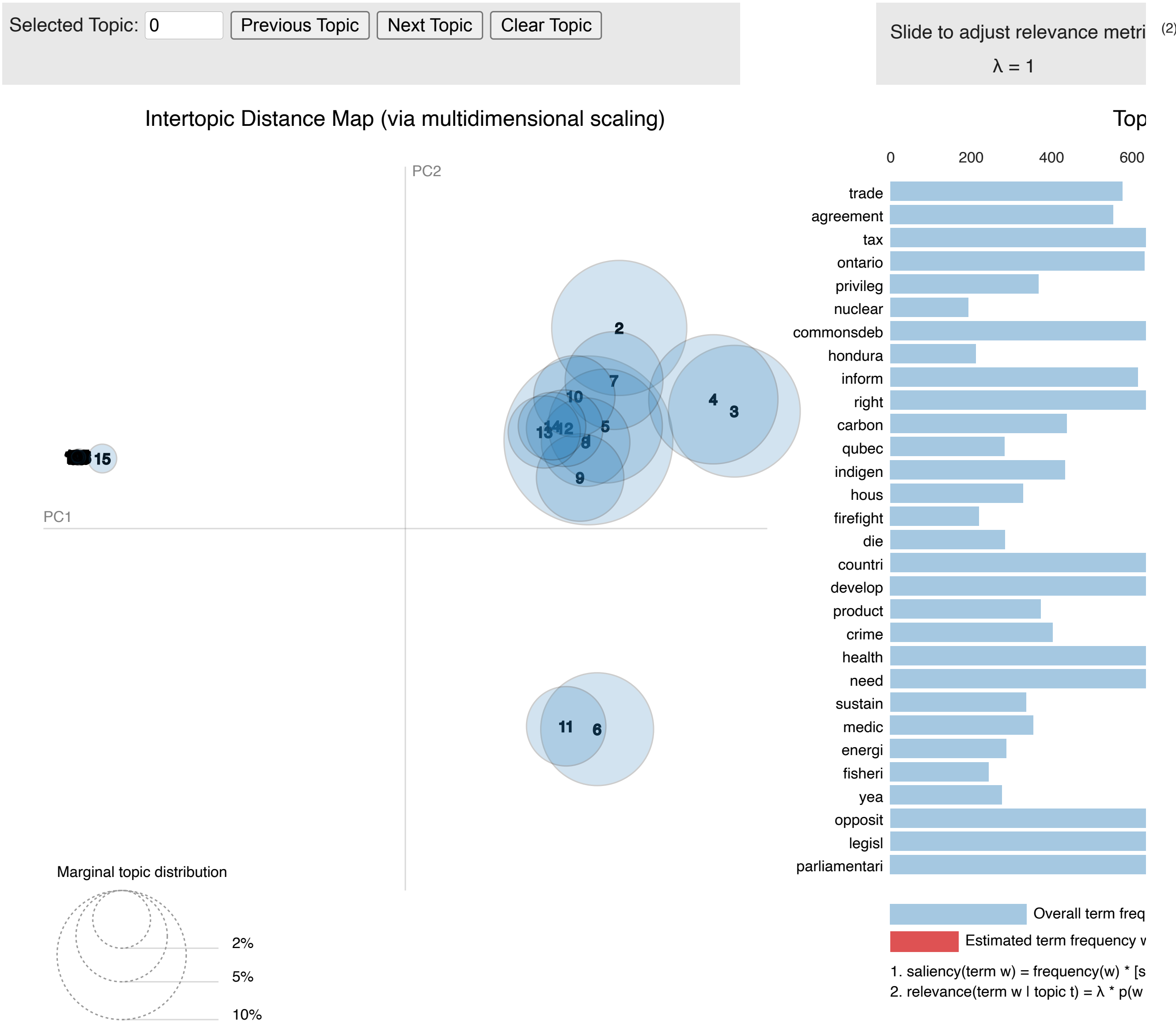
Out[30]:



In [31]:

```python
#Exploring the relevant terms for each topic of the HDP Model
pyLDAvis.enable_notebook()
vis = pyLDAvis.gensim.prepare(hdp_model, corpus, dictionary=dictionary)
vis
```

Out[31]:



Selected Topic: 0
Previous Topic
Next Topic
Clear Topic
Slide to adjust relevance metri
(2)
λ = 1
Intertopic Distance Map (via multidimensional scaling)
Top
PC2
PC1
2
7
10
4
3
14
12
13
5
8
9
15
11
6
Marginal topic distribution
2%
5%
10%
0
200
400
600
trade
agreement
tax
ontario
privileg
nuclear
commonsdeb
hondura
inform
right
carbon
qubec
indigen
hous
firefight
die
countri
develop
product
crime
health
need
sustain
medic
energi
fisheri
yea
opposit
legisl
parliamentari
Overall term freq
Estimated term frequency v
1. saliency(term w) = frequency(w) * [s
2. relevance(term w | topic t) = λ * p(w