

## TOWARDS A SYSTEMS APPROACH TO SUSTAINABLE DEVELOPMENT

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*“Sustainable development” as a concept was popularised by a 1987 report of the United Nations World Commission on Environment and Development. The report defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. However, from this definition, we cannot ascertain the central intuition of the notion of sustainable development. Failure to do this makes it difficult to derive methods that can be used to formulate effective intervention policies that can enable nations to attain sustainable development. This paper briefly reviews various schools of thought in popular literature on the notion of sustainable development, exposes their weaknesses and develops a holistic notion of sustainable development based on the systems approach.*

### 1 INTRODUCTION

#### 1.1 Truman’s Development Legacy

The development era can be said to have started on 20 January 1949 when American President Harry Truman in his inaugural speech before Congress defined for the first time the conditions of the poor countries as ‘underdeveloped areas.’ This definition established a single category for the South, despite their immeasurable diversity: the underdeveloped countries. Truman’s coinage was, according to Wolfgang Sachs [1], a precise expression of a worldview. According to this worldview, all the people of the world were moving along the same track; some faster, some slower, but all in the same direction. The Northern countries were running ahead, whilst the countries in the South, with their low per capita income, were lagging behind. The premise of Truman’s worldview is that civilisation in a country is indicated by the level of production. To him the world is an economic arena where nations compete for position on the Gross National Product (GNP) scale. No matter what ideals inspired the diverse nations of the South, Truman recognised them only as stragglers whose historical task was to participate in the development race and catch up with the lead runners. It was, consequently, the objective of the development policy to bring all the nations into the arena and to enable them to run in the race.

The policy instruments employed to turn the southern societies into economic competitors were capital injection, technology transfer and cultural transformation. The latter was deemed necessary, for many traditional ways of living were considered to be ‘impediments of development.’ Productivism and the accumulation of wealth, the core traits of the economic society, were to be inculcated into the societies of the South. This was to be attained through the application of textbook microeconomic models, which required revamping all kinds of institutions – law, education, economy, governance, etc. – and hence, the degradation of the traditional style or ethos of doing things.

Science and Technology were viewed by Truman as pivotal to increased production and hence to greater prosperity, and were seen as the reason for the superiority of the North. The call for the transfer of technical assistance and technologies of all sorts from North to South was clear and loud. This process received another boost when John F. Kennedy challenged Congress on March 14, 1961, to finance the ‘Alliance for Progress’. Countless programmes of aid and assistance consisting of technical assistance, technology transfer, foreign aid, and the like, were launched in the decades following the speeches.

After 50 years of development, the state of affairs is dismal. The gap between the North and the South keeps on widening, and it is inconceivable that it can ever be closed. Although the developing nations account for 80 percent of the world population, they occupy only about 54 percent of the land area, and their world output has shrunk to about 15%. Large majorities of people in most developing countries live today in greater hardship and misery than at the time of decolonisation [1]. K. Saeed [2] identifies some of the intractable problems as skewed distribution of wealth in favour of a few elites whilst the majority live in abject poverty, population growing faster than GNP and hence perpetuating the problem of low income per capita, political instability due to civil strife, high illiteracy levels, and environmental degradation.

It has also become evident in recent years that Truman’s racetrack may lead to a collapse of the global system. Largely because of the tapping of fossil minerals, energy use has skyrocketed, the enormous increase in energy and material inputs into industrial production being accompanied by generation of waste. Threatened as a result are the earth’s limits to serve as ‘sources’ for the inputs and ‘sinks’ for the wastes of economic progress. Sachs [1] argues that five or six planets the size of the earth would be needed to serve the economic system if the developing countries were



to attain the production and consumption levels of the North. Recognition of the finiteness of the earth is thus a fatal blow to the idea of development as envisaged by Truman.

Due to the failure of Truman's development theory to deal with critical issues, there is a shift in paradigms from the traditional development theory based on the notion of economic growth as an equivalent to progress, to that based on the notion of sustainable development. As is the case with any new and evolving paradigm, there are currently various views aimed at interpreting this notion. In the next section, we review briefly the various interpretations of sustainable development. The aim is to show that most of these interpretations are inadequate in guiding inquiry towards pragmatic attainment of sustainable development that preserves nature whilst improving the quality of life.

