A5G TECHNOLOGIES WILL DOUBLE THE GROWTH OF TECHNOLOGY AS WELL AS OUR COUNTRY'S GDP GROWTH OF COUNTRY BY 2 TIMES. ASSESS THIS CLAIM STATISTICALLY?

A PROJECT REPORT

Submitted by

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of

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in

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

BONAFIDE CERTIFICATE

Certified that this project report "5G TECHNOLOGIES WILL DOUBLE THE GROWTH OF TECHNOLOGY AS WELL AS OUR COUNTRY'S GDP GROWTH OF COUNTRY BY 2 TIMES. ASSESS THIS CLAIM STATISTICALLY?" is the bonafide work of J.B.VARSHA DEVI (19S038), Fifth Semester student of 5 Year Integrated MSc (Data Science) Degree Programme, who carried out the project under my supervision from 9.12.2021 to 03.01.2022 during the academic year 2021-2022.

The project report was submitted to the department on 06/01/2022 for evaluation/assessment.

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LIST OF ABBREVIATIONS:

S.No.	Abbreviation/ Acronym	Description
1.	GDP	Gross Domestic Product

1. Introduction:

This project is about examining how 5G technology will affect our country's GDP growth with respect to 4G technology. The project title states that if 5G technology comes into existence it would increase India's technology as well as *India's GDP growth* by *two times* that of 4G technology.

This should be examined statistically using python programming. Python provides a wide range of modules and libraries that makes assessment easier and effective. Pandas and Numpy are the predominantly used libraries in this project.

In this evolving world there is always need of improvement in technology and innovation and this pandemic has fueled the need of higher technologies as there is huge shift to distance learning. 5G technology could be a solution as it is meant to deliver higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users.5G technology in the recent years has became an important component in every sectors.

5G technology benefits number of sectors including:

- Manufacturing
- Energy and utilities
- Agriculture
- Retail
- Financial services
- Media and entertainment
- Healthcare
- Transportation
- AR/VR (augmented reality and virtual reality)
- Insurance
- Education
- Cloud and Edge computing
- Tourism

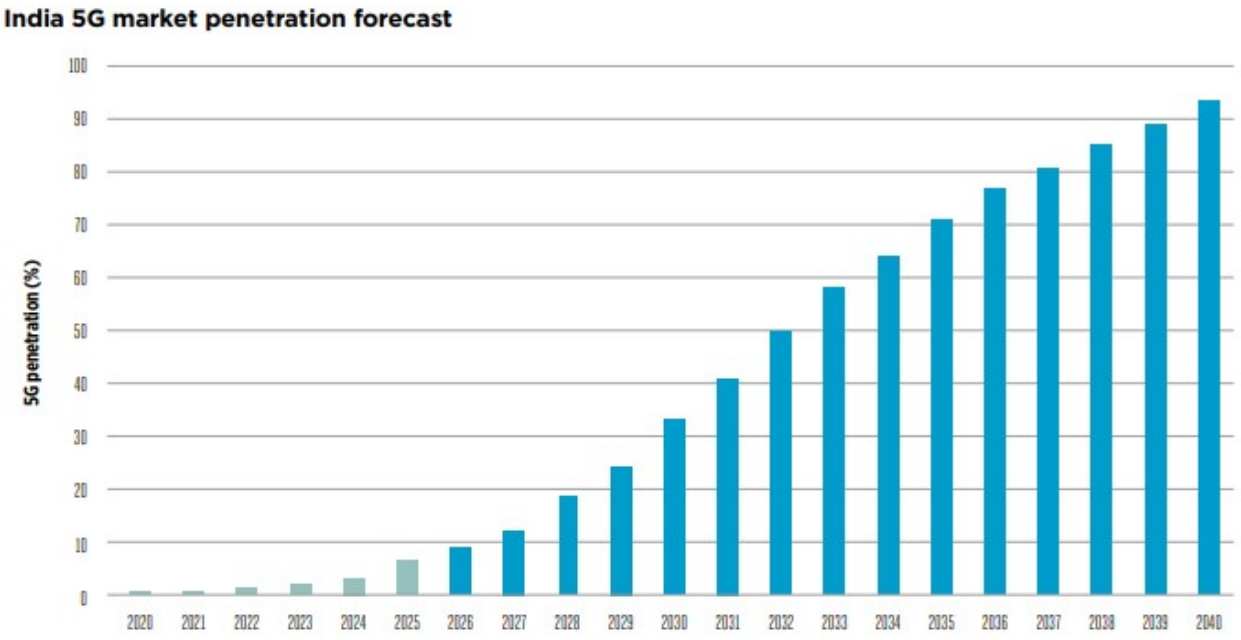


Fig. 1.1: India 5G market penetration forecast.

A newspaper article states that "Investments in key components of 5G network on mid or low-band spectrum with pan-India coverage is estimated to be about *Rs 1.3-2.3 lakh crore*, according to a report by Motilal Oswal Financial Services."

Article link:https://www.business-standard.com/article/economy-policy/india-s-5g-rollout-investment-plan-to-cost-govt-rs-1-3-2-3-trn-report-120101901052_1.html

Thus, it is crucial to estimate the GDP contribution of 5G technologies before setting up. Also, every technology has its drawbacks therefore it is important to assess its impact before setting up.

