DEVELOPMENT OF A QUANTITATIVE MODEL FOR DECISION MAKING IN SUSTAINABLE DEVELOPMENT (SD)

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ABSTRACT

Sustainable Development (SD) addresses the challenges by meeting the needs of the present generation without compromising the needs of future generations. Due to the changing nature and the increasing complexity of the modern economy, the consequences of future developments and interventions by governments are generally difficult to perceive and to incorporate into policy making. A framework has been proposed in this paper to consider economic, social, environmental aspects and quality of life. Many of the decision variables are qualitative and subjective. Researchers agree that it is important to quantify these variables for policy decisions in areas such as, the Energy Trading Scheme (ETS), economic and social challenges. A quantitative model is proposed to integrate these issues in a meaningful way for helping decision makers to take short-medium-long term decisions on SD covering the entire value stream.

Key Words: Sustainable Development (SD), Quantitative model, Decision making

1. SUSTAINABE DEVELOPMENT

A review of SD practices around the world exhibit some key observations. The first is the extraordinary broad list of items to be sustained and developed. This reflects the inherent malleability of the term "sustainable development". In many cases, the initiative is undertaken by a diverse set of stakeholders, and the resulting lists reflect their varied aspirations. With many stakeholders, each with different definitions of SD, achieving consensus often takes the form of long "laundry lists" of indicators, thus, to be inclusive; the range of indicators becomes very broad.

Data suggests that today's extractive industries (mining, energy, chemicals, forest products, agriculture, and transportation) are not environmentally sustainable. If the entire world were as materially intensive as the North America, it would take three planets to support the material requirements of the current world population. This has lead to the understanding that the task for SD is to find ways of reducing (decoupling) the amount of resource (e.g. water, energy, or materials) needed for the production, consumption and disposal of a unit of good or service based on the assumption that reducing resource use generally equates to reduced environmental degradation. Most efforts in 'greening and 'environmental management' serve only to improve incrementally the performance of existing products and processes.

Industry-based collaboration in climate control initiatives aids leading organizations to rewrite rules that are in their favour. [1].

The other major observation is the absence of space and time dimensions in SD practices. In a world of globalization marked by an integrated global economy, free-trade, free flow of capital, and the tapping of cheaper foreign labour markets the SD of an organization, region or a country is heavily influenced or even dependent upon the happenings outside its own space. The Global Financial Crisis of 2008 clearly indicates the reliance of economies on one and other for their subsistence and no organization or country is impervious to such a crisis. Time is another important dimension which has not been considered in current SD practices. Impacts of SD initiatives might manifest themselves in different time horizons.

Failing to recognize the significance of space and time undermines the impact of initiatives taken towards SD by stakeholders, who publish annual reports to indicate their progress towards SD. Majority of the reports review, track and report indicators that bear little significance to SD and are done to abide by International Audit Standards or to be recognized by investors as companies/regions that meet globally recognized SD norms. As indicated by a McKinsey report majority of the stakeholders follow SD as an obligation rather than a strategic tool that could help them to investigate the impacts of their decisions.

This paper looks at the development and application of an Integrated Model for SD (IMSD) to the coal industry. The paper is structured in 5 sections. Section 2 looks at the coal industry and its significance to the world economy. In section 3 an overview of the Australian Coal Industry is presented, followed by the application of the IMSD to the Australian coal industry in section 4 and conclusion in the 5th section.

2. COAL

Rapid world population growth and economic development, particularly in developing countries, is resulting in phenomenal growth in world energy demand. If the aspirations of many of the world's people, 2 billion of who currently have no access to electricity, has to be met, coal will play a major role in meeting this demand for at least the foreseeable future.

Coal contributes to about 24 % of global primary energy demand, second only to oil (35 %), and is used to produce 39 % of the world's electricity. Coal is also the key requirement for the production of steel, aluminium and cement. Around 14 % of total global coal production is used to produce over 66 % of the steel produced in the world. Coal remains an important input for the global cement industry. The world uses more than 1,350 million tonnes of cement every year.