## 1.2 The Notion of Sustainable Development

"Sustainable development" as a concept was popularised by a 1987 report of the United Nations World Commission on Environment and Development, *Our Common Future* [3], commonly referred to as the Brundtland Report. The report defined sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*".

We cannot ascertain a holistic central intuition of the notion of sustainable development from this definition. Ideally, the definition should develop the metaphysical, axiological, and epistemological notion of sustainable development within the systems approach. Axiology will answer questions of *why* sustainability is important, *why* it is the only viable alternative, and *why* it is unethical not to pursue it in preference to economic growth oriented development. Metaphysics will address *what* really constitutes sustainable development and *what* its metaphysical status is. Epistemology will look into *how* we should pursue it, *how* we can know that the path we are pursuing is sustainable and *how* we can ascertain that our policies are on a sustainable path.

## 2 INADEQUATE WORLDVIEWS ON SUSTAINABLE DEVELOPMENT

Developing the metaphysical, axiological, and epistemological notion of sustainable development within the systems approach is essential if nations are to derive methods that can be used to formulate effective policies. The proliferation of diverse schools of thought attempting to interpret the notion exacerbates the urgency. Five of these schools of thought, and their weaknesses, are briefly discussed below.

### 2.1 The Brundtland Report's Notion of Sustainable Development

The Brundtland Report is, in essence, an attempt to develop the notion of sustainable development and practical means of pursuing it, through compromise between development in the name of a global economy, and a balance on developmental and environmental policies. The report focuses on practical strategies for reviving growth, for meeting essential needs, for controlling population growth, and for sustaining, and if possible enhancing, basic resources. It addresses the need to reorientate and manage the associated risks, and include concerns for the environment within economic calculations.

According to Stanley Carpenter [4], the Brundtland Report attempts to reconcile two irreconcilable goals. One is to revive growth (at least partly to meet the needs of the world's poor), while the other is to avoid environmental degradation. What is wrong with this is that the "predominant" theory relied on in the report to assure the achievement of these goals is indefinite growth. This is incompatible with the goal of living within natural limits. Lacking in the report is thus a theoretical foundation that coherently explicates the metaphysical, axiological, and epistemological notion of sustainable development that can be used to guide national policy formulation.

### 2.2 Economists' Notion of Sustainable Development

To Jan Bojo, Karl-Goran Maler and Lena Unemo [5], it is possible to interpret the Brundtland definition as a demand that "all options [be] preserved, which would imply the preservation of all kinds of resources". This might, they say, even lead to the ridiculous conclusion that no oil – or iron, or any other exhaustible resource – should be used; that all resources ought to be left for future generations. To avoid any implication of this type, they propose an operational definition of sustainability that allows for substitutions saying, "*Economic development in a specified area (region, nation, and the globe) is sustainable if the total stock of resources – human capital, physical reproducible capital, environmental resources, exhaustible resources – does not decrease over time.*". They go so far as to say that "The cutting down of forests in order to increase export earnings is consistent with sustainable development", but also immediately add, "only if the whole or parts of the proceeds are invested in other export earning or import reducing activities in order to maintain the welfare of future generations".



Robert Solow, quoted by Shiva [6], also makes a similar argument: "If it is very easy to substitute other factors for natural resources, then there is, in principle, no problem. The world can get along without natural resources, so exhaustion is just an event, not a catastrophe" He thus defines sustainability as "an obligation to conduct ourselves so that we leave to posterity the option or capacity to be as well off as we are" According to this definition, all resources, including ecosystems, are fungible (i.e., substitutable). As noted by Norton [7] in interpreting Solow's definition, the "bequest package" that we pass on to our heirs is unstructured. "Monetary capital, labour, natural resources, and ecosystem functions are interchangeable elements of capital."

The care taken by Bojo [5] and others to deal with the problems associated with implementing sustainability through substitution is, however, in vain. Sustainability in this context does not involve recognition of the limits of nature and the necessity of adhering to them. It perpetuates the myth of man's domination over nature, leading into the current global ecological predicament.