2. Objective:

Problem Statement:

5G TECHNOLOGIES WILL DOUBLE THE GROWTH OF TECHNOLOGY AS WELL AS OUR COUNTRY'S GDP GROWTH OF COUNTRY BY 2 TIMES. ASSESS THIS CLAIM STATISTICALLY?

5G technology has numerous applications and use cases but it is necessary to find out the extent to which it is useful. Thus, in this project 5G technology is compared with 4G technology in terms of GDP growth.

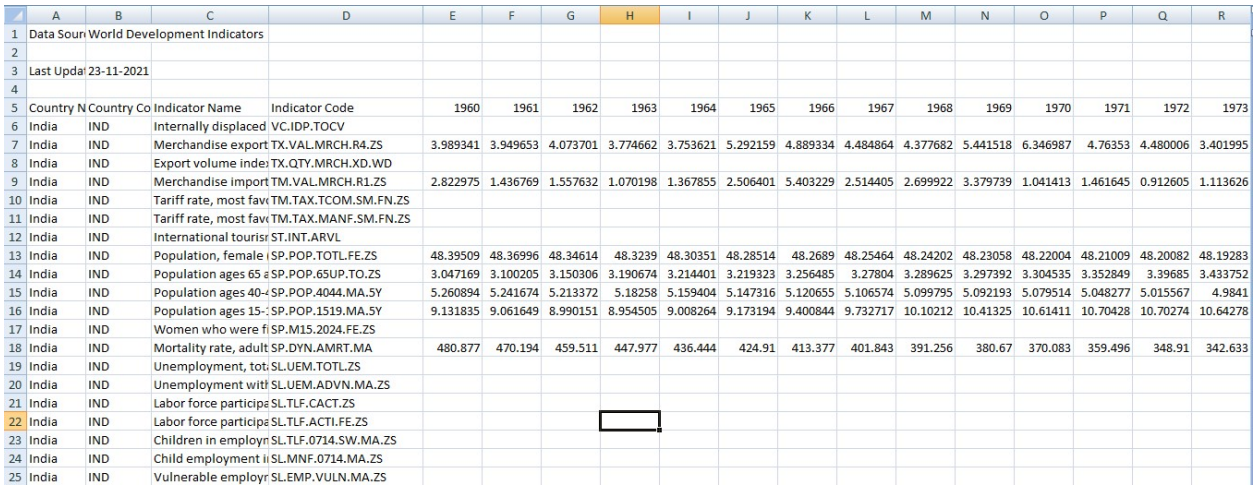
The sector-wise GDP data for 4G technology is taken from open source website. Since there is no existence of 5G dataset, Google survey forms were created and responses were collected. Using this dataset weights were introduced for individual sectors and for responses. Using this dataset were created. Then growth percentage of 5G dataset is calculated . The growth percentage of GDP is obtained.

The growth percentage is important in analyzing the advantage of introducing 5G technology. *GDP growth percentage* gives an overall idea about the economic growth because of 5G installation. Thus, the main objective of this project to statistically claim the contribution of 5G towards India's GDP.

3. Description of The Problem:

The GDP dataset for 4G technology is obtained from open source website.

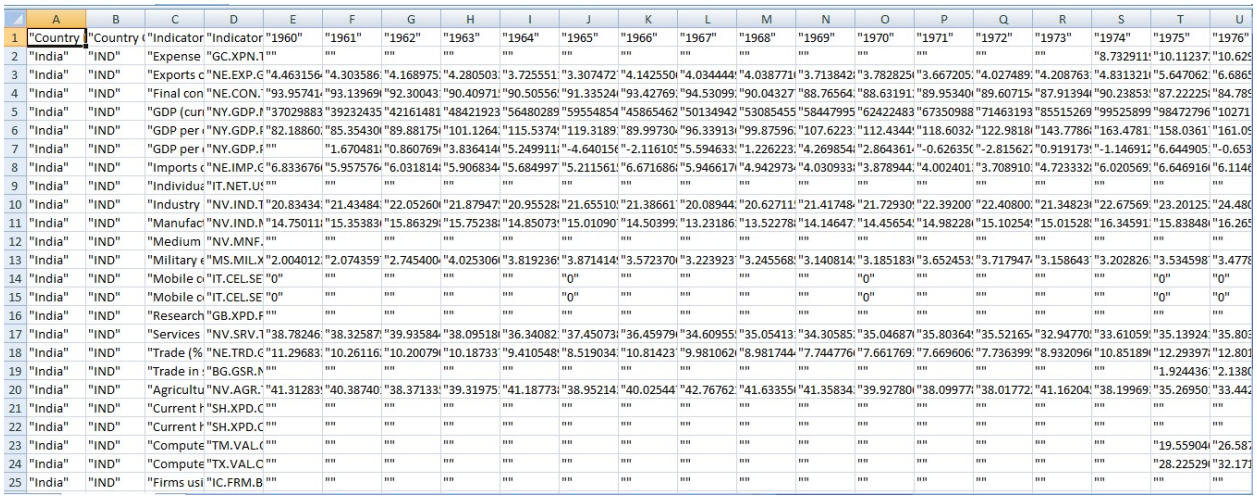
Dataset link:https://data.worldbank.org/country/india