Coal reserves are significantly more abundant and much more widely dispersed than other fossil fuels, which are concentrated in unstable regions. Coal is therefore well positioned to make a valuable contribution to global security. Current reserves to production ratios of coal are sufficient to last well over 200 years. This is approximately four times the level of known reserves of oil (about 45 years) and gas (about 65 years) [2].

3. AUSTRALIAN COAL INDUSTRY

Black Coal represented around 19 % of Australia's total commodity exports in 2005-06, worth more than $A24 billion [3].

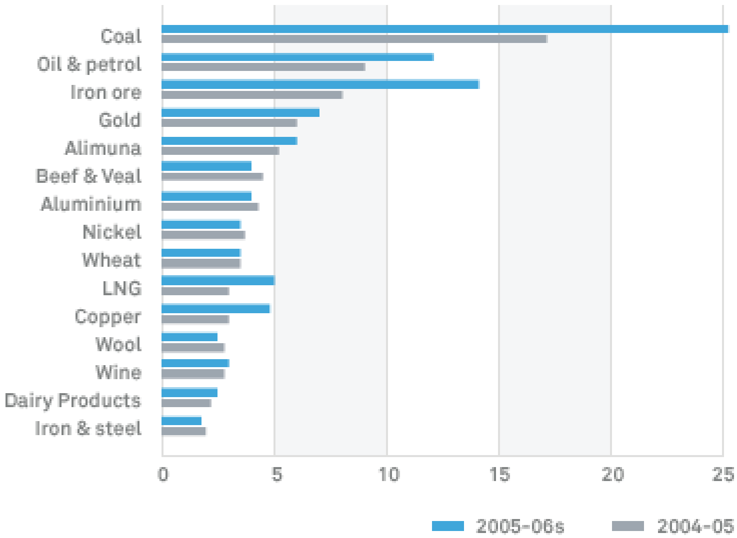

Figure 1: Australia's Largest Commodity Export [4]

Australia maintains its position as the world's largest coal exporter with 30% of the world total with major markets being Japan (44%) and other Asian economies, which together account for just over 80% of Australian coal exports. With 3 out of the 4 BRIC (Brazil, Russia, India and China) countries being the top importers of Australian coal it augers well not only for the industry but also for the Australian economy.

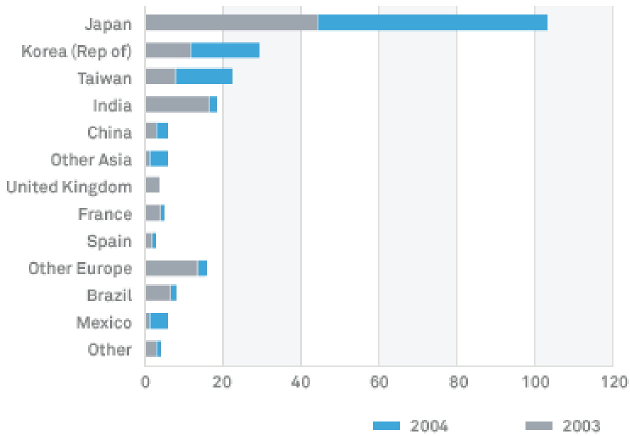

Figure 2: Markets around the Globe [5]

The Coal industry is a major force driving the social and economic development of many regions in Australia as it brings major flow-on benefits to all sectors of the community. The coal industry is supported by a strong equipment and services sector and contributes significantly to the local economy. Additional jobs are created in ancillary industries like tyre and fuel suppliers, engineering works and the transport industry. The trains transporting coal in Australia are among the longest in the world. These industries contribute significantly to the national economy.

SD practices in the Coal Industry follow a similar path taken by organizations around the world. The connotation of the term SD has been conflated with ‘greening’ activities and publishing annual reports. The need for a strategy for SD hasn’t been recognized. The implications of changes in society, the availability of natural resources and the implementation of climate change initiatives on the long-term sustenance of the industry are yet to be addressed.

