SINGAPORE LABOUR MARKET ANALYSIS

[IT8701] Introduction to Programming for Data Science

SNG TIAN HAO, KEITH
1273881F

OVERVIEW

01 Introduction

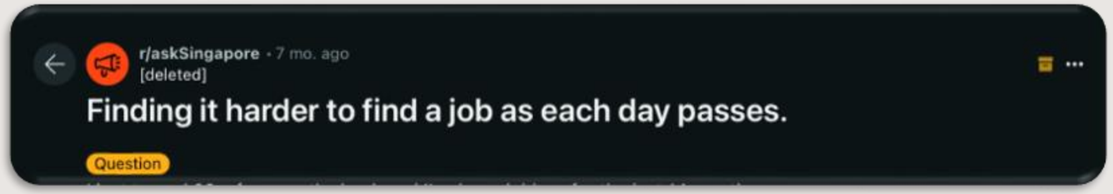
02 Objectives

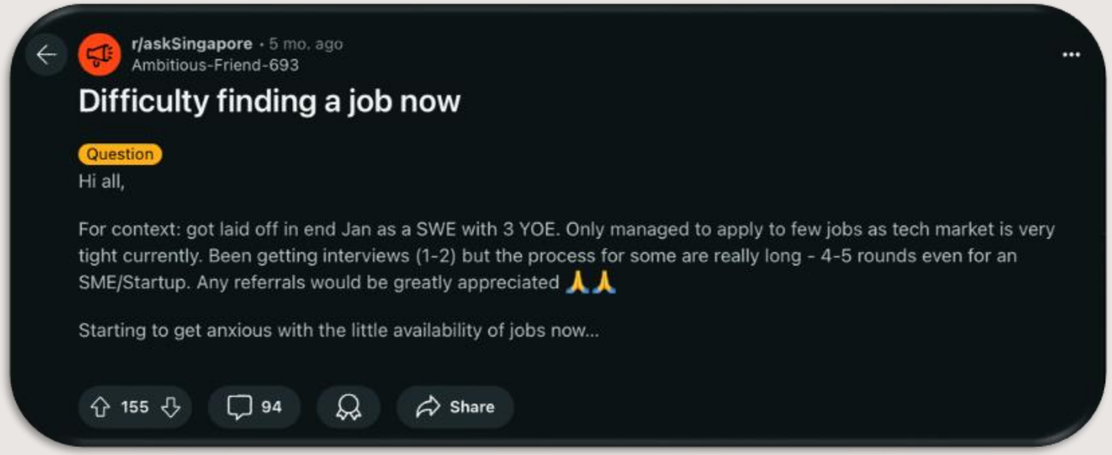
03 Methodology

04 Findings

05 Conclusion

INTRODUCTION





"With an improved economic outlook for 2024, sustained increase in the number of job vacancies, increased hiring optimism among firms over the next quarter, as well as declining retrenchment numbers, we expect the labour market to continue expanding and unemployment rates to remain low"

Ministry of Manpower (MOM)
Q1 2024 Labour Market Report

INTRODUCTION

How Is The Labour Market?

In recent months, there has been growing sentiment that Singapore's economy is facing significant challenges. Concerns about economic downturns, fluctuating markets, and domestic economic pressures have sparked discussions about the state of the job market. Despite these worries, the Ministry of Manpower's (MOM) outlook suggests that growth opportunities may still be on the horizon.

As such, this analysis seeks to assess the current state of Singapore's labour market amidst prevailing concerns. Specifically, we will focus on comparing Singapore's labour market globally and explore job opportunities across various industries and sectors, with the aim of helping job-seekers achieve both job security and satisfaction.

OBJECTIVES

Research Questions

1. **What** is the current state of Singapore's labour market in comparison to other countries?
2. **Which** sectors or industries in Singapore offer the greatest job security in the present economic climate?
3. **Where** can job-seekers look for opportunities within the various sectors or industries?
4. **How** can job-seekers find employment that aligns with their expectations and offers satisfaction?

Assumption

Job-seekers assumed to possess versatile skillsets with relevant qualifications, allowing them to apply for similar job roles across various industries (e.g., working as a data analyst / sales manager in the IT sector versus the petroleum industry)

METHODOLOGY (DATASETS & TOOLS)

Datasets

1. Overall Unemployment Rate, Annual
2. OECD Annual Unemployment Rates
3. World Bank Country and Lending Groups
4. Retrenchment By Industry
5. Average Monthly Recruitment/Resignation Rate by Industry and Occupational Group
6. Occupational Wages within each Major Occupational Group by Industry
7. Average Weekly Paid Hours Worked Per Employee by Industry and Type of Employment
8. Distribution of Full-Time Employees By Annual Leave Entitlement
9. Proportion of Establishments That Provided Non-Statutory Leave by Type
10. Proportion of Establishments Offering Scheduled FWAs-Industry

---

Technologies/Libraries Used

Python

Pandas	Seaborn
Numpy	Plotly
Requests	Matplotlib
Sklearn	MySQLconnector

MySQL

MySQL 8.0.35 for database creation

inserting data into tables, and querying

METHODOLOGY (APPROACH)

Analysis Framework

Job opportunities, benefits, and satisfaction

Job security and attrition

Labour market sensing

Singapore vs Global Unemployment	Retrenchment Rates	Turnover Rates	Wage Comparison	Weekly Hours Worked	Leave Package Comparison	Flexible Working Arrangements (FWA)
Comparison of Singapore's labour market health with other high income countries	Job security analysis using retrenchment rates in the past 10 years by industry and sector	Analysis of job satisfaction and opportunities using latest resignation and recruitment rates in 2023	Comparison of monthly wages across different occupation groups and industries using wage data from 2022	Work-life balance analysis by industry and sector using weekly hours worked data from 2023	Comparison of annual leave package by industry based on 2022 leave data	FWA analysis by industry based on 2022 FWA data

METHODOLOGY (APPROACH)

Analysis Framework

Job opportunities, benefits, and satisfaction

Job security and attrition

Labour market sensing

Singapore vs Global Unemployment	Retrenchment Rates	Turnover Rates	Wage Comparison	Weekly Hours Worked	Leave Package Comparison	Flexible Working Arrangements (FWA)
Comparison of Singapore's labour market health with other high income countries	Job security analysis using retrenchment rates in the past 10 years by industry and sector	Analysis of job satisfaction and opportunities using latest resignation and recruitment rates in 2023	Comparison of monthly wages across different occupation groups and industries using wage data from 2022	Work-life balance analysis by industry and sector using weekly hours worked data from 2023	Comparison of annual leave package by industry based on 2022 leave data	FWA analysis by industry based on 2022 FWA data

METHODOLOGY (APPROACH)

Analysis Framework

Labour market sensing

Job security and attrition

Job opportunities, benefits, and satisfaction

Singapore vs Global Unemployment	Retrenchment Rates	Turnover Rates	Wage Comparison	Weekly Hours Worked	Leave Package Comparison	Flexible Working Arrangements (FWA)
Comparison of Singapore's labour market health with other high income countries	Job security analysis using retrenchment rates in the past 10 years by industry and sector	Analysis of job satisfaction and opportunities using latest resignation and recruitment rates in 2023	Comparison of monthly wages across different occupation groups and industries using wage data from 2022	Work-life balance analysis by industry and sector using weekly hours worked data from 2023	Comparison of annual leave package by industry based on 2022 leave data	FWA analysis by industry based on 2022 FWA data