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Data Sour	World Development Indicators																
2																		
3	Last Upda	23-11-2021																
4																		
5	Country N	Country Co	Indicator Name	Indicator Code	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
6	India	IND	Internally displaced	VC.IDP.TOCV														
7	India	IND	Merchandise export	TX.VAL.MRCH.R4.ZS	3.989341	3.949653	4.073701	3.774662	3.753621	5.292159	4.889334	4.484864	4.377682	5.441518	6.346987	4.76353	4.480006	3.401995
8	India	IND	Export volume inde	TX.QTY.MRCH.XD.WD														
9	India	IND	Merchandise import	TM.VAL.MRCH.R1.ZS	2.822975	1.436769	1.557632	1.070198	1.367855	2.506401	5.403229	2.514405	2.699922	3.379739	1.041413	1.461645	0.912605	1.113626
10	India	IND	Tariff rate, most fav	TM.TAX.TCOM.SM.FN.ZS														
11	India	IND	Tariff rate, most fav	TM.TAX.MANF.SM.FN.ZS														
12	India	IND	International tourist	ST.INT.ARVL														
13	India	IND	Population, female	SP.POP.TOTL.FE.ZS	48.39509	48.36996	48.34614	48.3239	48.30351	48.28514	48.2689	48.25464	48.24202	48.23058	48.22004	48.21009	48.20082	48.19283
14	India	IND	Population ages 65 a	SP.POP.65UP.TO.ZS	3.047169	3.100205	3.150306	3.190674	3.214401	3.219323	3.256485	3.27804	3.289625	3.297392	3.304535	3.352849	3.39685	3.433752
15	India	IND	Population ages 40-4	SP.POP.4044.MA.5Y	5.260894	5.241674	5.213372	5.18258	5.159404	5.147316	5.120655	5.106574	5.099795	5.092193	5.079514	5.048277	5.015567	4.9841
16	India	IND	Population ages 15-:	SP.POP.1519.MA.5Y	9.131835	9.061649	8.990151	8.954505	9.008264	9.173194	9.400844	9.732717	10.10212	10.41325	10.61411	10.70428	10.70274	10.64278
17	India	IND	Women who were fi	SP.M15.2024.FE.ZS														
18	India	IND	Mortality rate, adult	SP.DYN.AMRT.MA	480.877	470.194	459.511	447.977	436.444	424.91	413.377	401.843	391.256	380.67	370.083	359.496	348.91	342.633
19	India	IND	Unemployment, tot	SL.UEM.TOTL.ZS														
20	India	IND	Unemployment with	SL.UEM.ADVN.MA.ZS														
21	India	IND	Labor force participa	SL.TLF.CACT.ZS														
22	India	IND	Labor force participa	SL.TLF.ACTI.FE.ZS														
23	India	IND	Children in employn	SL.TLF.0714.SW.MA.ZS														
24	India	IND	Child employment i	SL.MNF.0714.MA.ZS														
25	India	IND	Vulnerable employr	SL.EMP.VULN.MA.ZS														