### **2.3 Neo-Marxists' Notion of Sustainable Development**

Developing countries' spokespersons, suspicious of the capitalist underpinnings of traditional development theory, are quick to point out that researchers and practitioners have not accorded the same high priority to the needs of the poor as had the Brundtland Report itself. As W. R. Redclift [8] puts it, "Unless poor people are involved in meeting their aspirations," development can never be appropriately sustainable. Industrial growth needs to be redirected towards meeting the needs of the world's majority; renewable energy resources need to receive greater attention; natural resources and policies need to be shifted from the arms race to the protection of agronomic and biological resource systems [8]. He says what is called for is an historical analysis of the relationship between development and the environment. Such an analysis, he says, will reveal the limitations of those approaches that view development exclusively in terms of economic growth.

Redclift's view is however idealistic as it fails to explicate the methodology that can be used to ensure that emancipation of those affected through involvement in setting goals will lead to desirable results. How should the developing countries resolve pluralistic or coercive development goals? How do they know that the goals they are pursuing are most likely to lead to sustainability? How do they know if they have reached an appropriate compromise between the natural environment and the pursuit of economic growth?

### **2.4 Bio-Centric Notion of Sustainable Development**

Bio-centrists view the protection of the environment as the most important aspect of sustainability. They call for a revolution in economics, where nature is preserved, not as a resource, but as the common matrix within which humans live. Stanley Carpenter [4] argues for steady-state economics as opposed to traditional growth oriented economics. The former, he argues, conforms to the notion of autopoiesis which, as defined by ecologist W. Rees [9], is "the process whereby living organisms draw from a constantly regenerated environment and reorganize themselves." It is this process that necessarily comes into conflict with the demand for infinite growth postulated by almost all current economic models. In M. Sagoff's [10] view, economics is a matter of co-operative human behaviour – including co-operation to preserve and conserve nature. To treat nature as a resource is only to expose it to exploitation, which may endanger its survival.

At a pragmatic level, applying the bio-centrist's notion of sustainable development is problematic, mainly because the axiological, metaphysical, and epistemological concepts of bio-centrists' sustainable development are underdeveloped. As presented by its advocates, it tends to imply that nature ought to be preserved at the expense of the increased hardship of the world's poor, through the imposition of economic growth limits. Owing to its conflict with the dominant materialist ethics, it is not readily accepted by the majority of both developing and developed countries. Also, owing to theoretical underdevelopment, it is difficult to derive a coherent methodological framework for attaining this notion of sustainable development. Questions that need answers include the following: What is it that constitutes nature? Are all the constituents of nature to be preserved? How do we conserve nature and attain sustainable development? How do we know that sustainable development is likely to be attained? Why should nature be preserved if it limits economic growth? Why should developing countries conserve nature if its exploitation can increase short-term growth?

### **2.5 Culture Advocates' Notion of Sustainable Development**

According to Sachs [11], the biological metaphor of the evolution of nature has been turned into treating people, whole societies, and nature itself as resources for economic development. He warns, "Labelling things as 'resources' takes off whatever protective identity they may have and opens them for intervention from the outside, ... and reconstitutes them as objects for



management by planners and for pricing by economists". He considers the notion of sustainability to be utopian, and warns of the *either-or fallacy*, whereby it is assumed that the opposite of development is stagnation. According to him, "Distinctions such as backward/advanced or traditional/modern have become ridiculous given the dead end of progress in the North, from poisonous soils to the greenhouse effect" [12]. It is the multiple and diverse cultures of the world, and in particular the so-called undeveloped world - that can offer hope. What we need, Sachs says, are "efforts to elucidate the much broader range of futures open to societies which limit their levels of material output in order to cherish whatever ideals emerge from their cultural heritages".