Extract-Transform-Load (ETL) Workflow

- Downloaded datasets using self-defined function to call APIs (wherever possible)
- Cleaned raw data (minimally) by replacing blanks and nulls with `None` data type to mitigate data integrity errors enforced by MySQL when executing `INSERT INTO` statement

Frequently encountered error during attempts to import data into MySQL!

```
DatabaseError: 1366 (HY000): Incorrect integer value: '-' for column 'RETRENCH_CONTRACT' at row 1
```

```python
# Retrieve data
retrenchment = get_data('d_c794e2ad25c1d3bb7965d13dffd0b411')

# Data cleaning for importing into MySQL
retrenchment.replace('-', None, inplace=True)
```

Replace NULL values as None type

```python
# Retrieve data
wfh = get_data('d_9190c1b4524b6361ce6afdffd39fa94e')

# Data cleaning for importing into MySQL
wfh.replace({'-': None, 'na': None, 's': None}, inplace=True)
```

Different characters to replace to ensure data cleanliness and integrity

```python
def get_data(resource_id):
    """
    Returns data.gov.sg dataset through use of OpenAPI query.

    Args:
        resource_id (string): Resource ID string pointing to the API endpoint

    Returns:
        pandas dataframe: Dataframe of data.gov.sg dataset
    """
    # Define key arguments for data retrieval and formatting
    base_url = 'https://data.gov.sg/api/action/datastore_search'
    offset = 0
    df = []

    while True:
        # Set url and parameters for API endpoint
        parameters = {
            'resource_id': resource_id,
            'offset': offset # define offset
        }
        # Retrieve data
        response = requests.get(base_url, params=parameters)
        # Check if request is successful
        if response.status_code == 200:
            # Retrieve json text
            response_dict = response.json()
            # Check if at least 1 record
            if len(response_dict['result']['records']) > 0:
                # Normalize and append records to list, df
                df_temp = pd.json_normalize(response_dict['result']['records'])
                df.append(df_temp)
                # Continue the loop and increase offset to retrieve the next 100 records
                offset += 100
            # Repeat retrieval of every 100 records until the request returns 0 records - break loop
            else:
                break
        # If request not successful, print error message with status code
        else:
            print(f'The request failed and returned status code: {response.status_code}')

    # Concatenate list of dataframes
    df = pd.concat(df, ignore_index=True)
    # Return df
    return df
```

Custom function to call API and save data into pandas data frame

Define API URL (provided on data.gov.sg)

Specify end-point for individual datasets

Retrieve data

Parse JSON data into pandas data frame

Iterate until all available rows have been read and saved

Concatenate and save data into data frame

METHODOLOGY (DATA PRE-PROCESSING)

Database Schema Creation

- Created MySQL database schema to facilitate loading of downloaded tables

```
# Create database schema if schema does not yet exist
query = '''
CREATE DATABASE IF NOT EXISTS SGMARKET
'''

try:
    cursor.execute(query)
    con.commit()
except:
    print('Unexpected error:', sys.exc_info()[0])
    print(sys.exc_info()[1])
finally:
    cursor.close()
    con.close()
```

Ensures that I can re-run the code without error

Importing of Data Tables into MySQL Database

- After cleaning of datasets to ensure data integrity based on constraints defined in `CREATE TABLE` statement, data loaded using `INSERT INTO` statement
- Once loaded, test query is run to extract table from MySQL in Python using `SELECT` statement and result set is visually inspected for validation

```
# Retrieve data
sg_unemployment = get_data('d_e3598914c86699a9a36e68190f78c59a')

# Create table
query = '''
CREATE TABLE IF NOT EXISTS SG_UNEMPLOYMENT (
    ID INT NOT NULL,
    YEAR INT NOT NULL,
    RESIDENTIAL_STATUS VARCHAR(20) NOT NULL,
    UNEMPLOYMENT_RATE FLOAT(10) NOT NULL,
    PRIMARY KEY (ID)
)
'''

try:
    cursor.execute(query)
    con.commit()
except:
    print('Unexpected error:', sys.exc_info()[0])
    print(sys.exc_info()[1])

# Insert data into table
for index, row in sg_unemployment.iterrows():
    data = {
        'id': row['_id'],
        'year': row['year'],
        'residential_status': row['residential_status'],
        'unemployment_rate': row['unemployment_rate']
    }

    # %(key)s: This syntax is used for string formatting where key is a placeholder
    # that will be replaced by the value associated with key in a dictionary.
    query = '''
        INSERT INTO SG_UNEMPLOYMENT (
            ID,
            YEAR,
            RESIDENTIAL_STATUS,
            UNEMPLOYMENT_RATE
        )
        VALUES (
            %(id)s,
            %(year)s,
            %(residential_status)s,
            %(unemployment_rate)s
        )
    '''
    cursor.execute(query, data)
    con.commit()

# View data
query = '''
SELECT * FROM SG_UNEMPLOYMENT
'''

pd.read_sql(query, con).head()
```

Define and create table in MySQL for loading dataset

Specify attribute data types after inspecting raw data

Execute SQL query through Python to create table

Iterate through each row to retrieve data for inserting into table

Insert query to run in MySQL

Execute SQL query through Python to insert values

Check that data has been successfully inserted by querying data and doing a quick inspection

METHODOLOGY (DATA CLEANING & MANIPULATION)

Data Cleaning

```
# Extract 2022 other leave data
query = '''
SELECT * FROM OTHER_LEAVE
WHERE YEAR = 2022
'''
other_leave = pd.read_sql(query, con)

# Data cleaning
other_leave.fillna(0, inplace=True)
other_leave_melt = other_leave.melt(id_vars=['INDUSTRY1', 'INDUSTRY2', 'INDUSTRY3'],
                                    value_vars=['COMPASSIONATE_LEAVE', 'MARRIAGE_LEAVE', 'UNPAID_LEAVE_MORETHAN_1MTH', 'UNPAID_LEAVE_LESSTHAN_1MTH', 'STUDY_LEAVE', 'CHILD_SICK_LEAVE', 'PARENT_CARE_LEAVE'],
                                    var_name='LEAVE_TYPE')
other_leave_group = other_leave_melt.groupby(['INDUSTRY1', 'INDUSTRY2', 'LEAVE_TYPE'])['value'].mean().reset_index()
other_leave_pivot_cleaned = pd.pivot(data=other_leave_group, index=['INDUSTRY1', 'INDUSTRY2'], columns='LEAVE_TYPE', values='value').reset_index()
```

- Fill missing NAs with 0 to make sure means are calculated correctly
- Melt wide format data frames into long format for easier manipulation
- Re-pivot into long format for specific analysis / visualisation

- To facilitate analysis, datasets were cleaned using `Pandas` after extracting the necessary from MySQL
- Common issues encountered:
  - `NaNs` which affects calculation of mean
  - Raw data often in wide format (not friendly for visualisation)
  - Tables with common columns unable to be merged due to inconsistent casing/punctuation

```
# Update join keys in other_leave_pivot_cleaned as they are slightly different from annual_leave table
other_leave_pivot_cleaned['INDUSTRY2'].replace('electronic and computer products', 'electronic, computer and optical products', inplace=True)
other_leave_pivot_cleaned['INDUSTRY2'].replace('fabricated metal products and machinery', 'fabricated metal products, machinery and equipment', inplace=True)
```