Fig. 3.1 - 4G complete dataset

The 4G dataset is reduced to dataset that contains only required sectors. This dataset contains country's GDP data from 1960 to 2020.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	"Country	"Country	"Indicator	"Indicator	"1960"	"1961"	"1962"	"1963"	"1964"	"1965"	"1966"	"1967"	"1968"	"1969"	"1970"	"1971"	"1972"	"1973"	"1974"	"1975"	"1976"
2	"India"	"IND"	"Expense	"GC.XPN.T	""	""	""	""	""	""	""	""	""	""	""	""	""	""	"8.732911	"10.11237	"10.625
3	"India"	"IND"	"Exports c	"NE.EXP.G	"4.463156	"4.303586	"4.168975	"4.280503	"3.725551	"3.307472	"4.142550	"4.034444	"4.038771	"3.713842	"3.782825	"3.667205	"4.027489	"4.208763	"4.831321	"5.647062	"6.6865
4	"India"	"IND"	"Final con	"NE.CON.	"93.95741	"93.13969	"92.30043	"90.40971	"90.50556	"91.33524	"93.42769	"94.53099	"90.04327	"88.76564	"88.63191	"89.95340	"89.60715	"87.91394	"90.23853	"87.22225	"84.789
5	"India"	"IND"	"GDP (cur	"NY.GDP.M	"37029883	"39232435	"42161481	"48421923	"56480289	"59554854	"45865462	"50134942	"53085455	"58447995	"62422483	"67350988	"71463193	"85515269	"99525899	"98472796	"10271
6	"India"	"IND"	"GDP per	"NY.GDP.F	"82.18860	"85.35430	"89.88175	"101.1264	"115.5374	"119.3189	"89.99730	"96.33913	"99.87596	"107.6223	"112.4344	"118.6032	"122.9818	"143.7786	"163.4781	"158.0361	"161.09
7	"India"	"IND"	"GDP per	"NY.GDP.F	""	"1.670481	"0.860769	"3.836414	"5.249911	"-4.64015	"-2.11610	"5.594633	"1.226223	"4.269854	"2.864361	"-0.62635	"-2.81562	"0.919173	"-1.14691	"6.644905	"-0.653
8	"India"	"IND"	"Imports c	"NE.IMP.G	"6.833676	"5.957576	"6.031814	"5.906834	"5.684997	"5.211561	"6.671686	"5.946617	"4.942973	"4.030933	"3.878944	"4.002401	"3.708910	"4.723332	"6.020569	"6.646916	"6.1146
9	"India"	"IND"	"Individua	"IT.NET.US	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""
10	"India"	"IND"	"Industry	"NV.IND.T	"20.83434	"21.43484	"22.05260	"21.87947	"20.95528	"21.65510	"21.38661	"20.08944	"20.62711	"21.41748	"21.72930	"22.39200	"22.40800	"21.34823	"22.67569	"23.20125	"24.480
11	"India"	"IND"	"Manufac	"NV.IND.M	"14.75011	"15.35383	"15.86329	"15.75238	"14.85073	"15.01090	"14.50399	"13.23186	"13.52278	"14.14647	"14.45654	"14.98228	"15.10254	"15.01528	"16.34591	"15.83848	"16.265
12	"India"	"IND"	"Medium	"NV.MNF.	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""
13	"India"	"IND"	"Military e	"MS.MIL.X	"2.004012	"2.074359	"2.745400	"4.025306	"3.819236	"3.871414	"3.572370	"3.223923	"3.245568	"3.140814	"3.185183	"3.652453	"3.717947	"3.158643	"3.202826	"3.534598	"3.4778
14	"India"	"IND"	"Mobile c	"IT.CEL.SE	"0"	""	""	""	""	""	"0"	""	""	""	""	"0"	""	""	""	""	"0"	"0"
15	"India"	"IND"	"Mobile c	"IT.CEL.SE	"0"	""	""	""	""	""	"0"	""	""	""	""	"0"	""	""	""	""	"0"	"0"
16	"India"	"IND"	"Research	"GB.XPD.F	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""
17	"India"	"IND"	"Services	"NV.SRV.T	"38.78246	"38.32587	"39.93584	"38.09518	"36.34082	"37.45073	"36.45979	"34.60955	"35.05413	"34.30585	"35.04687	"35.80364	"35.52165	"32.94770	"33.61059	"35.13924	"35.803
18	"India"	"IND"	"Trade (%	"NE.TRD.G	"11.29683	"10.26116	"10.20079	"10.18733	"9.410548	"8.519034	"10.81423	"9.981062	"8.981744	"7.744776	"7.661769	"7.669606	"7.736399	"8.932096	"10.85189	"12.29397	"12.801
19	"India"	"IND"	"Trade in :	"BG.GSR.N	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	"1.924436	"2.1380
20	"India"	"IND"	"Agricultu	"NV.AGR.	"41.31283	"40.38740	"38.37133	"39.31975	"41.18773	"38.95214	"40.02544	"42.76762	"41.63355	"41.35834	"39.92780	"38.09977	"38.01772	"41.16204	"38.19969	"35.26950	"33.442
21	"India"	"IND"	"Current h	"SH.XPD.C	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""
22	"India"	"IND"	"Current h	"SH.XPD.C	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""
23	"India"	"IND"	"Compute	"TM.VAL.(	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	"19.55904	"26.587
24	"India"	"IND"	"Compute	"TX.VAL.C	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	"28.22529	"32.171
25	"India"	"IND"	"Firms usi	"IC.FRM.B	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""	""

Fig.3.2-Dataset containing only important sectors

Survey form for 5G technology is created in accordance to 4G dataset.

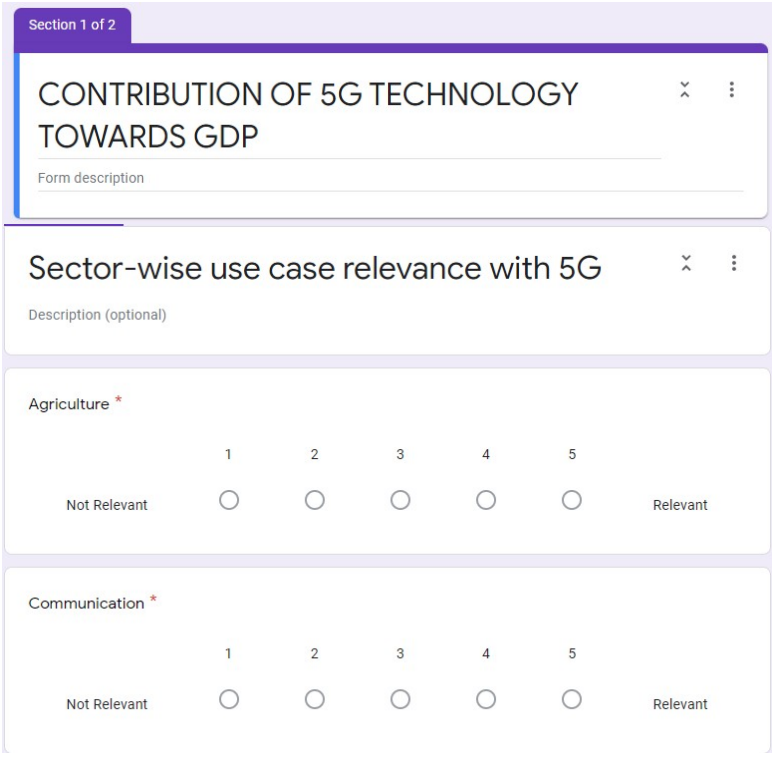


Fig.3.3- 5G survey form

Form responses were collected and processed.

