1.0 Introduction to Gross Domestic Product (GDP)

The Gross Domestic Product (GDP) is an economic indicator measuring the flow rate of money in a particular location. Economists measure GDP through the sum of all income, profits, and tax revenue, the sum of final products made, and the sum of expenditures which are given to the location whose economy is being measured [1].

In public discourse and from some mainstream politicians' point of view, GDP is used to indicate a place's standard of living. In recent years, Conservative organizations and politicians have blamed slow GDP growth per capita on the incumbent Liberal government and claims Canadians are getting poorer because of it [2, 3]. Poilievre himself has stated the lack of GDP growth is also responsible for high inflation [4]. Other groups such as the Alberta Enterprise Group stated GDP per capita is an indicator of a country's standard of living [5]. Clearly, politicians and political organizations believe that per-capita GDP is responsible for standard of living and/or the value of citizens' money.

However, while a strong flow of money indicates people in a particular place have the resources to spend, it does not show who has those resources [6]. Wealth inequality can not be accounted for in a GDP measurement despite its major impact on the wellbeing of most of the population. GDP also does not account for exchanges that do not involve money and items which do not have a market price. This includes both informal exchange, social factors such as life expectancy and educational attainment, and environmental resources. Environmental resources are particularly important as the health of our home planet depends on them. As a result, an ecological disaster would cause severe social welfare problems whether or not that disaster is reflected in GDP.

Thus, while GDP can show how monetarily rich a society is it can not account for inequality between residents of things with an unclear monetary value. A good measure of a society's well being would account for all those, and should be much more prominent than a simple sum of financial transactions only showing economic factors. Other indicators such as the Planetary Pressures–Adjusted Human Development Index (PHDI) add both social and environmental factors to make a more balanced index. This report examines the PHDI as an alternative metric

to GDP and whether it should be used instead. It also examines how engineers can improve East Asian countries' PHDI by focusing on underserved areas, improving healthcare efficiency to keep aging populations healthy, and to improve the efficiency of urban areas to limit their effect on the environment.

2.0 Planetary Pressures–Adjusted Human Development Index (PHDI)

The Human Development Index (HDI) is an indicator created by the United Nations to assess countries based on social factors along with economic factors [7]. The PHDI adds additional environmental factors not accounted for in the HDI [8].

2.1 Economic

To measure a nation's economy, the HDI uses the logarithm of the per-capita Gross National Income (GNI) adjusted for Purchasing Power Parity (PPP). The GNI measures the total income earned by a country's residents regardless of where that money is earned, while ignoring income made within a country earned by foreign entities [9]. The GNI is adjusted for PPP as it accounts for differing costs of living in different countries [10]. Both of these factors allow for a more accurate comparison of living standards as the GNI shows the money actually earned by a country's people and adjusting for PPP provides a more accurate comparison of what one can buy with the money they have earned.

However, since GNI is proportional to the mean rather than the median income, it does not account for income inequality. If 1% of the population earns 100 times more than the rest of the population, the GNI will make it seem as though the average person makes twice as much as they actually do. The UN Development Programme (UNDP) which created the index has acknowledged HDI (and by extension the PHDI) does not account for inequality [7].

2.2 Social Factors

The HDI uses two social factors: Life expectancy at birth as a metric of human health, and expected and mean years of schooling as a metric of human knowledge [7]. These metrics are meant to both show a society's well-being and the trained abilities of its people[7]. This provides a broad look at both health and ability but like with GNI the metrics do not account for inequality

or differences in educational quality. For example, Canada's educational quality has been declining since the early 2000s according to international tests despite years of schooling remaining around 14 years [11-13]. As well, life expectancy does not account for the number of years one might live with a disease or a severe injury. The healthy life expectancy takes these into account to provide a more representative indicator of good health [14]. However, it is not currently part of the HDI. The social factors used in the HDI may relate well with health and knowledge, but socioeconomic and educational quality differences cause discrepancies between those factors and people's true health and knowledge. Of course, PHDI and HDI still outperform GDP in social aspects as they actually examine them, ensuring that they are considered when talking about development.

2.3 Environmental Factors

Examining environmental factors puts the "sustainable" in sustainable development. The Planetary Pressures–Adjusted HDI (PHDI) adds two environmental factors to the HDI meant to account for environmental well-being: Carbon dioxide emissions and material footprint [8]. These indicators focus on the main causes of global climate change, itself the most major environmental problem facing the planet. However, the environmental factors do not take into account other climate change–causing activity like deforestation, removing trees which suck up some carbon as well as causing habitat loss.

Like the economic and social factors measured by the HDI, while carbon emissions and material footprint are reasonably accurate indicators of a nation's contribution to climate change it does not provide a full picture of all environmental damage caused by that nation. However, PHDI's acknowledgment of environmental factors puts it well above GDP, which does not at all account for any metric of sustainability preventing it from being helpful for measuring sustainable development.

3.0 How East Asian Nations Can Improve Their PHDI

3.1 China

While China's HDI is within the top 40 percent of countries globally, its PHDI is within the bottom half [15]. The main reason for the low PHDI is the country's per-capita material

footprint, which brings down its PHDI significantly more than its emissions [15]. Material use varies heavily by province, with rich, coastal regions having a material footprint over twice as large as poorer, rural regions [16]. However, resource use is still high in those rural provinces due to infrastructure construction [16]. Thus, as China's economy transitions away from construction and manufacturing and toward a more service-focused one, material consumption per capita will go down. However, the country must also improve its material efficiency to further curb it, which will improve its PHDI [17].