Data Manipulation

- Joining relevant data tables for comprehensive analysis
  - e.g., Left join Annual Leave and Other Leave tables on `INDUSTRY` column to analyse overall leave package
- Aggregating data to calculate means at different levels for analysis

Annual leave data | Other leave data

	INDUSTRY1	Join key INDUSTRY2	14 days & below	15 to 21 days	over 21 days	CHILD_SICK_LEAVE	COMPASSIONATE_LEAVE
0	construction	construction	90.6	8.7	0.7	50.9	78.2
1	manufacturing	electronic, computer and optical products	51.7	44.8	3.6	35.1	100.0
2	manufacturing	fabricated metal products, machinery and equip...	70.4	26.6	3.0	47.8	93.7
3	manufacturing	food, beverages and tobacco	78.3	17.4	4.3	46.7	84.3
4	manufacturing	other manufacturing industries	56.5	39.6	4.0	46.4	93.2

```
# Merge annual_leave and other_leave for analaysis
df = pd.merge(annual_leave_pivot_cleaned, other_leave_pivot_cleaned, on='INDUSTRY2', how='left', suffixes=('', '_OL'))
```

```
turnover_group = turnover.groupby(['YEAR', 'INDUSTRY1', 'INDUSTRY2']).agg(RECRUITMENT_MEAN = ('RECRUITMENT', 'mean'),
                                                                           RESIGNATION_MEAN = ('RESIGNATION', 'mean'),
                                                                           TURNOVER_MEAN = ('TURNOVER_RATE', 'mean')).reset_index()
```

Calculation of means for various metrics for each year, and industry

Dimensionality Reduction

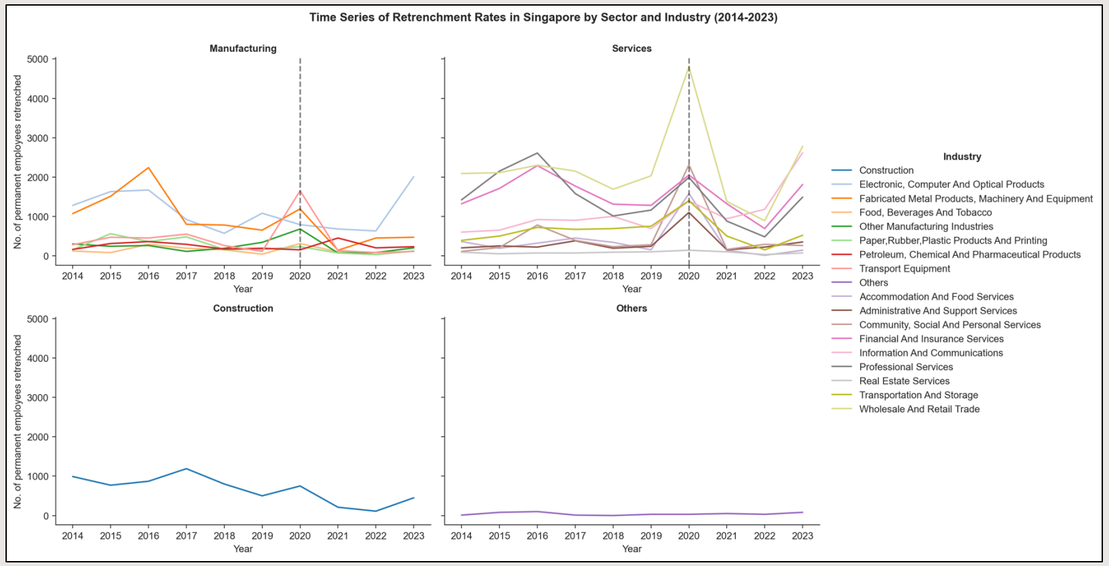
- Used Principal Component Analysis (PCA) to reduce number of dimensions (fields)
- Allows for plotting of data on a 2-D axis for analysis while preserving information from raw data

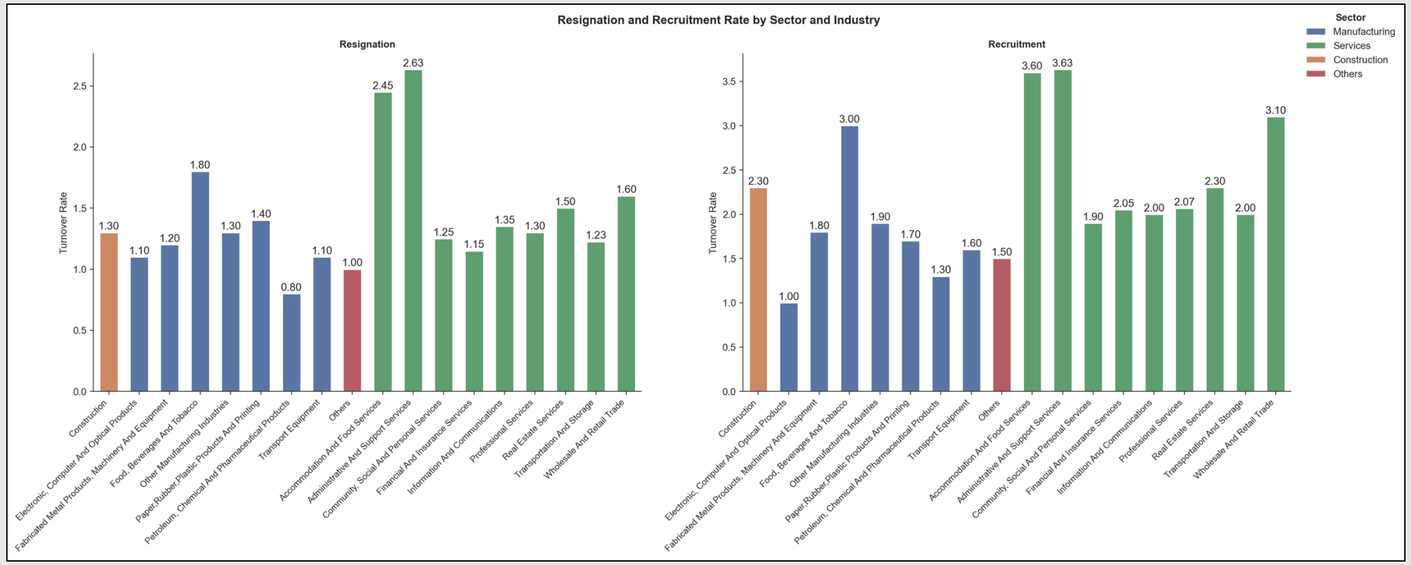
```
# Normalise and apply dimensionality reduction to 2 dimensions only for plotting on scatterplot
pca = PCA(n_components=2)
df_scaled = StandardScaler().fit_transform(df_tidy)
df_pca = pca.fit_transform(df_scaled)
```