	A	B	C	D	E	F	G	H
1	Timestamp	Name (optional)	Age	Gender	How much do you think 5	To what extent, do you th	Do you think 5G technolo	Which of the following industries do you think
11	12-23-2021 18:49:45	Jesvin Sam Geoffrey R	18 to 25	Male	4	5	4	Information and Communication
12	12-23-2021 18:51:27	Guna S	18 to 25	Male	5	5	4	Finance and insurance, Education, Healthcare
13	12-23-2021 18:56:21	Varsha devi Priya	Above 55	Male	3	3	4	Education, Information and Communication
14	12-23-2021 18:58:29		18 to 25	Female	4	4	4	Finance and insurance, Education, Healthcare
15	12-23-2021 19:01:26	Shandy	18 to 25	Male	4	5	3	Education, Media and Entertainment, Military
16	12-23-2021 19:03:06		18 to 25	Female	4	5	4	Agriculture, Education, Healthcare, Media and
17	12-23-2021 19:05:22	Logeshwaran R	18 to 25	Male	3	5	4	Military and defence, Information and Commur
18	12-23-2021 19:11:22	Sai Suraj	18 to 25	Male	5	4	3	Education, Media and Entertainment, Transpo
19	12-23-2021 19:11:30	Vinotha	18 to 25	Female	5	5	5	Manufacturing, Education, Media and Entertai
20	12-23-2021 19:13:59	Varsha	18 to 25	Female	4	3	4	Education, Healthcare, Media and Entertainm
21	12-23-2021 19:14:32		18 to 25	Female	4	4	2	Retail, Education, Healthcare, Media and Ente
22	12-23-2021 19:15:12	Praveen	18 to 25	Male	3	5	4	Manufacturing, Finance and insurance, Educa
23	12-23-2021 19:15:28		18 to 25	Male	4	4	5	Media and Entertainment, Military and defenc
24	12-23-2021 19:15:44		18 to 25	Male	4	4	3	Finance and insurance, Education, Healthcare
25	12-23-2021 19:15:57		18 to 25	Female	4	3	2	Military and defence, Transportation and stora
26	12-23-2021 19:17:18	ArunKumar P R	18 to 25	Male	3	3	4	Education, Healthcare, Media and Entertainm
27	12-23-2021 19:17:23		18 to 25	Female	4	5	3	Information and Communication
28	12-23-2021 19:17:39		18 to 25	Male	5	5	5	Education, Healthcare, Media and Entertainm
29	12-23-2021 19:17:51		18 to 25	Female	5	5	5	Manufacturing, Retail, Education, Healthcare,
30	12-23-2021 19:18:39	Deepika	18 to 25	Female	4	3	3	Education, Media and Entertainment, Military
31	12-23-2021 19:19:02		18 to 25	Female	3	3	3	Education, Media and Entertainment, Military
32	12-23-2021 19:19:11	Pragharsitha	18 to 25	Female	4	4	3	Education, Healthcare, Media and Entertainm
33	12-23-2021 19:22:16	Shruthi	18 to 25	Female	3	4	4	Finance and insurance, Education, Media and

Fig.3.4. -5G survey responses

Weights were assigned to sectors accordingly.

