Introduction

Life satisfaction is defined as a positive evaluation made by an individual on the total quality of their life measured to a certain degree (Radcliff, 2001). In general sense, it is the perception of living a happy and fulfilled life. The focus of life satisfaction is essential as one study made by Oishi & Diener (2014) showed well-being measurements which is the same as life satisfaction and happiness objectively tracks societal and economic conditions of a country sufficiently well. From an economic point of view, the authors added that this type of measurement gives clarity to any governing party of a country in dealing the effectiveness of specific public policies relating to unemployment, taxation, income equality, healthcare, quality of life and day-to-day activities ongoing in a citizen's life (Oishi & Diener 2014). Moreover, through a psychological perspective, the analysis of life satisfaction provides a comprehensive understanding on the impact of the quality of life for the disable and non-disable, changes in the status of health, caregiver burden, grief, retirement, job transitions and loss, social networks, activity involvement and personality development over a life course (Mannell & Dupuis 2007). All in all, both aspects compliment the understanding in developing effective policies for country affairs.

There have been many accounts of countries using life satisfaction scores for policy deliberations. The United Kingdom is one example as it began using life satisfaction scales for policy deliberations as early in 2010 when Prime Minister, David Cameron announced that the well-being of its citizens would be of government concern as mentioned in the study made by Diener & Inglehart (2012). The authors added other countries such as Japan, Chile, Germany, and Australia have followed into the British footsteps by initiating ongoing longitudinal panel studies on life satisfaction tracked over time for the use of policy making. This shows the relevancy of life satisfaction being used in the current world and it plays an important role in making effective policies.

In addition, life satisfaction is useful in supplying additional information to economic indicators like real GDP where it lacks the measures of the quality of people's social life, environmental factors, and illnesses. According to Diener & Inglehart (2012), life satisfaction supplements information where GDP could not provide in building effective policies to tackle major issues faced by a country such as income inequality, high unemployment rates, death rates, ageing population, pollution, international trade matters, poor living standards etc. Therefore, life satisfaction is proven to be essential for governments of a country in improving the quality of people's life.

There are 4 crucial factors in securing life satisfaction around the world which includes political, economic, institutional, and human development as found by Bjørnskov, Dreher, & Fischer (2008) in their research for cross-country determinants of life satisfaction.

Political factors refer to the allocation of goods and services aligning with people's expectation. These factors determined to what extent politicians are responsive to its citizens either gaining favourable or unfavourable expectations within societal groups.

Economic factors include the consumption of private and public goods like education and infrastructure, personal income level, country's openness to trade, provision of welfare

payments, and economic stability. Variables such as GDP, inflation rate, unemployment rates are economic factors well studied against life satisfaction. Higher level of these types of variables should increase well-being.

Institutional factors suggests that good governance and better social interaction between citizens affects life satisfaction. Aspects of good governance are defined as fair regulations with the absence of corruption and unrestrained media for transparency. Whereas, with social interaction, it is the social cohesion and connectedness of citizens in the country.

Lastly, human development factors include aspects of education development, access to healthcare systems and life expectancy. Higher education levels are associated with increasing well-being as schooling makes people more informed about their surrounding world and society at large. Regarding the other two factors, access to developed healthcare systems, lowers infant mortality rate and increases longevity of people are found to be central measures of quality of life.

The objective of this report is to analyze the various macro-economic variables that crucially influences people's life satisfaction around the world.

Descriptive Analytics

This section will first have an overview of life satisfaction around the world and its nature, followed by the correlation analysis between the other independent variables against it.

sumtable {vtable} Summary Statistics

Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 50	Pctl. 75	Max
Life Satisfaction (score 1 to 10, higher the happier)	142	5.452	1.108	3.083	4.551	5.429	6.196	7.769

Table 1: summary statistics for life satisfaction

Looking at a global perspective, life satisfaction was ranked 5.452 on average around the world in 2018. This was measured using the summary statistics in above (Table 1) around 142 countries. The standard deviation was 1.108 which indicates on average the values of life satisfaction deviates by 1.108 from the mean. The minimum point observed for life satisfaction is 3.083 outlining the country of Central African Republic as the unhappiest country among the 142 countries while the maximum point is 7.769 which is affiliated with the country of Finland, indicating the happiest country among them. It was observed that 25% of the 142 countries have life satisfaction less than or equal to 4.551 while 75% of them are less than or equal to 6.196. The nature of distribution of life satisfaction was normally distributed as shown below (Table 2) where the black vertical line represents the median of 5.429.