This ideological view has merits and demerits. It argues for preservation of cultural identities, as it is diversity, both bio and cultural, which ensures global system viability. A monoculture limits the chances of survival of humans for they may all be on a single track to doom. Ackoff [13] also takes this view that cultural diversity is more desirable than the current trend of breeding a Western monoculture for the human race. However, it argues against any form of development, including sustainable development. There is the danger of stagnating the 'developing countries' while the 'developed' take advantage and have a field day on the limited resources. Poor nations will continue to aspire to meet the basic needs of their people, and in pursuance of their short-term goals, they may desecrate nature. The issue is therefore not if, but rather how, sustainable development should be pursued.

### 3 NOTIONS OF SUSTAINABLE DEVELOPMENT

#### 3.1 Metaphysical Notion of Sustainable Development

The philosophy used in development of the notion of sustainable development is that of Charles Sander Peirce (1839-1914). According to Peirce, Firstness, Secondness, and Thirdness roughly correspond to the following modes of being: possibility, actuality, and the law. Firstness is characteristic of the mode of being which consists in its subject's being positively such as it is, regardless of anything else (CP 1.25)<sup>1</sup>. Secondness or actuality is typified by experience of effort, or resistance; of struggle or opposition. Thirdness consists in the fact that future facts of Secondness will take on a determinate general character. It is characterised by its mediating role. Law, governing events, mediates between pure possibility

(Firstness) and pure actuality (Secondness). In logical terms, we can say that Thirdness is always, and exclusively, a triadic relation.

In applying this philosophy, we can infer that sustainable development belongs to a category of Thirdness because it is a *law* mediating between the ends (Firstness) and the means (Secondness) of a system. The ends in this case are the desirable or ideal goals that a system ought to pursue to ensure its future existence, and the means are the actual processes that the system is undertaking to attain the ends. The law of sustainable development is obeyed if the means are directed towards the desirable ends of the system.

The view of sustainability as a law can also be inferred from researchers such as Hartmut Bossel [14], Jorgen S. Norgard [15], and Goodland [16]. The human-made economy is a subsystem of the total ecological system. This system is closed with respect to material exchange, and open with respect to energy exchange, with the outer space in the form of solar energy coming in, and heat energy radiated out (see Figure 1).

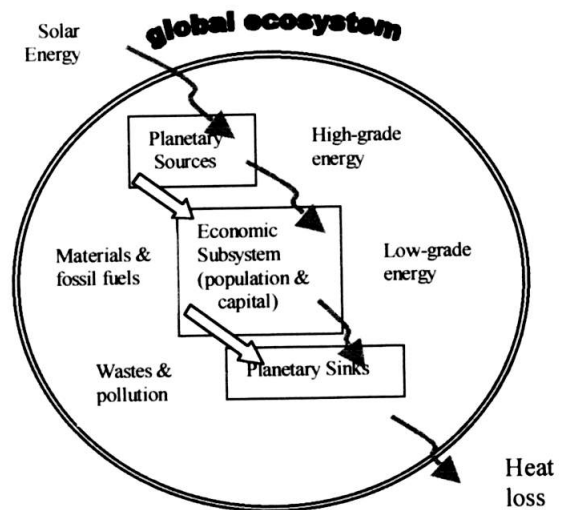


Figure 1 Illustration of the human made economic system as part of the global ecological system (Source: Goodland (1991) and Norgard (1996))

The ecological system has to obey natural laws and system laws to remain. The laws of nature that apply are the First and the Second Laws of Thermodynamics. The First Law (the *Law of Conservation of mass and energy*) states that energy and mass cannot be created or destroyed while the Second Law (*Law of Energy Degradation*) states that there is an irreversible loss of the ability to do work associated with all material processes. These laws have to be obeyed by the ecological system.

<sup>1</sup> Peirce, C.S. *Collected Papers of Charles Sanders Peirce*. Vol. 1-8. Charles Hartshorne and Paul Weiss (eds.), Harvard University Press, Cambridge, MA, 1931. Citation CP1.25 refers to volume 1, paragraph 125.



Also, ecological processes obey three basic system laws:

**Law 1: *Self Organising Systems Law.*** Complex systems organise themselves; the characteristic structural and behavioural patterns are a result of the interactions among the system parts [17]. In ecosystems, the self organising process results in energy and matter flow whose macroscopic variables obey non-linear equations [18].