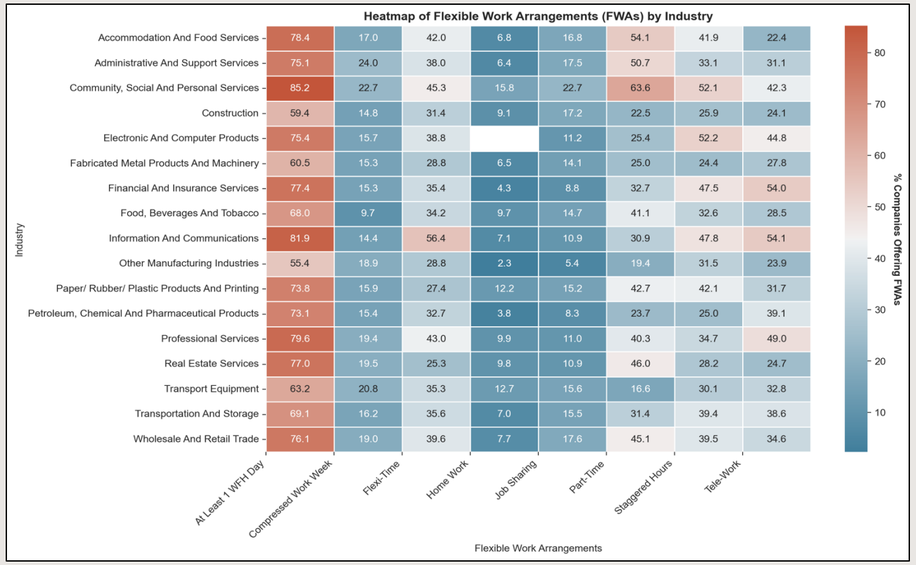
METHODOLOGY (ANALYSIS)

Data Visualisation

- Used `Seaborn`, `Plotly` to analyse different facets of the labour market
- Types of charts used in this analysis:
  - **Line chart** (for time series)
  - **Pie chart** (for comparison of proportions)
  - **Bar chart** (for comparison of means across different categories)
  - **Scatter plot** (for PCA analysis)
  - **Heat map** (for comparison of multiple dimensions across different categories)



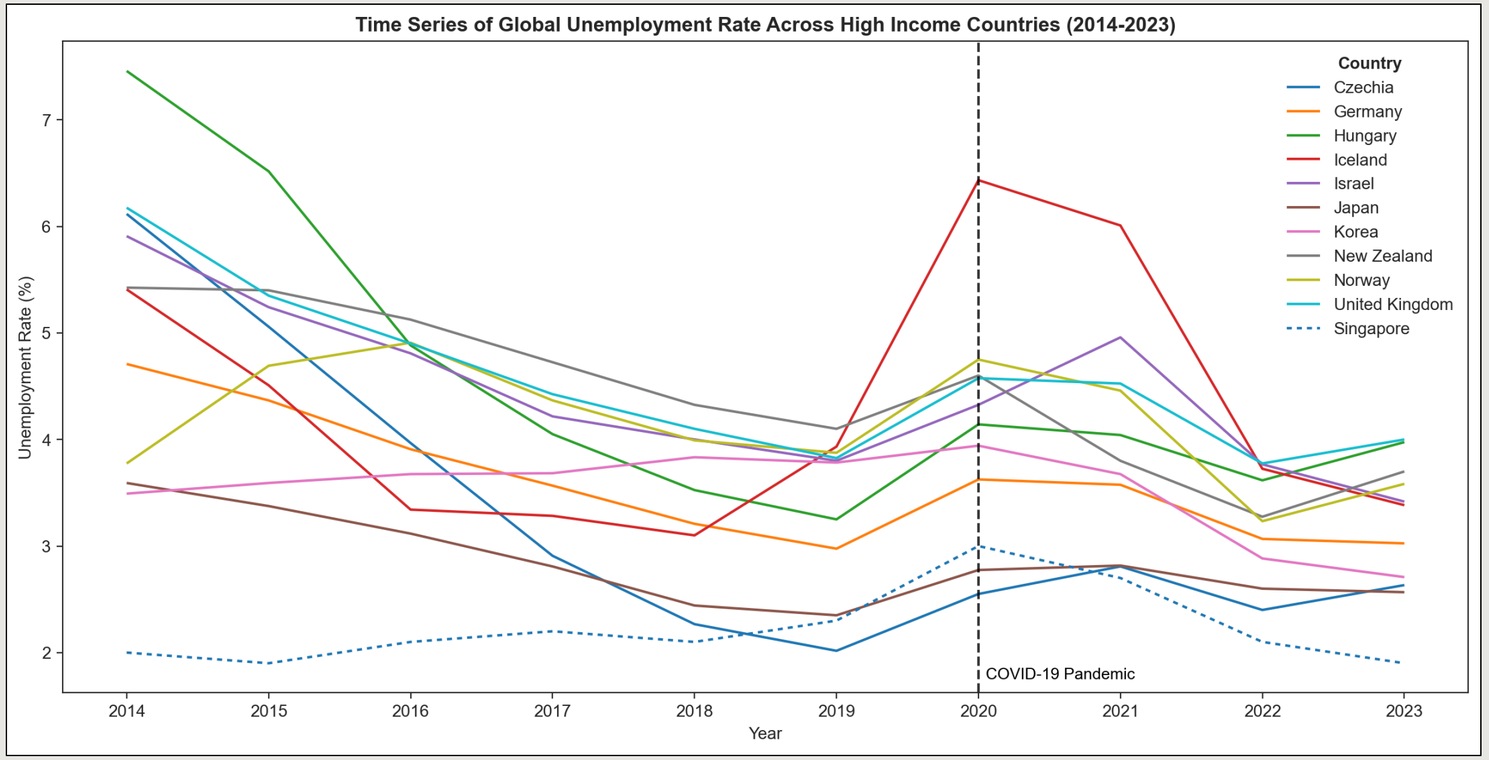




What is the current state of Singapore's labour market in comparison to other countries?

FINDINGS (TOPLINE LABOUR MARKET COMPARISON)

Relative to the top 10 high income countries with the lowest average unemployment rates, Singapore consistently has one of the lowest unemployment rates



Which sectors or industries in Singapore offer the greatest job security in the present economic climate?

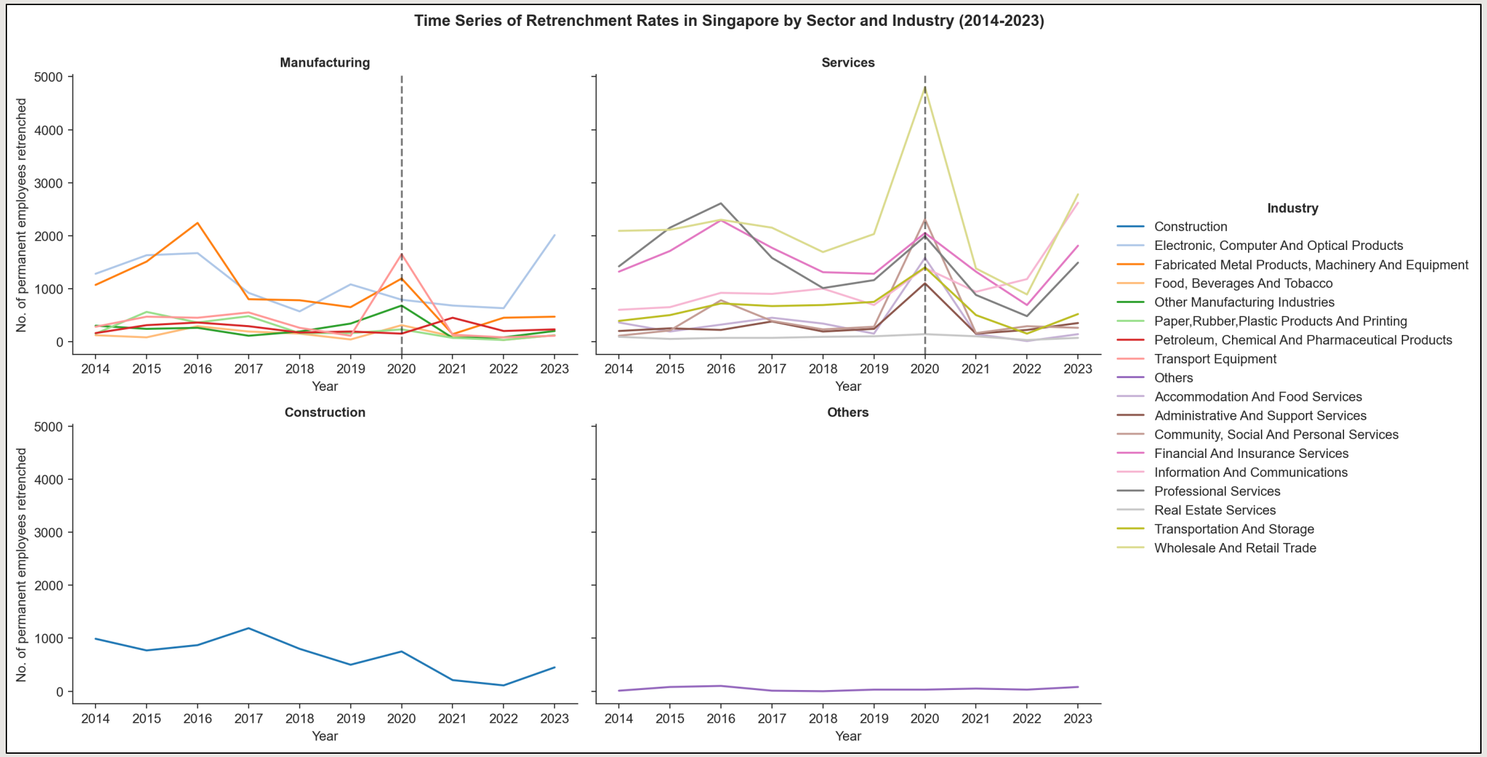
FINDINGS (JOB SECURITY)