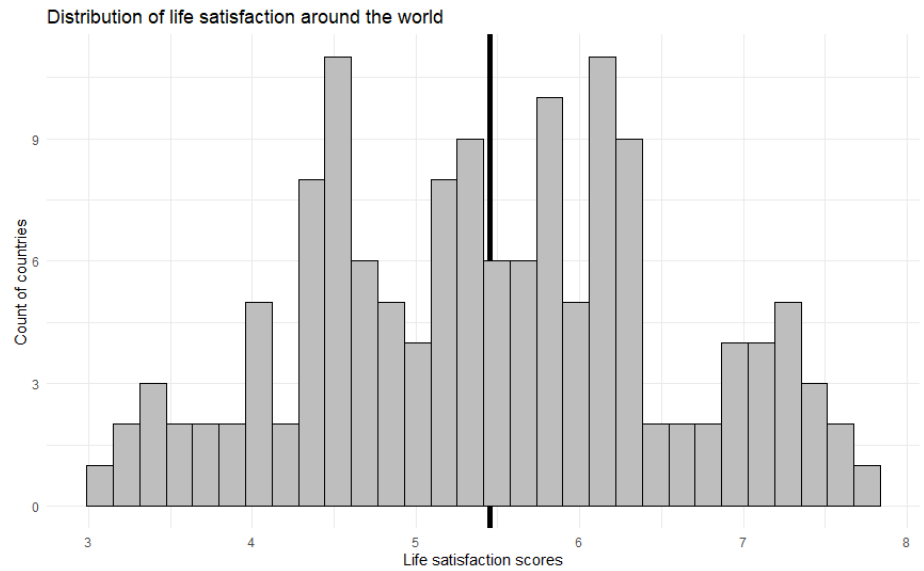


Table 2: Histogram of Life Satisfaction

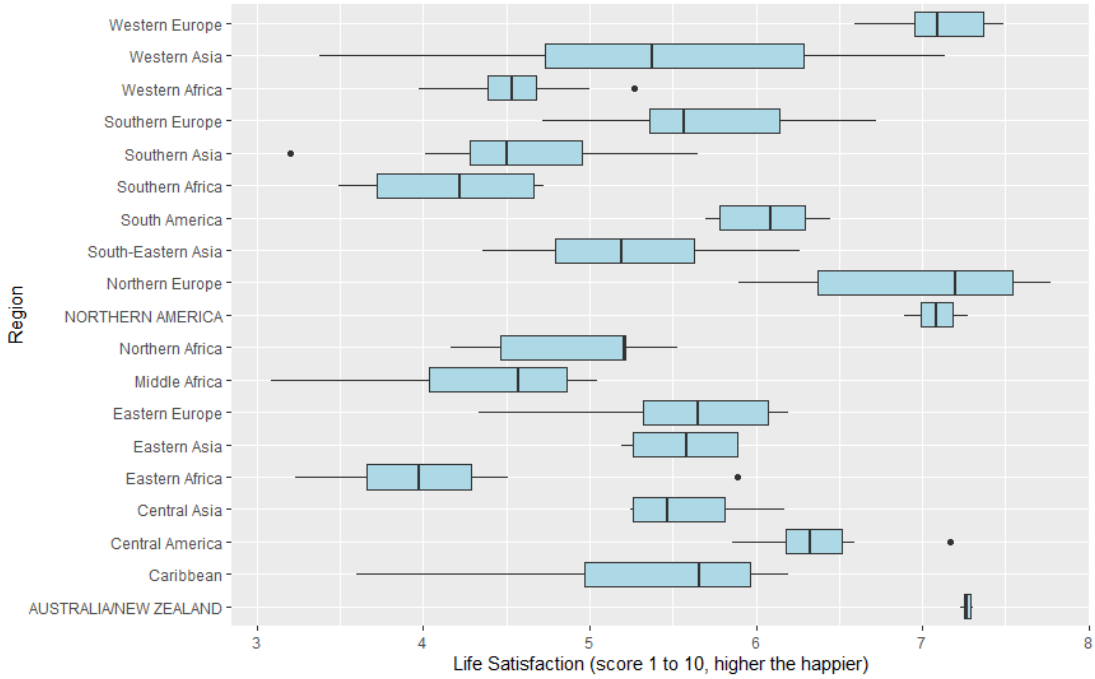


Table 3: Boxplot of regions against life satisfaction scores

By comparing across regions using the boxplots in above (Table 3), it appears Australia/New Zealand (7.27), Northern Europe (7.2), Western Europe (7.09), and Northern America (7.09) had the highest life satisfaction scores with their respective median values. In contrast, regions of Eastern Africa (3.97), Southern Africa (4.22), Southern Asia (4.5), Western Africa (4.53) were the lowest life satisfaction scorers among them. The median values for regions were calculated and shown in (Appendix 1).

Moving on, the correlation analysis of life satisfaction against all 12 independent variables are analyzed. Utilizing the ggpairs function, there are positive correlations associated with life expectancy, access to electricity, GDP constant, and ratio of female to male participation rate.