**Law 2: *Feedback.*** The output of a complex system is dominated by the feedback and, within wide limits, the inputs are irrelevant [17]. Population growth, for example, is driven by a positive feedback loop between the state of population and the birth rate. There is also a negative feedback loop between the state of population and the death rate. If the birth rate continues to be higher than the death rate, the population will grow exponentially as the positive feedback loop dominates the system.

**Law 3: *The Law of Requisite Variety.*** Given a system and some regulator of that system, the amount of regulation attainable is absolutely limited by the variety of the regulator [17]. According to this law, the maximum possible effectiveness of the regulator will be directly measurable by a comparison between the variety of the regulator and that of the reguland.

We can thus infer that sustainability is a law that mediates between the ends and the means constrained by the natural and systems laws. Sustainable development has to work within these laws to ensure that the ends which the systems is aiming for are ideal and desirable, and the means are likely to lead to those ends.

The total potential energy from all (still available) fossil and nuclear fuel resources is roughly equal to solar energy received by the earth in one month [18]. The fossil fuel resources are non-renewable and, at the current rate of exploitation, they cannot be the foundation for sustainable development. Furthermore, they impact adversely on the environment because of their emission of CO<sub>2</sub> and other pollutants. Nuclear wastes also threaten the environment as they are hazardous for thousands of years.

According to Norgard [15], *the current global ecological predicament is a symptom of a too high flow of energy and materials, extracted from the ecosystem, passing through the ecosystem, and discarded back into the ecosystem as waste. The high flow is aggravated by a growing number of people, increasing their material affluence, using inappropriate production methods, all in a limited global ecosystem. Although not all energy sources or raw materials are equally harmful, sustainability is basically a question of keeping the flows sufficiently low. This is a question of axiology.*

### 3.2 Axiological Notion of Sustainable Development

According to Peirce, aesthetics belongs to the category of Firstness. It is the study of the monadic, aesthetic quality of the end in itself. For an object to be aesthetically good, “[it] must have a multitude of parts so related to one another as to impart a simple positive quality to their totality” whatever that quality may be. It is the *summum bonum*. It is not a state of absolute harmony and absence of strife but rather a feeling that accompanies increasing order of harmony.

Also, practices (ethics) belongs to the category of Secondness, as it studies the dyadic relationship of conformity of means and ends. It aims to determine the ends to which one’s will ought to be directed. Our part of the *summum bonum* is expressed in Peirce’s interpretation of the Golden Rule: “*Sacrifice your own perfection to the perfectionment of your neighbor.*” The axiology of Peirce’s philosophy is opposed hedonism in which man competes against both fellow man and nature.

Sustainable development theory as espoused by leading systems theorists captures the concept of Peircean aesthetics and ethics. Bossel [12], argues that nations can opt between two ethical paths of development: Path A “*Competition*” and Path B “*Partnership*” (Figure 2).

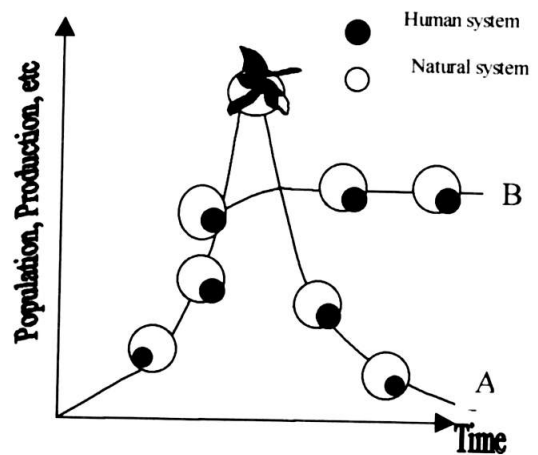


Figure 2. Sustainable Development vs Unsustainable Development.

Path A is an unsustainable ‘business as usual’ scenario where nations pursue economic growth without regard to the social system’s long-term ability to survive. The models of Meadows [19]; [20] have also demonstrated the non-sustainability of this path. They argue that collapse of the system is inevitable if the growth of the



population and the economy exceed its carrying capacity.