Analysis

Time series to allow job-seekers to identify industries that are thriving or not doing well

Insights

- Certain industries continue to see rising retrenchment levels, possibly indicating the decline (either short/long-term) of these industries
- Most of the decline appears to be in the Services sector (IT, Wholesale & Retail Trade, Finance & Insurance industries)
- Spike in 2020 due to COVID-19



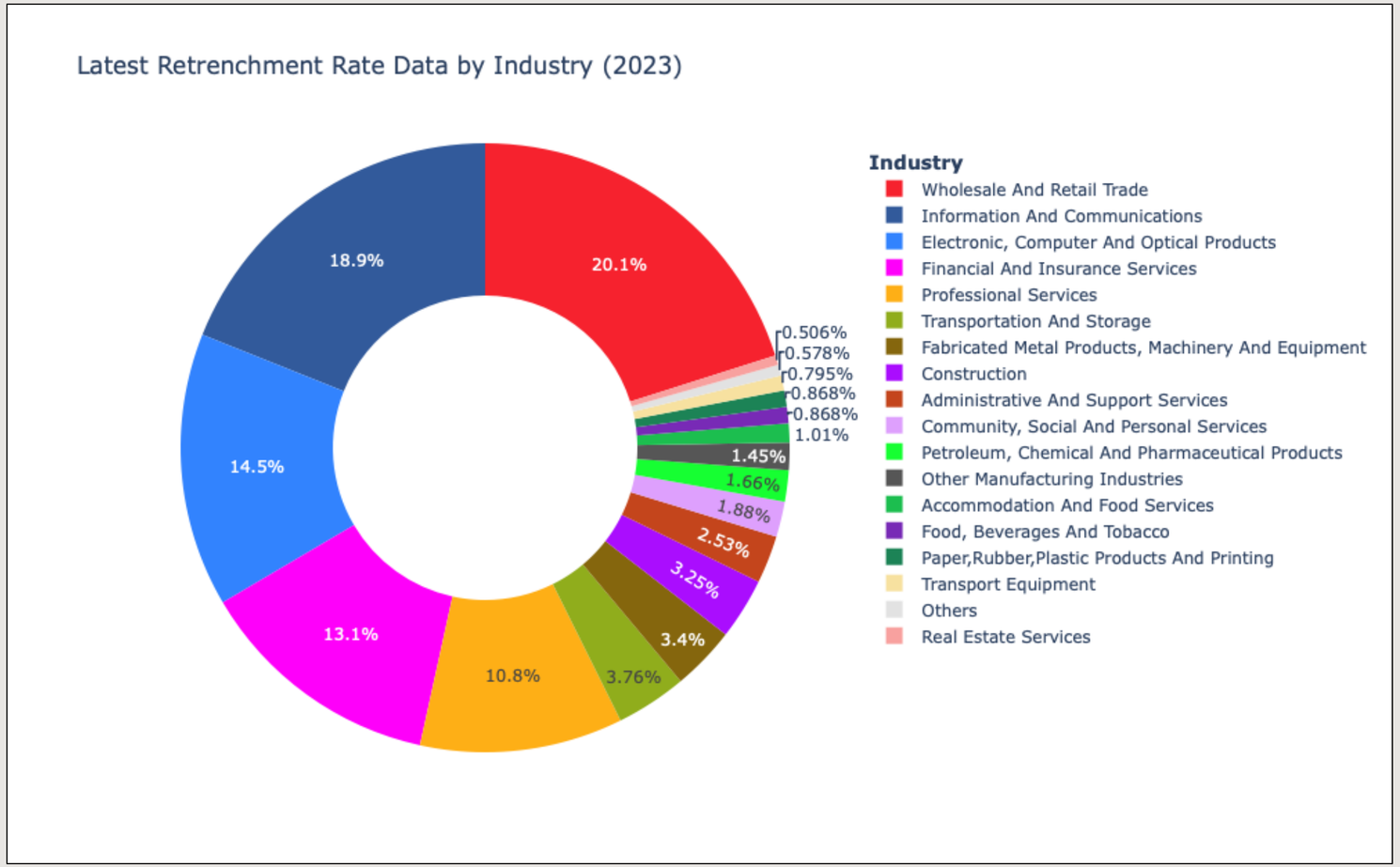
FINDINGS (JOB SECURITY)

Analysis

Pie chart to examine proportion and absolute retrenchment of each industry in latest year

Insights

- With a focus on immediate job security, values from 2023 reflect current job market condition across industries
- Majority of more ‘stable’ industries are within the Manufacturing sector
- Within the Services sector, industries such as Accoms. & Food Services; Admin & Support Services; Community, Social & Personal Services are doing better