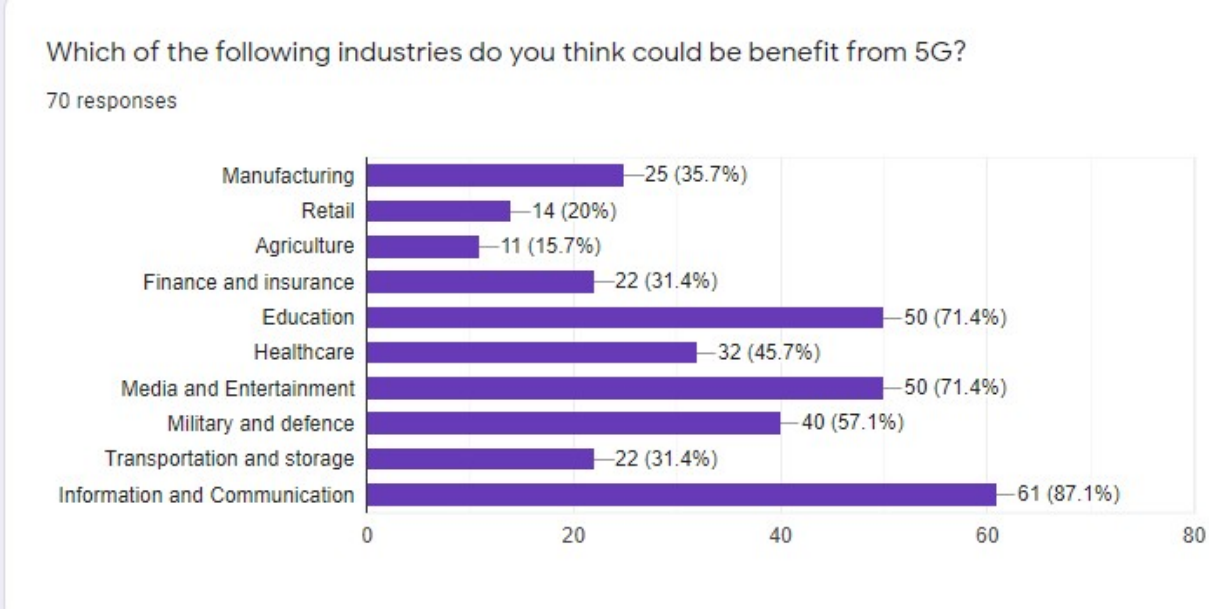


Fig.3.5- 5G contribution towards each sector

T-test Definition: Mathematically, the t-test takes a sample from each of the two sets and establishes the problem statement by assuming a null hypothesis that the two means are equal. Based on the applicable formulas, certain values are calculated and compared against the standard values, and the assumed null hypothesis is accepted or rejected accordingly. If the null hypothesis qualifies to be rejected, it indicates that data readings are strong and are probably not due to chance.

Since there is difference in the mean of two datasets the null hypothesis has been rejected in our case and it is evident that our data readings are precise. Then GDP growth percentage is calculated for 5G technology .

4. Implementation:

- 4G dataset which contains Country's sector-wise GDP is loaded and cleaned.

Loading the Dataset

In [1]:
```
import pandas as pd
import numpy as np
import re

# Loading data
data = (pd.read_csv("OurDataGDP.csv")
        .set_index('"Indicator Name"')
        .drop(['"Country Name"', '"Country Code"', '"Indicator Code"'], axis=1).T)

# Cleaning the column names
cols = []
for i in data.columns:
    cleancol = re.sub(r"\"", "", i)
    cleancol = re.sub(r"\(", "- ", cleancol)
    cleancol = re.sub(r"\)", "", cleancol)
    cols.append(cleancol)
data.columns = cols

data
```

Fig.4.1- Dataset loading

Out[1]:

	Expense - % of GDP	Exports of goods and services - % of GDP	Final consumption expenditure - % of GDP	GDP - current US$	GDP per capita - current US$	GDP per capita growth - annual %	Imports of goods and services - % of GDP	Individu using Internet of populat
"1960"	""	"4.4631564556351"	"93.9574148135212"	"37029883875.4573"	"82.1886027387829"	""	"6.83367665697623"	
"1961"	""	"4.30358618999178"	"93.1396905155186"	"39232435784.0946"	"85.354300989206"	"1.67048184332761"	"5.95757640480206"	
"1962"	""	"4.16897528315647"	"92.3004316277917"	"42161481858.7014"	"89.8817564947458"	"0.860769633331188"	"6.03181489594084"	
"1963"	""	"4.28050338493504"	"90.4097152762689"	"48421923458.7413"	"101.126429448401"	"3.83641409698178"	"5.90683445823862"	
"1964"	""	"3.7255511726421"	"90.5055651618194"	"56480289940.8261"	"115.537496074678"	"5.24991183202739"	"5.68499774747481"	
...	...	...	...	...	...	...	...	
"2016"	"15.2719500252282"	"19.1582349105904"	"69.603829307514"	"2294797980509.51"	"1732.55424231697"	"7.08222758310006"	"20.9242508026768"	"1
"2017"	"15.6141099220975"	"18.7917648392972"	"69.4923486310429"	"2651472946375.05"	"1980.66701982813"	"5.66578114881196"	"21.9507321152231"	"1
"2018"	"15.673673712955"	"19.9412406764114"	"70.2055893983676"	"2701111782774.57"	"1996.91508739755"	"5.43307745100874"	"23.6574164799281"	"20.081300
"2019"	""	"18.4293865080003"	"71.7115897172649"	"2870504096717.48"	"2100.75146060783"	"2.99266440570658"	"20.9573845344725"	
"2020"	""	"18.0765867880475"	"71.6508116047652"	"2622983732006.45"	"1900.70680971528"	"-8.87073122264151"	"18.3932965777645"	

61 rows × 32 columns

Fig.4.2-4G dataset

- Dataset contains many elements whose value is not defined thus, data cleaning is done

Cleaning the dataset

In [2]:
```
# Function to clean a data
def load_data(col):
    column = data[col]
    new = []
    for i in column.values:
        clean = re.sub(r"\"", "", i)
        new.append(clean)
    new = pd.Series(new, index=column.index)
    new = new[new != ""]
    new = new.astype(float)
    return new
```

Fig.4.3-Cleaning dataset

- After data cleaning sector-wise dataset is has been created and loaded individually

Loading data for various sectors

In [3]:
```
# Agriculture
Agriculture = load_data('Agriculture forestry and fishing value added - % of GDP')

# Communication
CommImports = load_data("Exports of goods and services - % of GDP")
CommExports = load_data("Imports of goods and services - % of GDP")

# Healthcare
Health = load_data('Current health expenditure - % of GDP')

# Manufacturing
Manufacturing = load_data('Manufacturing value ad\'ded - % of GDP')

# Finance
# Finance1 = load_data("Firms using banks to finance working capital - % of firms")
# Finance2 = load_data("Firms using banks to finance investment - % of firms")
Finance3 = load_data('Domestic credit to private sector by banks - % of GDP')

# Education
Education = load_data('Government expenditure on education total - % of GDP')

# Military and Defence
Military = load_data('Military expenditure - % of GDP')

# Transportion
Transport1 = load_data('Transport services - % of service exports BoP')
Transport2 = load_data('Transport services - % of service imports BoP')

# GDP
GDP = load_data("GDP - current US$")
GDPper = load_data("GDP per capita growth - annual %")
```

Fig.4.4- Loading dataset for individual sectors

- A survey form has been created for 5G dataset. The form has corresponding sectors of the 4G dataset.