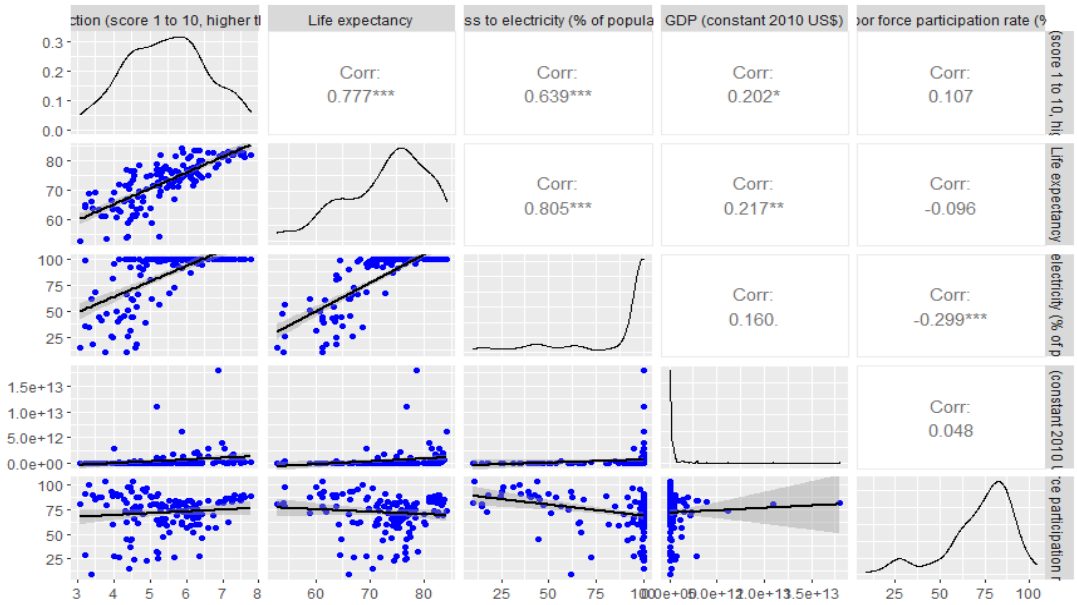


Table 4: Positive correlations found with life satisfaction

There is a strong positive linear relationship between life expectancy (0.777) and access to electricity (0.639) to life satisfaction, while GDP constant (0.202) ratio of female to male participation rate (0.107) have a weak linear relationship. By nature, "life expectancy", "access to electricity" and "ratio of female to male participation rate" are negatively skewed while GDP is positively skewed as seen with the line graph above (Table 4). The scatterplot (1st column, 2nd row of Table 4) displaying life satisfaction plotted against life expectancy, generally shows countries with longer life expectancy have higher life satisfaction. Conversely, to the scatterplot of access to electricity (1st column, 3rd row), shows a cluster of points gathered horizontally on top, indicating that some countries with high access to electricity may have low satisfaction and not necessarily high life satisfaction. This probes further investigation into the regression model whether access of electricity will be significant in predicting life satisfaction even though it has high correlation.

Some additional univariate analysis on the positive correlated variables is indicated below (Table 5). On average, countries of the world in 2018 experience 73 years of life expectancy, have 85% access to electricity and had 72% ratio of female to male labor force participation rate.

Summary statistics for positive correlated variables

Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 50	Pctl. 75	Max
Life expectancy	142	72.964	7.59	52.805	67.624	74.6	78.201	84.211
Access to electricity (% of population)	142	85.111	25.756	10.122	82.393	99.86	100	100
GDP (constant 2010 US$)	142	5677909877 40.296	1901062913 724.61	1167531669	1773802455 6	5464366014 9.5	3.385e+11	1.8e+13
Ratio of female to male lab or force participation rate (%) (modeled ILO estimat	142	72.034	19.398	8.569	62.78	77.584	85	103.948

Table 5: Summary statistics

Furthermore, in (Table 6) below, it was observed that inflation rate, unemployment rate, infant mortality rate, and dependency ratio had negative correlation. Amongst the relevant variables, infant mortality rate (-0.691) and dependency ratio (-0.541) showed strong negative linear relationship while inflation rate(-0.225) and unemployment rate(-0.189) showed weak negative relationship.