China's HDI lags its East Asian counterparts, Japan and South Korea [15]. According to the 2025 Human Development Report, the country's per-capita GNI is less than half its East Asian counterparts while its mean years of schooling is only 8 years, half its expected years of schooling which itself is on par with other East Asian nations [18]. This can be explained by a continual increase in years of schooling over time and inequality in education between urban and rural areas, the latter of which is declining under current government policy [19-21]. Continued investment in rural education will continue to close the gap, allowing education levels in China to match its East Asian neighbours. An improvement in education will also allow rural populations more opportunities which will increase their ability to get high-paying jobs.

3.2 Japan

Japan has the highest PHDI in East Asia, though its PHDI of 0.785 still leaves much room for improvement [15]. Its emissions are better than both of its East Asian counterparts and its carbon emissions have fallen 23% since their 2013 peak [22]. Over a third of its carbon emissions are from electricity generation of which over 85% are from fossil fuels [23]. Thus, reducing its share of electricity produced from fossil fuels would provide a strong improvement to its carbon emissions and ensure they continue declining. Japan's material productivity is higher than most OECD countries, so more efficient material consumption will do little to improve its PHDI [24].

3.3 South Korea

South Korea has a higher HDI than the other two East Asian countries, yet its PHDI is well below Japan's with its per-capita material footprint comparable to China's and its per-capita carbon emissions greater than both China's and Japan's [15]. As a result, South Korea must

mainly focus on environmental initiatives to improve its PHDI. A majority of the country's power comes from fossil fuels contributing to around 30 percent of its carbon emissions [25, 26]. Thus, South Korea would make significant strides in improving its PHDI if it decreased its reliance on fossil fuels for power. The OECD notes South Korea's material productivity is low [27]. This suggests that the country needs to use its resources more efficiently if it wants to reduce its material footprint.

4.0 How Engineers Can Improve PHDI

4.1 Focusing on China's Rural Areas

For the economic and social aspects, the main country of focus is China and the broad economic and social inequality between its urban and rural areas. Engineers can focus their efforts in ensuring rural communities get the support they need to build their social capital. We have the power to design and build good spaces in the areas of education and healthcare both to ensure rural residents have access to them but to also provide more job opportunities to these residents [28]. A particular focus on rural areas will ensure the continued decline of China's urban-rural inequality allowing its economic and social indicators to match those of other East Asian nations. Given the importance of social capital in enabling built and human capital to succeed, the social impacts should be the focus rather than economic goals [29].

4.2 Adapting to Aging Societies

That does not mean the other East Asian nations do not need help as well. South Korea and Japan have extremely low fertility rates, leading to a shrinking workforce which can not support the increasing number of elderly citizens [30]. This will particularly impact health care, and engineers have developed solutions such as portable health clinics to reach more people who can not quickly access a doctor [31]. Other solutions to ensure more efficient delivery of work and health care will be vital in these countries to ensure their social capital remains strong, preventing economic problems and the deterioration of other types of capital which rely on social capital.

4.3 Building More Sustainable Cities

All East Asian countries can improve their environmental metrics. This is most important as all capital relies on natural capital to be useful. A study of cities in China noted that public transport investment drove sustainability, but that if people do not use it enough compared to their cars the cities will still not be particularly sustainable [32]. Another study in the country found that its cities' environmental efficiency varied between cities due to their design [33]. Indeed, more efficient cities can create more than tenfold changes in carbon emissions and we as engineers must design spaces to allow for these efficiencies to ensure the Earth's natural capital remains sound [31].

5.0 University Education Partly Helps

Coming back to my experience here in Canada, my course work and extracurricular activities are somewhat but not completely preparing me to improve outcomes. The Engineering Strategies & Practice courses introduced engineering design but simply told us to obey our client whether or not the assigned project truly improves outcomes. CME259 brought up ethics and the importance of improving outcomes in a clearer way, but did not apply it to any engineering projects. In my extracurricular activities, sustainability and improving outcomes have both been rather neglected as topics for consideration. The closest I have come to doing this is in my personal transportation projects, where I have mainly been attempting to make transit operate more efficiently or find untapped potential for transit demand, but never in a way which suggests my goal is to improve outcomes in any category [34]. Improved investment in bus operations was not shown as a clear way to improve environmental outcomes, but higher transit use helps [32]. Clearly, my time in university has only partly introduced me to the role of engineers in improving outcomes and the closest I have come to doing that is in projects I have done on my own time. Thus, I am not being prepared well to improve the world's broad environmental, social, or economic outcomes.

6.0 Conclusion

GDP is not a great indicator of a society's progress. It only focuses on the economy, and does not even account for inequalities that may prevent an improvement in human and social capital. While PHDI includes all types of capital, it also does not factor in inequality very well. In spite of this, its inclusion of all types of capital makes it a significantly better alternative than GDP.

The East Asian countries examined show how all nations need significant improvement in the social and especially environmental metrics to ensure sustainable development. There is significant progress needed to ensure the world can develop sustainably, even with what is prioritized in a university education.

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