Meadows' critics argue that science and technology, and discovery of new resources, will raise the capacity limits. This argument may have merits, but there is compelling evidence indicating that this may be only partially true for developed countries and less so for most developing countries. Kinsley [21], contends that over the past thirty years, the fertile land of Ethiopia has rapidly turned into a desert because intensive farming practices exhausted the soil and it is now unable to provide sufficient food for its society. Can the eroded limits be raised? Maybe, but it may be too late for the current generation of Ethiopians. National system decay is not new. Several ancient cultures collapsed because the increase of affluence and population led to an over-exploitation of the natural environment [22]. Civilisations like the Mesopotamians (circa 2000 B.C.), the Maya (800 A.D.) and the Polynesians on Easter Island (1500 A.D.) show that a nation that over-exploits its natural system endangers its long-term survivability.

Path B is that of sustainable development. Such a path is not necessarily against economic growth, but it is processes which ensure that resource use and environmental pollution remain within the regenerative potential of the resource base and environment. It is pro development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Hence, we argue that it is the only viable alternative for national development.

### 3.3 Epistemological Notion of Sustainable Development

According to Peirce's pragmatic maxim, the meaning of a concept is attained through establishing the relationship between the concept and elements affecting it. It is attained through the study of the *situation*.

As noted earlier, sustainable development belongs to a category of Thirdness, a law that mediates between the ends (Firstness) and the means (Secondness) of the system. Our study of the situation should ascertain whether the ends are desirable, and whether the means are likely to lead to the ends. In development of the axiological notion of sustainable development, we presented aesthetic and ethical ideals that are purely theoretical and vague. This vagueness is prudent as it allows practical values to evolve through time. There is however a need to answer the following epistemological question: *How do we know that the system is on a sustainable path of development?* The answer lies in the development of a systemic indicator set for sustainable development.

#### 3.3.1 A need for a systemic set of indicators

Using Gross Domestic Product (GDP) as the key indicator of national development has been criticised by researchers [23], [24]. One criticism is its failure to differentiate services adding value to the society, from those that are not. The other major criticism levelled at GDP is that it encourages nations to pursue short-term goals that may be detrimental to their long-term survival. Acceleration of deforestation to generate income will undoubtedly increase GDP, but if deforestation occurs at a rate faster than reforestation, long-term consequences may arise. Rather than being mere accumulation of material and monetary wealth, development should enrich the overall well being of society. As noted by Bossel [23] "GDP is mainly a measure of how fast resources are squandered and converted to money flows, irrespective of their effect on society." It can thus not be relied upon to measure the well being of the system.

Methods to try to redress the imbalances of the GDP measures for progress have been developed by various researchers. One such measure is the Index of Sustainable Economic Welfare (ISEW), which has evolved into the Genuine Progress Indicator (GPI). Though this measure is an improvement over GDP, it cannot inform us of the critical problems in the system, which need to be addressed.

The UNDP uses the Capability Poverty Measure (CPM) which considers the lack of three basic capabilities: The first is the capability to be well-nourished and healthy – represented by the proportion of children under five who are underweight. The second is the capability for healthy reproduction – proxied by the proportion of births unattended by trained health personnel. The third is the capability to be educated and knowledgeable – represented by female illiteracy. This is a useful measure as it forces nations to concentrate on addressing the issue of poverty rather than just improving the GDP measure. However, it is mainly money-driven, and, as noted before, the collapse of ancient cultures indicates that affluence is not a guarantee for system viability.

The ability of a nation to survive and evolve depends on its ability to source intelligence from its environment, and make effective decisions that will aid its strivings for its normative goals [25]. A nation is comprised of subsystems, and improvement of the subsystem should occur only if it leads to the improvement of the whole. However, time lags occur before the impact of the policies implemented by one sector on the whole is detected. Usually, by the time detrimental effects are noticed, it is too late to take corrective action. It is thus



critical that a comprehensive set of indicators be used to monitor the performance of the subsystems, thus enabling governments to take corrective action whilst there is sufficient time.