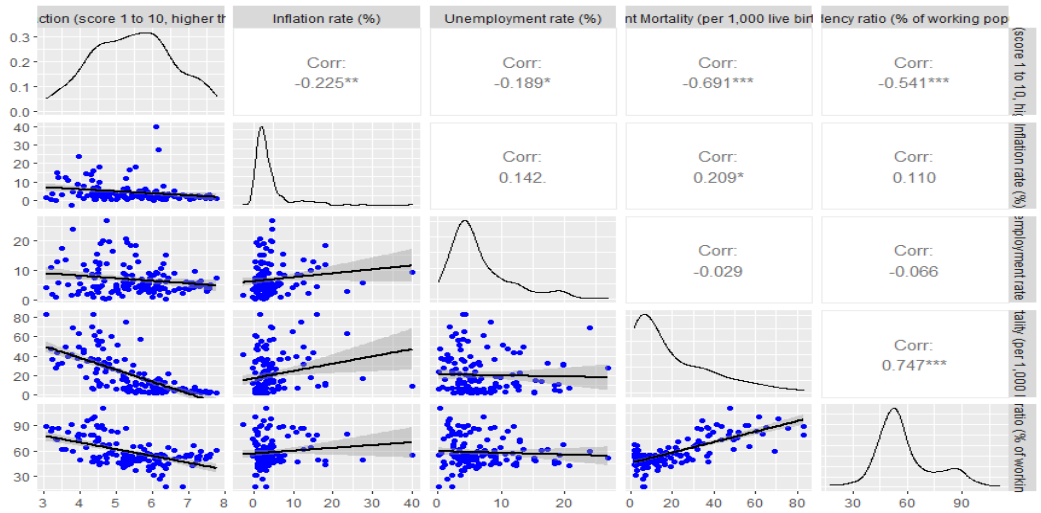


Table 6: Negative correlation found with life satisfaction

Additionally, on average countries of the world in 2018 experience 4.255% inflation rate, 6.79% unemployment, had 20,204 infant mortalities, and have 58.5% of dependency ratio (Table 7) below.

Summary statistics for negative correlated variables

Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 50	Pctl. 75	Max
Inflation rate (%)	142	4.255	5.48	-2.815	1.507	2.573	4.494	40.012
Unemployment rate (%)	142	6.79	5.151	0.11	3.652	5.165	8.965	26.91
Infant Mortality (per 1,000 li ve births)	142	20.204	19.835	1.6	4.8	12.5	32.175	83.4
Dependency ratio (% of wo rking population)	142	58.505	16.412	17.524	48.411	54.532	65.976	110.879

Table 7: Summary statistics

Lastly, it was concluded that suicide mortality rate, carbon emissions, population and population density had no relationship with life satisfaction as their correlation values were close to zero (Table 8) below. These variables will be omitted from the regression model analysis.

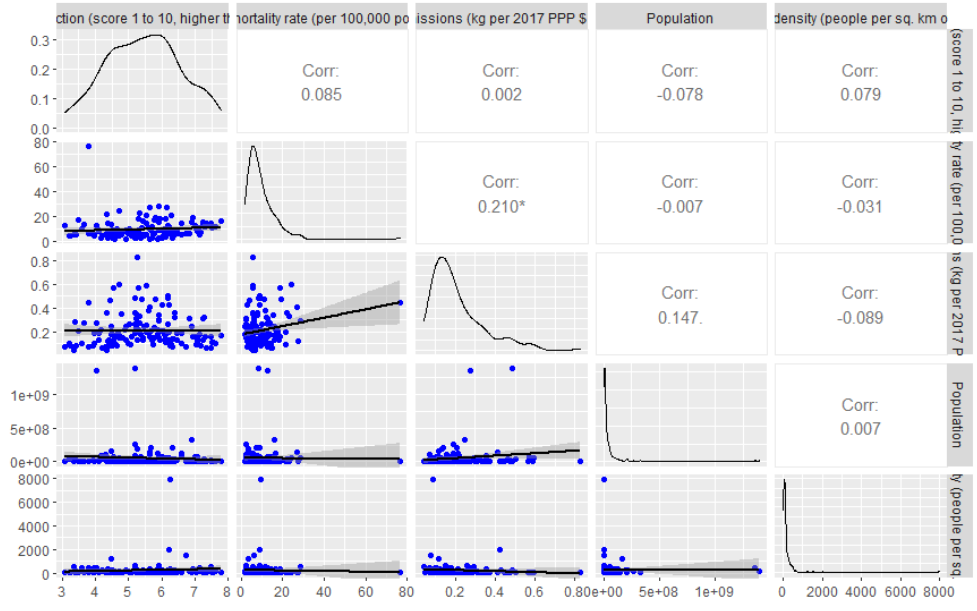


Table 8: No correlation found with life satisfaction

Predictive analysis

Referring to Appendix 2, there were 7 variables used in the multiple linear regression model to identify crucial factors affecting people's life satisfaction around the world. The inclusion of the 7 variables were due to its distinct correlation strength showing asterisk sign (*) in the correlation analysis while the other variables were excluded due to its insignificant correlation strength. GDP (constant 2010 US$) was logarithmically transformed due to its skewed nature found in descriptive analysis.