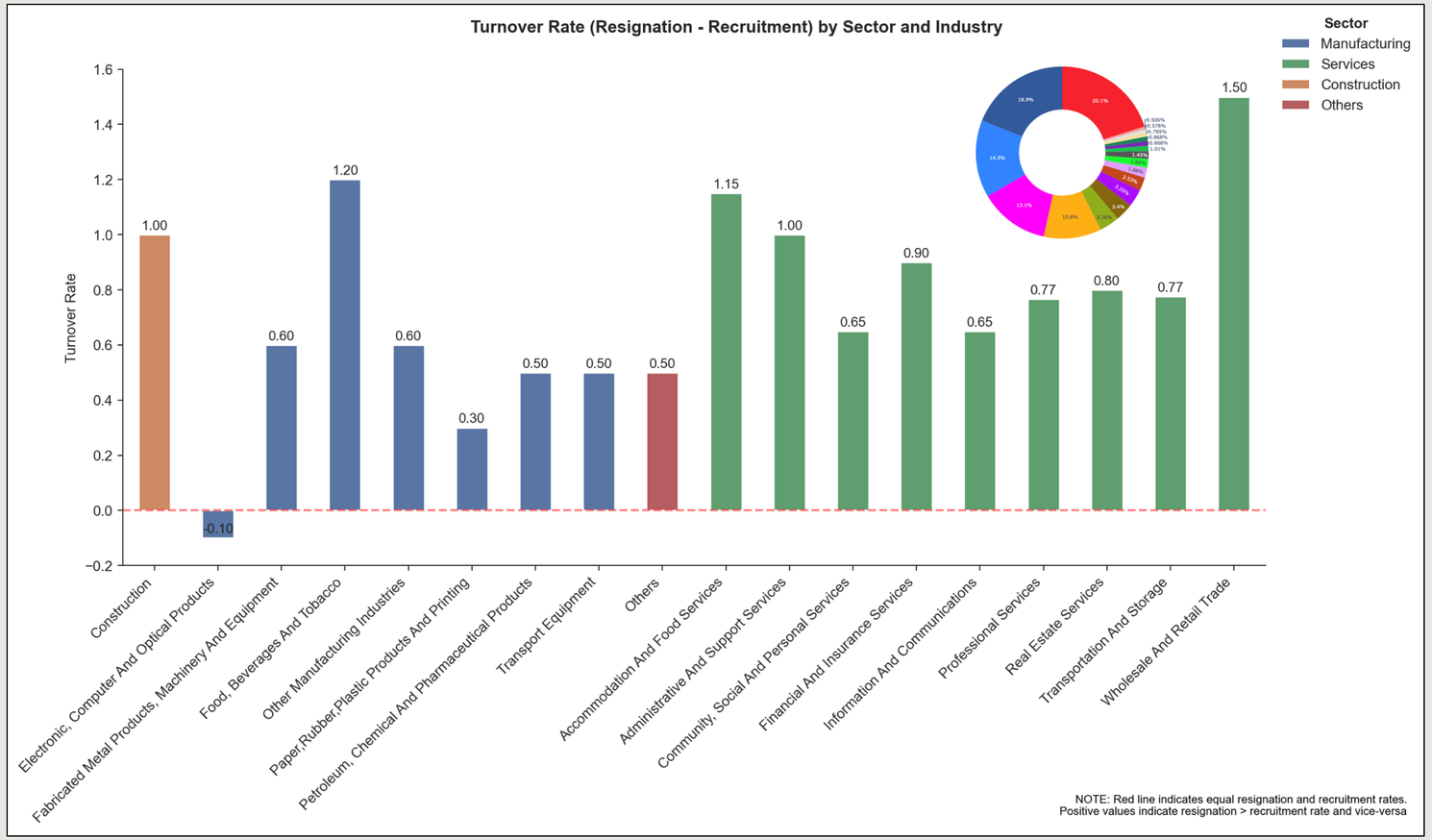
Where can job-seekers look for opportunities within the various sectors or industries?

Analysis

Comparison of latest turnover rate across industries to elucidate job opportunities

Insights

- Resignations and recruitment signals job availability, consider overall turnover rate to guide job search (positive = opportunities available)
- Wholesale & Retail Trade has low resignation but high recruitment, indicating industry growth
- However, previous analysis shows high retrenchment, implying restructuring within industry — reducing redundancy, focus on more strategic roles



Caveat: Important to note that positive turnover (i.e., high recruitment) not entirely indicative of residential employment. Job-seekers should be mindful of prevailing market conditions and labour regulations / laws which are not considered in this analysis

How can job-seekers find employment that aligns with their expectations and offers satisfaction?

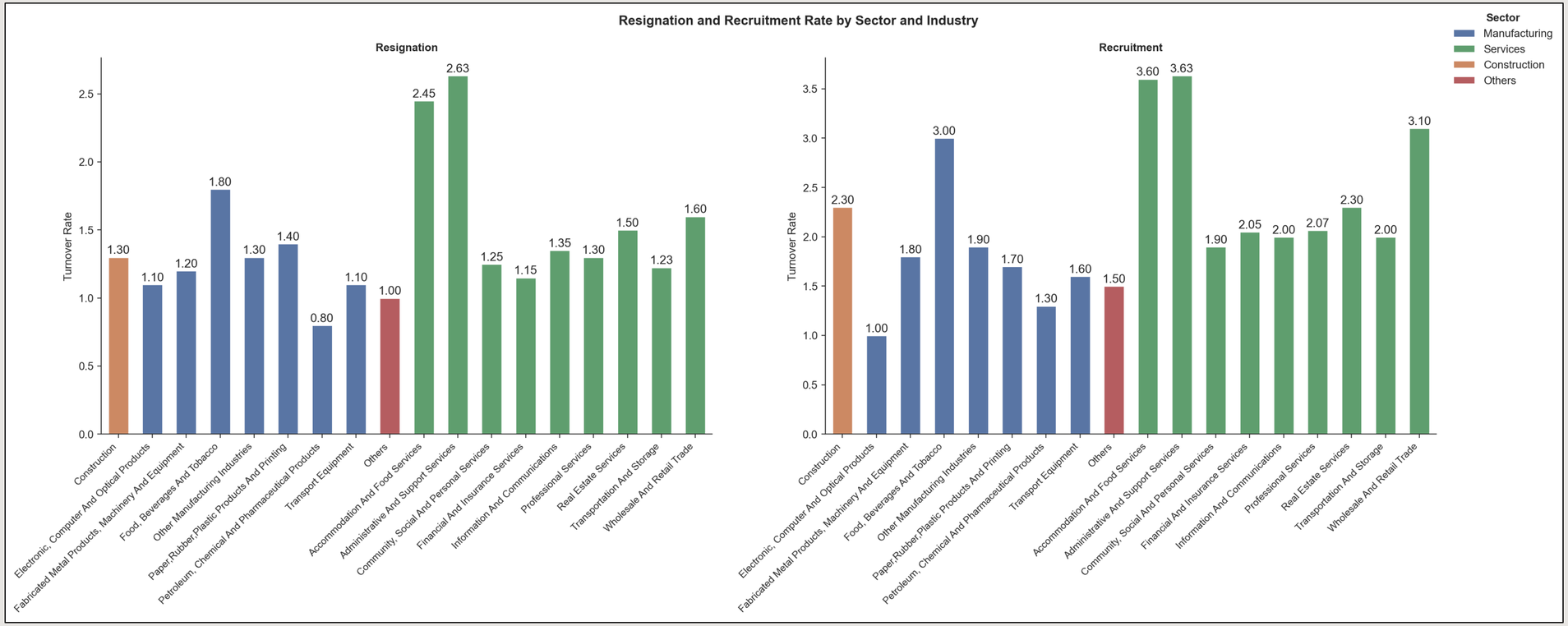
FINDINGS (JOB SATISFACTION)

Analysis

Breakdown of turnover into resignation and recruitment across industries for granularity as resignations serve as proxy for satisfaction, indicating labour-management relations

Insights

- High correlation between resignation and recruitment ($r = 0.913$, $p \approx 0.00$)
- Accoms. & Food Services and Admin. & Support Services industries indicative of low job satisfaction
- Other than resignations, important to consider other indicators



Caveats:

- Important to note that positive turnover (i.e., high recruitment) not entirely indicative of residential employment. Job-seekers should be mindful of prevailing market conditions and labour regulations / laws which are not considered in this analysis
- Low resignations not entirely indicative of high satisfaction. Job-seekers to keep in mind that there are other indicators of satisfaction which are not explored in this analysis.