5G survey data

In [4]:
```
# 5g form responses data
data_5g = pd.read_csv("5G and GDP (Responses).csv")
data_5g.head()
```

Out[4]:

	Timestamp	Name (optional)	Age	Gender	How much do you think 5G technology will impact the GDP of our Country?	To what extent, do you think Robotics, Internet of Things, Virtual Reality, Augmented Reality will significantly contribute towards the GDP of our country?	Do you think 5G technology will increase the employment opportunities?	Which of the following industries do you think could be benefit from 5G?	Which of these 5G use case could contribute maximum towards GDP of our Country?	Agriculture	Communication	Healthcare	Manufac
0	12/23/2021 16:49:04	K R	18 to 25	Male	5	4	4	Manufacturing, Agriculture, Finance and insura...	Broadband for public transport, Industrial aut...	4	5	4	
1	12/23/2021 18:44:01	NaN	18 to 25	Female	4	5	4	Manufacturing, Retail, Finance and insurance, ...	Broadband for public transport, Industrial aut...	2	5	5	

Fig.4.5-5G Survey responses

- Weight for each sector is calculated respectively and weights has been assigned for responses. Thus, mean for each sector is calculated using sector weight and response weight.

Custom functions

In [5]:
```
# Function to count based on group
def countPerGroup(col):
    return (pd.DataFrame(data_5g[col].groupby(data_5g[col]).count(), index=[1, 2, 3, 4, 5])
        .replace(np.nan, 0.0)
        .astype(int))

# Function to calculate weights
def ourFormula(col):
    sector = countPerGroup(col)
    sector['weights'] = np.linspace(0, 1, 6)[-5:]
    sector['weightedVal'] = sector[col] * sector['weights']
    return sector

# Function for our calculation
def calcreq(df, col1, col2):
    return df['GDP per capita growth - annual %'] + ((ourFormula(col1)['weightedVal'].mean() * col2.mean()) / 5.0)

# Function to compute overall GDP Growth
def calcGDP(row):
    return row.values[1:].mean()# * np.max(ourFormula("Agriculture")['weightedVal'], axis=0)
```

Fig.4.6-5G mean calculation

- 5G Dataset containing each sector is created after performing above calculations.

In [6]:
```
# Creating own dataset
df = pd.DataFrame(load_data('GDP per capita growth - annual %'), columns=['GDP per capita growth - annual %'])
df['Agriculture'] = calcreq(df, "Agriculture", Agriculture / 3)
df['Communication'] = (calcreq(df, "Communication", CommExports) + calcreq(df, "Communication", CommImports)) / 2.0
df['Healthcare'] = calcreq(df, "Healthcare", Health)
df['Manufacturing'] = calcreq(df, "Manufacturing", Manufacturing)
df['Financial Services'] = calcreq(df, "Financial Services", Finance3) / 2.5
df['Education'] = calcreq(df, "Education", Education)
df['Military purpose'] = calcreq(df, "Military purpose", Military)
df['GDP Growth'] = df.apply(calcGDP, axis=1)
impactper = ourFormula("How much do you think 5G technology will impact the GDP of our Country?")['weightedVal'].mean() / 100
df['% growth'] = ((df['GDP Growth'] - np.abs(df['GDP per capita growth - annual %'])) / np.abs(df['GDP per capita growth - annual
# df
```

Fig.4.7-5G dataset creation

- T-test is applied to 4G and 5G dataset and there is significant difference between two means

```
In [7]: from scipy.stats import ttest_ind

        def ttest(a,b):
            tstat, p_val = ttest_ind(a, b, equal_var=False)

            print(p_val)
            if p_val < 0.05:
                print("Rejecting Null Hypothesis, There is some significant difference in means of two groups")
            else:
                print("Rejecting Alternate Hypothesis, There is no significant difference in means of two groups")
```

Result is well Obvious

```
In [8]: ttest(df['GDP per capita growth - annual %'], df['GDP Growth'])

        5.365282919782848e-57
        Rejecting Null Hypothesis, There is some significant difference in means of two groups
```

The Growth is only .76%

Fig.4.8-T-test

- The GDP growth of both technologies is analyzed and there is growth of 0.76% in GDP by 5G technology.

```
In [9]: print("The % of increase of GDP is : {} %".format(round(df['% growth'].mean(),2)))

        The % of increase of GDP is : 0.76 %
```

Fig.4.9-5G growth percentage calculation

5. Significance:

Datasets plays a vital role in any project. The dataset for 4G data has GDP from 1960-2020. This dataset is sufficient for effective calculation. The dataset covers all the important sectors which contribute to the GDP of our country. 5G dataset has been created using Google survey form and has been circulated among students of our department. There has been about significant amount of responses. This survey form has been created with respect to the sectors of the 4G dataset. Thus survey form covers the important sectors.