The estimated regression equation:

$$\widehat{Life\ satisfaction} = 0.967 + 0.045(LifeExpectancy_i) + 0.062log(GDPConstant2010US\$_i) + 0.006(AccesstoElectricity_i) - 0.038(UnemploymentRate_i) - 0.003(InflationRate_i) + 0.004(DependencyRatio_i) - 0.347log(InfantMortalityRate_i)$$

The testing of robustness for the model was done through the evaluation of goodness of fit, VIF and residual test. Firstly, the goodness of fit involves the R-squared and 0.65 was resulted. Therefore, 65% of the variation of life satisfaction scores can be explained by the variation of life expectancy, GDP constant, access to electricity, unemployment rate, inflation rate, dependency ratio and infant mortality rate. The adjusted R-squared for this model was 0.6317 which is higher compared to a 2nd regression model with R-squared value at 0.6271 involving 5 variables. Next, the variation inflation factor (VIF) was tested for multicollinearity. It showed 2.86 [1/1-0.65] which is considered high as it is close to conservative views of 3. This indicates a moderate correlation among the independent variables, nevertheless it is not severe to warrant corrective measures, therefore it is acceptable. Finally, the residual vs fitted plots for the model (Appendix 3) appears to have residuals randomly scattered around the horizontal line however there is some non-linearity as the blue line has a curvilinear shape. The Q-Q plot (Appendix 3) shows that most of the residual points fit along the diagonal line, however there are some discrepancies at the right end as some points deviate which shows some skewness. The histogram of the regression model (Appendix 4) also shows that it has a slight left skewness representation which means the model does not accurately predict life satisfaction scores well.

The hypothesis testing was conducted at a 5% significance level ($\alpha = 0.05$). Amongst the variables, life expectancy, unemployment rate and infant mortality rate were statistically significant.

Hypothesis testing for life expectancy:

$$H_0: \beta_{Life\ Expectancy} = 0 \qquad H_1: \beta_{Life\ Expectancy} > 0,\ \ p - value = 0.0139$$

Firstly, life expectancy was deduced it would positively affect life satisfaction as this was consistent with the positive coefficient estimation of 0.049 found in the regression output. This variable was not chosen to be transformed with the logarithmic and quadratic functions as there were no signs of skewness or any exponential relationship when plotted against life satisfaction as depicted in Table 4. Based on the regression output (Appendix 2), the p-value was 0.0139 [0.0278/2] which is less than 0.05 alpha. Therefore, we reject H_0 and conclude at the 5% level

of significance, there is sufficient evidence that life expectancy has a significant positive effect on life satisfaction. Additionally, the model predicts that a 1-year increase in life expectancy would increase life satisfaction scores by 0.049 on average while holding GDP, access to electricity, unemployment rate, inflation rate, dependency ratio and infant mortality rate constant.

Secondly, unemployment rate was hypothesized to negatively affect life satisfaction and the negative estimated coefficient (-0.159) proves this (Appendix 2). The usage of logarithm on unemployment rate was to interpret the results of the coefficient in terms of percentage and transform its right skewed nature into a normal distribution as indicated in Table 6. The p-value indicated was 0.0125[0.025/2] which is lesser than 0.05 alpha. Hence, we reject H_0 and conclude at the 5% level of significance, there is sufficient evidence that life expectancy has a significant negative effect on life satisfaction. The model also predicts that a 1 percent increase in unemployment rate would decrease life satisfaction scores by 0.00159[0.159/100] on average while holding other variables constant.

Lastly, infant mortality rate evidently effects life satisfaction negatively as shown in (Appendix 2) the regression output having a negative coefficient (-0.348). The log transformation was used on infant mortality rate because there was a highly skewed relationship when plotted against life satisfaction and the interpretation is wished to be explained with percentages. Without the usage of logarithmic transformation, the estimated coefficient would be positive which does not align to its negative correlation linked to life satisfaction. In other cases, the quadratic transformation would not be viable as well because there would be two possible outcomes showing a positive and negative coefficient which does not make sense to infer higher infant mortality rates should increase life satisfaction. Therefore, the log transformation is proven useful to convey the proper results. The p-value result showed 0.003[0.006/2] which is lesser than 0.05 alpha. Conclusively, we reject H_0 and there is sufficient evidence at the 5% level of significance, that infant mortality rate has a significant negative effect on life satisfaction. The model predicts that a 1 percent increase in infant mortality rate would decrease life satisfaction scores by 0.00348[0.348/100] on average while holding other variables constant.

Hypothesis Testing	**P-value (α = 0.05)**	**Decision**
$H_0: \beta_{Unemployment\ Rate} = 0$ $H_1: \beta_{Unemployment\ Rate} < 0$	0.025	Since p-value < α, we reject H_0 and conclude at the 5% level of significance, there is sufficient evidence that life expectancy has a negative effect on life satisfaction
$H_0: \beta_{Infant\ Mortality\ Rate} = 0$ $H_1: \beta_{Infant\ Mortality\ Rate} < 0$	0.00627	Since p-value < α, we reject H_0 and conclude at the 5% level of significance, there is sufficient