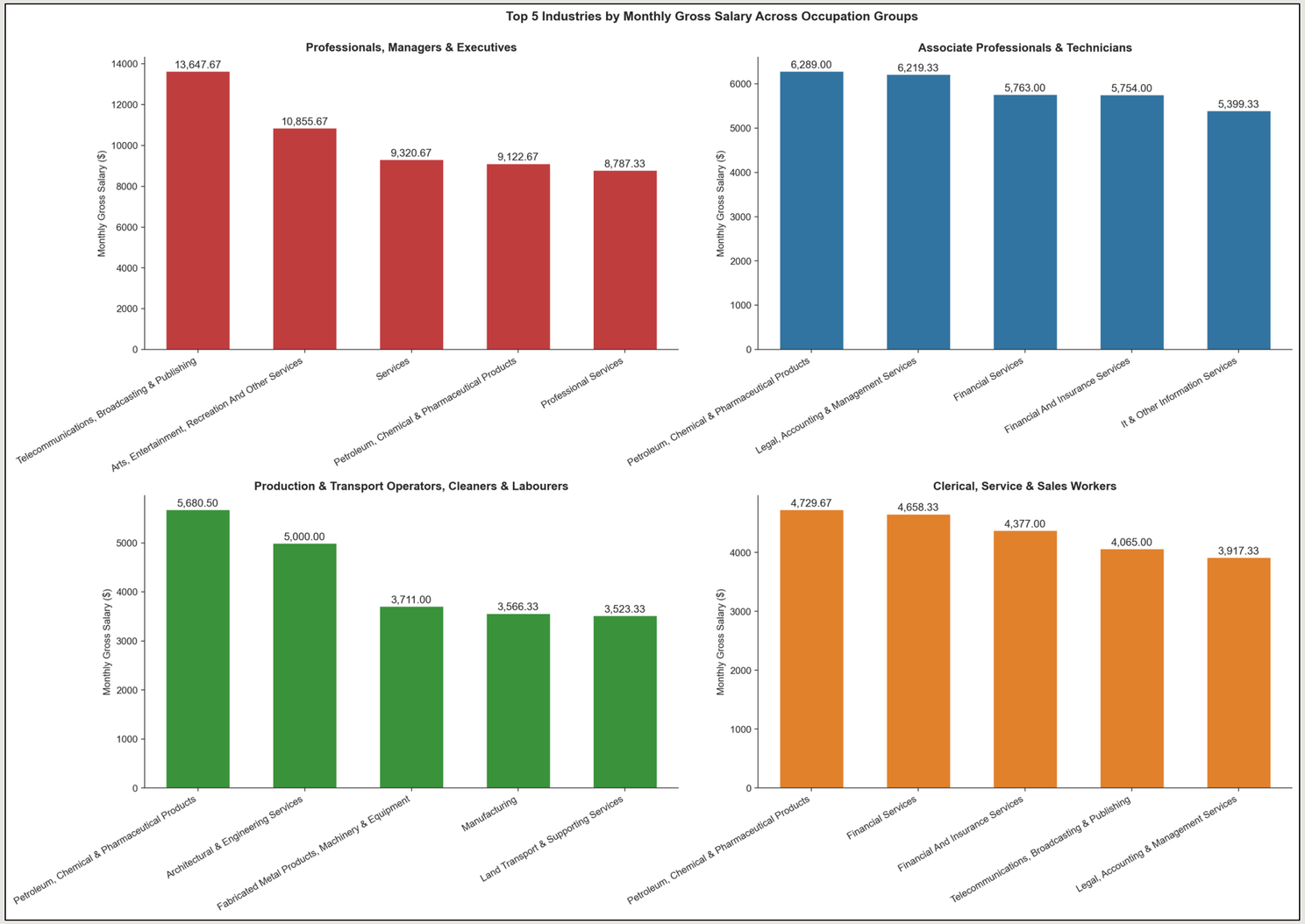
FINDINGS (WAGES)

Analysis

Comparison of top-earning industries across occupation groups to identify opportunities

Insights

- PMEs have highest wages generally, especially from Telecommunications, Broadcasting & Publishing industry
  - Sales Manager
  - ICT Sales & Services Professional
  - Systems Analyst
- Across remaining occupation groups, Petroleum industry the most lucrative
  - Engineering Technician
  - Supervisor / Foreman
  - Office / Information / Production Clerk

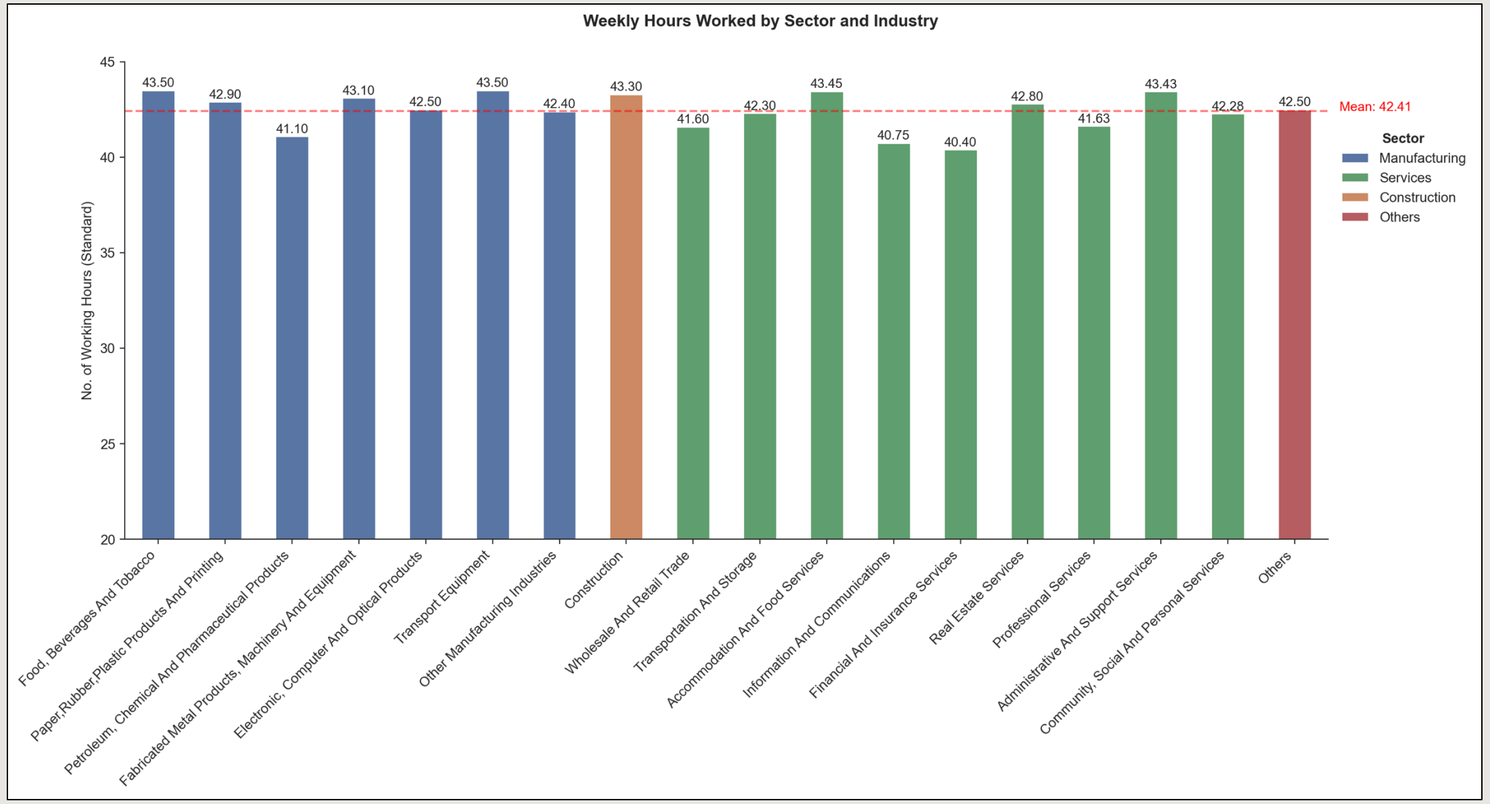


Analysis

Comparison of weekly working hours across industries and sectors to work-life balance