Then significant weights had been applied to the responses and similarly weights had been assigned to each sector accordingly. Then T-test has been performed and states that the datasets for each technology are precise. One dataset has been validated the percentage increase in the GDP by 5G technology is calculated. It states that 5G technology

would increase our country's GDP by approximately 0.76%. Thus it is evident from the procedure that this result is precise.

Also, it is important to highlight the snippet from the article *"The Impacts of mmWave 5G in India October 2020"*
Article link:The Impacts of mmWave 5G in India

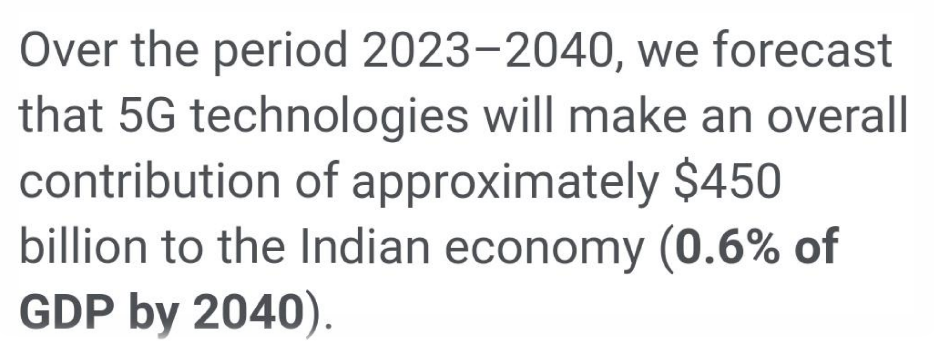


Fig.5.1-5G growth percentage article snippet

It states that 5G technology would contribute 0.6% of India's GDP by 2040 , which is analogous to our result 0.76%.

How this project benefits user:

- Thus, our project would benefit users, developers, innovators and large sectors who are analyzing their shift towards 5G technology.
- There is no evident dataset for 5G technology till date therefore the enthusiast who are willing to research about 5G technology could be benefited from the project. There is no requirement to collect data as 5G dataset used here is precise to a large extent.
- This project is simple and easy to understand.Thus, it takes minimal amount of time for any reader to understand the project and extract important information.
- This would benefit student, researchers, developers and manufactures to analyse the impact of 5G technology.

Challenges faced during this project:

- Finding appropriate dataset was the tedious task
- Since 5G technology has not been in existence there has been lot of research work done behind.
- Creating appropriate survey form 5G was another challenge.
- Establishing the relationship between technology and GDP was challenging.

6. Conclusion:

The problem statement is given such that the setup of 5G technology would increase country's GDP twice that of 4G and it is asked to be assessed statistically. The dataset for 4G and GDP dependence for each sector of our country is taken.

The dataset is processed cleaned and modified according to requirements. Since 5G does not have evident data, survey form is created in accordance to 4G dataset. The responses of 5G dataset are assigned weights sector-wise so that both the dataset shares similarity.

Then T-test is the test used here for Hypothesis testing. Using this dataset are validated. Once, the datasets are evident. The objective of this project is carried out. The overall percentage increase in the country's GDP is calculated. Lots of article has been read to understand and draw relationship between 5G and its GDP contribution. Also, articles had been helpful to verify results.

The problem statements says that 5G technology would double the country's GDP but after sequence of research and calculations it is statistically concluded that it would only increase by 0.76%. Lots of articles and research papers also highlight this conclusion. Thus, it can be concluded that "Eventhough 5G technologies does not double the growth of technology and as well as our country GDP growth by 2 times there is a significant (0.76%) amount increase in our country's GDP.

PROJECT WORKSHEET / DIARY

	Date	Topics learned / Activity carried out / Task completed / Online /E-resources accessed
WEEK 1	10.12.2021	Understand the project title
	13.12.2021	Learnt few concepts about 5G
	14.12.2021	Learnt about past years GDP data
	15.12.2021	Learnt how 5G can create an impact towards GDP
	16.12.2021	Collected GDP data from worldbank website
	17.12.2021	Organized the collected data

	Date	Topics learned / Activity carried out / Task completed / Online /E-resources accessed
WEEK 2	20.12.2021	Learnt about the data by means of Graphs and plots
	21.12.2021	Gathered questions for 5G survey
	22.12.2021	Created a Google form to collect 5G survey data
	23.12.2021	Circulated the Google form to students and collected data
	24.12.2021	Visualized the responses from the survey
	27.12.2021	Started the implement the project

	Date	Topics learned / Activity carried out / Task completed / Online /E-resources accessed
WEEK 3	28.12.2021	Cleaned the GDP data and loaded the data sector wise
	29.12.2021	Loaded the 5G survey data
	30.12.2021	Calculated the annual GDP growth
	31.12.2021	Hypothesis testing is done
	2.01.2022	Average GDP growth percentage per year is calculated
	3.01.2022	Project Review

Signature of the Student
(with date)

Signature of the faculty guide
(with date)