		evidence that infant mortality rate has a negative effect on life satisfaction
$H_0: \beta_{GDPconstant2010US\$} = 0$ $H_1: \beta_{GDPconstant2010US} > 0$	0.057	Since p-value > α, we do not reject H_0 and conclude at a 5% level of significance, there is insufficient evidence that GDP constant 2010US$ has a positive effect on life satisfaction scores
$H_0: \beta_{Access\ to\ Electicity} = 0$ $H_1: \beta_{Access\ to\ Electicity} > 0$	0.16	Since p-value > α, we do not reject H_0 and conclude at a 5% level of significance, there is insufficient evidence that access to electricity has a positive effect on life satisfaction scores
$H_0: \beta_{Inflation\ Rate} = 0$ $H_1: \beta_{Inflation\ Rate} < 0$	0.77	Since p-value > α, we do not reject H_0 and conclude at a 5% level of significance, there is insufficient evidence that inflation rate has a negative effect on life satisfaction scores.
$H_0: \beta_{Dependency\ Ratio} = 0$ $H_1: \beta_{Dependency\ Ratio} < 0$	0.32	Since p-value > α, we do not reject H_0 and conclude at a 5% level of significance, there is insufficient evidence that dependency ratio has a negative effect on life satisfaction scores.

Limitations

Regarding the limitations, the model does not accurately predict life satisfaction scores well. As seen with the low R-squared value of 0.65, it seems it was missing other important predictors which could increase its value to explain the model better. A future suggestion would be to include non-correlated variables such as suicide rates as it would serve potential analysis in studying against life satisfaction based on common intuition. Moreover, the VIF value of 2.86 shows a moderate strength in multicollinearity which shows some intercorrelations among the independent variables. High multicollinearity would ineffectively predict the dependent variable so the suggestion would be to remove highly correlated variables such as access to electricity as Table 4 shows a high correlation result of 0.805 against life expectancy. Furthermore, the residual vs fitted plot showed a non-linearity relationship as the blue fitted line has a curvilinear shape. This suggests for the usage of quadratic transformations on certain variables in the dataset that could straighten the line. Another suggestion would be to omit outlier values to decrease variability in the data as the residual plot showed abnormal points on the lower sides of the plot (Appendix 3). Similarly, the Q-Q plot shows discrepancies at the right end of the plot as some points deviate from the diagonal line which indicates it is not normally distributed. The histogram confirms this as it shows a left skewed graphical representation. A future suggestion would be to further test logarithmic and exponential transformation on variables that showed skewed representation which are life expectancy, access to electricity, and inflation rate. Interestingly, the variable GDP would be of great analysis using the quadratic function as a study showed poor countries with rising GDP, ultimately raise life satisfaction scores but tends to decline after a certain point when it becomes developed (Proto & Rustichini, 2013). This research has certainly had its limitations due to time constraints, however, it can be improved in the future with these suggestions listed.

Implication & Recommendation

As previously analyzed, life expectancy was statistically significant in the regression analysis having a positive effect on life satisfaction. Therefore, practical implications to policymakers of a country should find ways in increasing life expectancy of their people. One of the major deterrents to life expectancy is the habitual drug usage in people. According to Rehm et al (2016) governments should have regulations on the availability of substances (i.e illegal drugs) as this has huge ramifications to life expectancy of a nation. Substance use policies include the control of legal and illegal drugs along with public health awareness of the harm it causes. Additionally, the researchers recommend tightening trade agreements on a global and regional scale to restrict traded psychoactive substances and improve treatment with social assistance to existing heavy users and families who have substance use disorders to reduce stigmatization and ultimately its life expectancy of its people. Furthermore, Montez et al (2016) proposed laws on protecting the environment, regulation of tobacco and firearms and civil rights as practical policy making in raising life expectancy. The authors found these types of policies contributed to the longevity of men and women at a substantial level and subsequently the well-being of people.

In relation to unemployment rates, it was statistically significant that it had a negative effect on life satisfaction. Both Wulfgramm (2014) & Montez et al (2016) agreed implementing labor

policies such as higher minimum wage and paid family leave would improve economic well-being as it has been found that the adverse effects of unemployment most notably linked with depression and anxiety would double if there were a lack of unemployment benefits. In addition, policymakers should pay attention to infant mortality rates that was shown to have negative effects on life satisfaction and proving to be statistically significant. Studies show there are neglected sanitary efforts in providing clean water, dedicated facilities for child labor, poor maintenance of latrine at home along with insufficient vaccination programs to counter early child diseases such as measles and smallpox (Bhatia et al, 2019). Therefore, to decrease infant mortality rates, governments would need to invest resources into providing purified drinking water to every household, improved healthcare facilities for childcare, and have adequate amounts of immunization vaccine programs for common child diseases.