Insights

- Fairly consistent working hours across industries, Services sector has the lowest mean working hours (42.1 hours)
- E.g., IT, Financial & Insurance Services industries work 2 hours less than average
- Transport Equipment, Construction, and Administrative & Support Services industries work 1 hour more than average



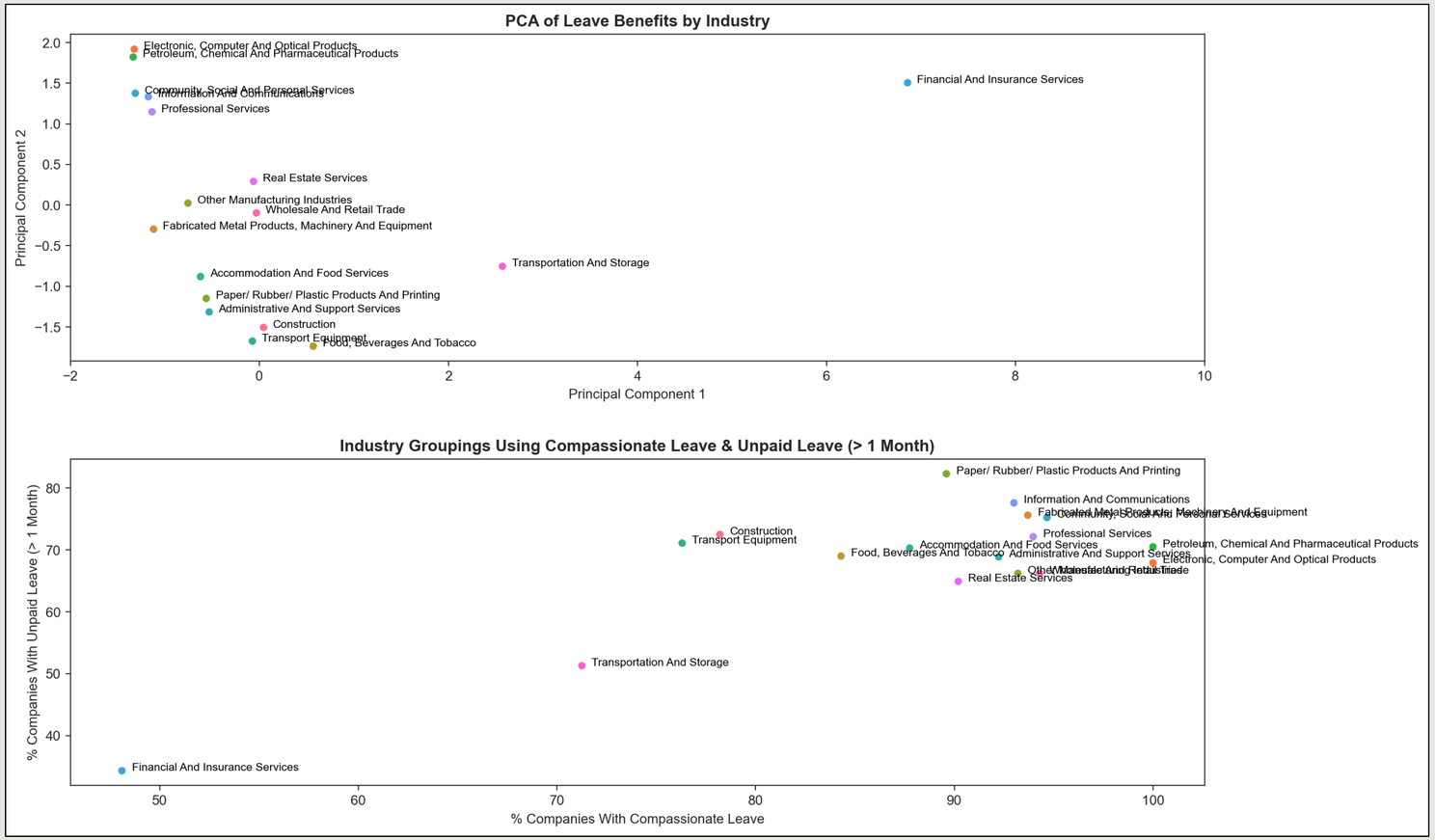
FINDINGS (LEAVE PACKAGE)

Analysis

PCA simplifies information on different leave types across industries into two principal components (PCs) for easy comparison of relative industry groupings by leave package

Insights

- Compassionate and unpaid leave biggest differentiators, can be used as a start-point to examine differences in leave packages
- E.g., Financial & Insurance Services industry low compassionate and unpaid leave but also highest annual leave compared to mean
- Job-seekers can use this approach to compare leave package across industries based on groups



	over 21 days	CHILD_SICK_LEAVE	COMPASSIONATE_LEAVE	MARRIAGE_LEAVE	PARENT_CARE_LEAVE	STUDY_LEAVE	UNPAID_LEAVE_MORETHAN_1MTH
INDUSTRY MEAN	9.32	41.07	87.1	72.89	29.33	45.67	67.99
Financial And Insurance Services	63.70	10.95	48.1	44.95	21.60	34.55	34.30

Analysis

Comparison of FWAs across industries to determine industries with greatest flexibility

Insights

- Most companies in Singapore offer WFH
- Compressed work week not yet the norm, with full-time home-working and job-sharing being rare across all industries
- Part-time work prevalent in Services sector
- Staggered hours and tele-work (remote working) considerably higher in tertiary industries such as IT, Financial and Insurance Services, Electronic & Computer Products

KEY TAKEAWAYS

1

Singapore is doing well compared to other countries

Despite concerns and fears, data shows Singapore's job market outperforms other countries (things could be worse)

2

Job-seekers must balance job security and satisfaction expectations

In a tight job market, job-seekers should prioritise job security and be ready to seize opportunities when conditions improve

3

IT sector (us) probably not doing very well, benefits are good though

2nd highest retrenchment levels in 2023, little resignations and thin recruitment opportunities ☹

CONCLUSION

What Now?

Despite economic challenges, Singapore’s job market demonstrates resilience and performs well compared to other countries. While the pursuit of job benefits is important, job-seekers need to carefully and strategically balance with job security in both the short and long-term.

While the labour market within Singapore may be tight now, the potential for growth opportunities exists. Staying adaptable and prepared will be crucial for capitalising on future opportunities when markets recover and rebound.

THANK YOU