4. IMSD FOR THE AUSTRALIAN COAL INDUSTRY

4.1 CHALLENGES FACING THE COAL INDUSTRY

One of the biggest challenges facing the Coal industry in Australia amongst others is the ETS. While the Government debates on the amount of carbon reduction targets, it is almost certain that Australia would commit to some reduction targets in the near future. While the reduction target remains unclear, the major concern is the affect of such a scheme to the Australian coal industry, the industries in the value chain and the ancillary industries. As it stands, a 5% reduction in carbon emission by 2020 from 2000 targets equates to 250 million tonnes of emissions taken out of the system. This is equivalent to the total emissions that the transport and power generation industries contribute. While industries in Australia would be subject to such targets, it is unlikely its competitors in countries in South Africa, Indonesia, Mongolia, Mozambique, Columbia, and a range of countries would adhere to such targets. This makes these countries economically attractive and would encourage investments offshore [6]. This has ramification transgressing beyond the coal industry. Jobs lost in any sector would not only put a strain on the social fabric but would also underpin the government's plan for future growth.

Though addressing climate change initiatives is imperative for the quality of life of people, leading researchers are unable to quantify its affect on peoples' lives. The IMSD tries to integrate these issues in a meaningful way for helping decision makers to take short-medium-long term decisions on SD covering the entire value stream.

4.2 DESIGNING THE IMSD

The IMSD would contain the following components:

- Objective function
- Decision variables
- Constrains

Objective function: The objective function would define the criteria for evaluating the goodness or badness of the solution [7]. The IMSD could have multiple objective functions; viz, maximizing revenue, minimizing the environmental impact and improving the quality of life.

Decision variables: Decision variables would be input conditions controlled by the decision maker. The stakeholder might want to know the affect of fluctuating fuel prices or the value of the currency on their business. The stakeholder could select the best numerical values of the variables for the objective function.

Constrains: The constrains are a set of functional equalities or inequalities that represent physical, economic, technological, legal, ethical, or other numerical values that can be assigned to the decision variables. The constraints under which organizations would have to work could be a carbon reduction target set by the Government, or in the case of a mining organization, the throughput of a mine which cannot exceed the mineral reserves of the mine.

The SD Framework is presented below using 4 themes: Economic Growth, Production Pattern, Environment and Quality of life. These themes are further divided into 16 issues. The framework indicates the interactions between the pillars of SD.

SD Framework					
Issues		Themes			
	UOM	Economic Growth	Production Patterns	Environment	Quality of Life
EBITDA	$				
Revenue	$				
Gross Profit	$				
Earnings per share	$				
Total Production	(000)t				
Material Intensity	kgs/ $1000 of GDP				
Generation of Waste	(000)t				
Share of renewable energy sources in total energy use	%				
Emission of Greenhouse gases	ppm				
Consumption of Ozone depleting substances	Weighted tonnes of ODS				
Land Degradation	% of land area affected /(000)t produced				
Work Environment	hrs/week				
Income ratio	average wage/national average				
Cost of living					
Liesure	hrs/week				
Social Life					

Figure 3: SD Framework [5]

- **The objective function for the framework could be**
  - maximize economic growth
  - minimize the impact on environment
  - maximize quality of life

- **The decision variables could be**
  - Hedging the value of the ($/ commodity prices): the business would gain if the value of the ($/ commodity prices) appreciates, but stands to lose if their value depreciates
  - Investment in new technologies: would involve an initial cost, but the cost of not investing might be much greater if the business looses ground to its competitors
  - Expenditure on resource acquisition: the decisions could be to invest in further mines, in the anticipation of a hike in demand from major importers. The alternatives could be to explore sites locally at higher labor costs, but a stable working environment, or to explore offshore where costs would be minimal but in an uncertain environment.
- **The constraints could be**
  - Emission reduction targets set by the Government
  - Availability of infrastructure to conduct the business activity
  - Future offtake from importers because of policy changes by the local governments.

Addressing all the above stated conditions in their totality is a prerequisite for the existence for any business; researches agree that quantifying the impact of individual parameters on one another is a task fraught with difficulty. The IMSD tries to decipher the interactions between these parameters and presents a framework for stakeholders to make informed decisions.

5. CONCLUSION

The changing nature and the increasing complexity of the modern economy, the pace of development for alternate sources of energy, the implications of the affect of climate change and government interventions are generally difficult to perceive and incorporate into policy making. A quantitative model for SD is proposed to integrate these challenges in a meaningful way to help decision makers to take short-medium-long term decisions on SD covering the entire value stream.

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