Appendixes

(Appendix 1)

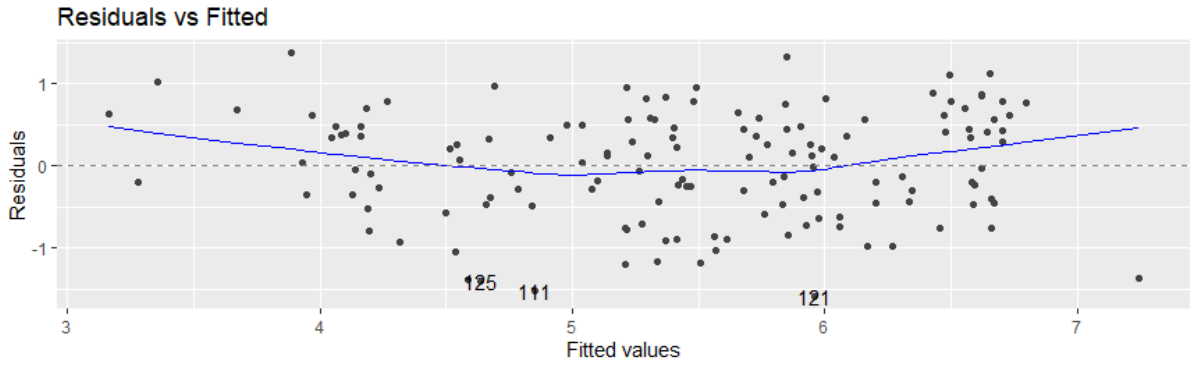
Life Satisfaction Summary over the Regions

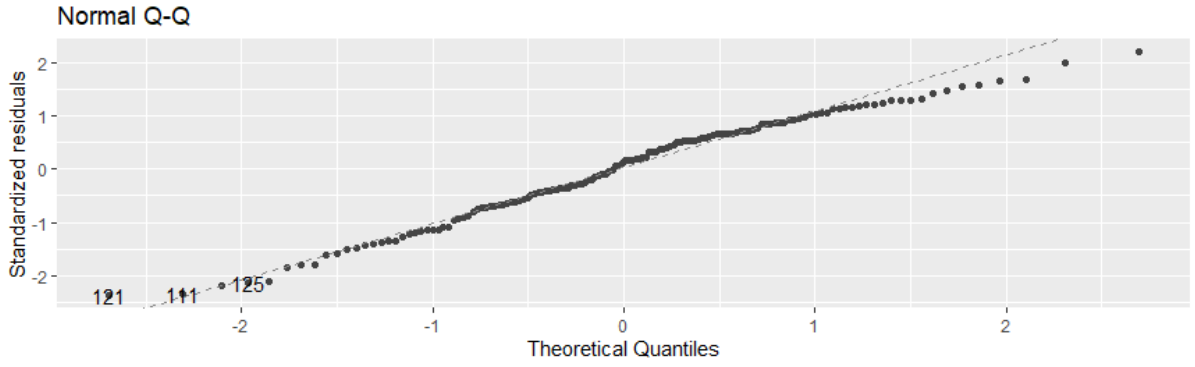
Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 50	Pctl. 75	Max
Region: AUSTRALIA/NEW ZEALAND								
Life Satisfaction (score 1 to 10, higher the happier)	2	7.27	0.06	7.23	7.25	7.27	7.29	7.31
Region: Caribbean								
Life Satisfaction (score 1 to 10, higher the happier)	4	5.28	1.16	3.6	4.97	5.66	5.97	6.19
Region: Central America								
Life Satisfaction (score 1 to 10, higher the happier)	7	6.39	0.42	5.86	6.18	6.32	6.52	7.17
Region: Central Asia								
Life Satisfaction (score 1 to 10, higher the happier)	5	5.59	0.4	5.25	5.26	5.47	5.81	6.17
Region: Eastern Africa								
Life Satisfaction (score 1 to 10, higher the happier)	13	4.06	0.69	3.23	3.66	3.97	4.29	5.89
Region: Eastern Asia								
Life Satisfaction (score 1 to 10, higher the happier)	4	5.56	0.38	5.19	5.26	5.59	5.89	5.89
Region: Eastern Europe								
Life Satisfaction (score 1 to 10, higher the happier)	9	5.56	0.61	4.33	5.32	5.65	6.07	6.2
Region: Middle Africa								
Life Satisfaction (score 1 to 10, higher the happier)	4	4.32	0.87	3.08	4.03	4.57	4.86	5.04
Region: Northern Africa								
Life Satisfaction (score 1 to 10, higher the happier)	5	4.91	0.57	4.17	4.46	5.21	5.21	5.53
Region: NORTHERN AMERICA								
Life Satisfaction (score 1 to 10, higher the happier)	2	7.09	0.27	6.89	6.99	7.09	7.18	7.28
Region: Northern Europe								
Life Satisfaction (score 1 to 10, higher the happier)	10	6.98	0.72	5.89	6.37	7.2	7.54	7.77
Region: South-Eastern Asia								
Life Satisfaction (score 1 to 10, higher the happier)	9	5.27	0.62	4.36	4.8	5.19	5.63	6.26
Region: South America								
Life Satisfaction (score 1 to 10, higher the happier)	9	6.05	0.27	5.7	5.78	6.09	6.29	6.44
Region: Southern Africa								
Life Satisfaction (score 1 to 10, higher the happier)	4	4.16	0.61	3.49	3.72	4.22	4.66	4.72
Region: Southern Asia								
Life Satisfaction (score 1 to 10, higher the happier)	8	4.53	0.73	3.2	4.28	4.5	4.96	5.65
Region: Southern Europe								
Life Satisfaction (score 1 to 10, higher the happier)	12	5.69	0.56	4.72	5.36	5.56	6.14	6.73
Region: Western Africa								
Life Satisfaction (score 1 to 10, higher the happier)	13	4.57	0.35	3.98	4.39	4.53	4.68	5.26
Region: Western Asia								
Life Satisfaction (score 1 to 10, higher the happier)	15	5.5	1.04	3.38	4.73	5.37	6.29	7.14
Region: Western Europe								
Life Satisfaction (score 1 to 10, higher the happier)	7	7.11	0.32	6.59	6.95	7.09	7.36	7.49

(Appendix 2)

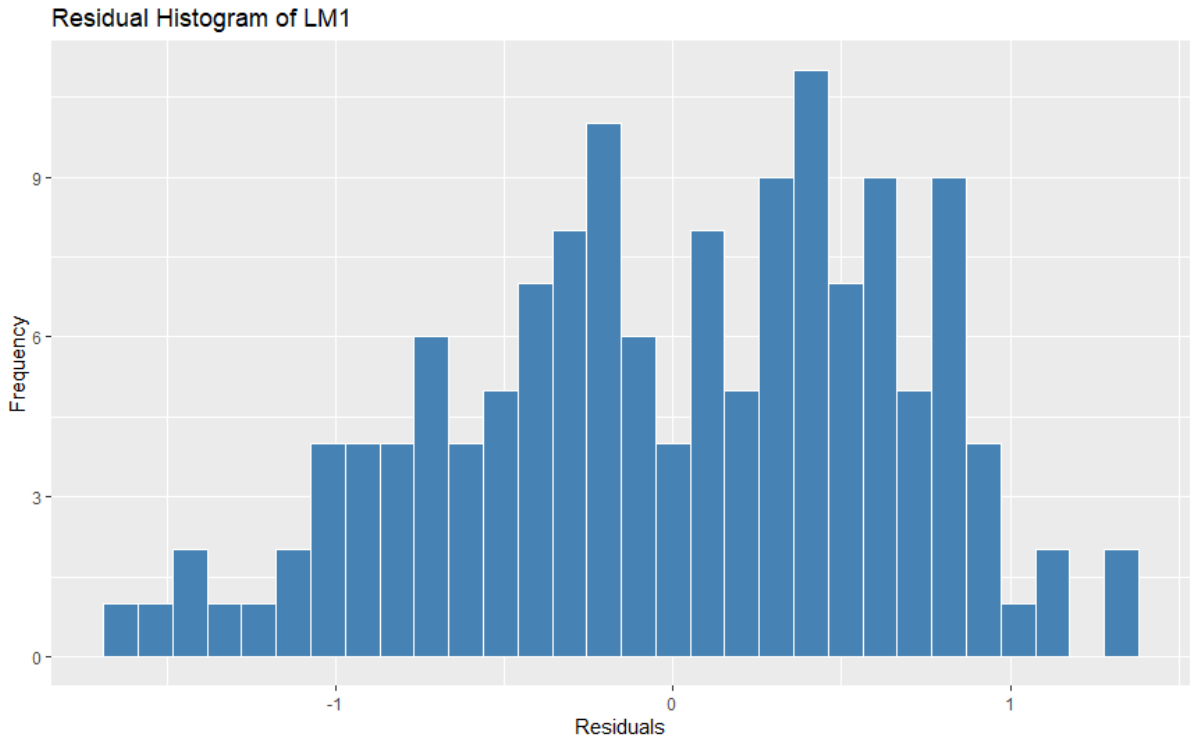
```
Residuals:
     Min       1Q   Median       3Q      Max
-1.59128 -0.44904  0.09274  0.48577  1.37578

Coefficients:
                                                Estimate Std. Error t value Pr(>|t|)
(Intercept)                                     0.332117   1.915023   0.173  0.86258
`Life expectancy`                               0.049406   0.022213   2.224  0.02781 *
log(`GDP (constant 2010 US$)`)                  0.069037   0.036015   1.917  0.05738 .
`Access to electricity (% of population)`       0.006591   0.004699   1.403  0.16298
log(`Unemployment rate (%)`)                   -0.158833   0.070170  -2.264  0.02521 *
`Inflation rate (%)`                           -0.003268   0.011127  -0.294  0.76947
`Dependency ratio (% of working population)`    0.006038   0.006080   0.993  0.32243
log(`Infant Mortality (per 1,000 live births)`) -0.347542   0.125139  -2.777  0.00627 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6726 on 134 degrees of freedom
Multiple R-squared:   0.65,     Adjusted R-squared:  0.6317
F-statistic: 35.54 on 7 and 134 DF,  p-value: < 2.2e-16
```

(Appendix 3)





(Appendix 4)



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