### 3.3.2 Systemic view of a nation

A nation is a conglomerate of many complex dynamic systems, organisations and individuals interconnected in a myriad ways that can be divided into subsystems aggregated under headings like environment and resource, infrastructure, economic, social, individual development, and government (See Figure 3).

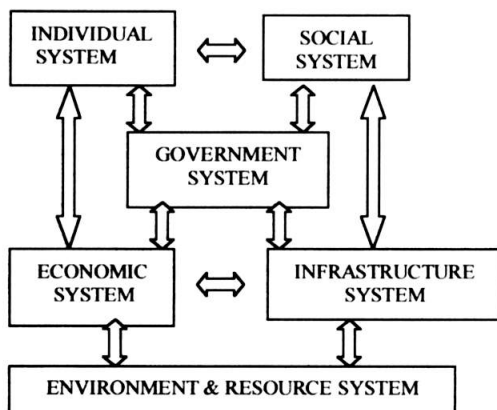


Figure 3: Six major subsystems of a nation and their major relationships.

The *infrastructure* provides essential services to the social system and provides the facilities and possibilities for individual development. The quality of the infrastructure depends on the economic system's productive power and the government's efficiency and performance. In its use of land, waters, atmosphere, and the waste absorption capacity of ecosystems, the infrastructure system has a major impact on the environment and resource system.

The *economic system* provides essential services to the infrastructure that maintains the social system, and to individual development. Its performance is greatly affected and partly regulated by the government system. The material and energy resources needed by the economic system are drawn from the environment and resource system, which also has to absorb wastes and pollutants resulting from human activities.

The *social system* is a vital fabric of relations between humans that both supports and constrains individual human development. It depends on the infrastructure system, and is regulated and shaped by the government system. Much of what happens in the social system is in response to impacts of the economic system.

*Individual development* is embedded in, and supported by, the social system. The products and services supplied by the economic system, as well as the personal challenges and opportunities it provides, all contribute significantly to individual development. The environment and resource system constrains the material side of human development, but it also provides the basis for much recreation and leisure.

The *government system* regulates the economic system by legal constraints, and by financial incentives (subsidies) and disincentives (taxes). It shapes the infrastructure system by building codes, zoning laws, and construction projects. It determines individual development through education, security and welfare which it allows in the social system. It also regulates the environment and resource system, to the benefit or detriment of the natural resource system and future generations.

The *environment and resource system* provides the essential material and energy inputs to the economic system, and it has to absorb the burdens that this system and the infrastructure system produce. Because of its importance for the viability of the social system, the government system regulates its interaction. The motives of individual development, modified by the demands and standards of the social system, ultimately drive human interactions with the environment and resource system.

Each subsystem remains part of the whole, intimately connected to it. Change in one subsystem affects other subsystems and the total system. A systemic set of indicators should therefore include elements viewed as critical from each subsystem.

### 3.3.3 Basic orientors

Bossel [17] argues that for a system to be viable, it needs to satisfy the following set of *orientors*, or fundamental interests:

*Existence*, necessary to insure the immediate survival and subsistence of the system in the normal environment state.

*Effectiveness*, necessary to warn the system if it is sacrificing effectiveness for efficiency. The former is long-term oriented whilst the latter is short-term. Striving for efficiency may be to the detriment of the long-term survivability due to depletion of scarce resources.



*Freedom of action*, which judges the system's ability to cope with the various challenges posed by the environment interests.

*Security*, which judges the system's ability to protect itself from the detrimental effects of environmental variability.

*Adaptability*, which judges the system's ability to change its parameters and/or structure in order to generate more appropriate responses to challenges posed by environmental change.

*Coexistence*, which judges the system's ability to modify its behaviour to account for behaviour and orientors of other systems in its environment

*Psychological needs*, which judges the ability of the system to satisfy the psychological needs of the society.

Stakeholders with different social and scientific backgrounds and political convictions should be involved in the selection of the indicator sets by defining systems and using a scheme of orientor impact questions. Bossel proposes a scale of 4 ranging from completely satisfactory state, danger, good condition and excellent condition. Using Liebig's Law, the orientor that is at the minimum is the limiting factor to development, which means that progress of the system can only be attained if the orientor that is at the minimum is improved.

#### 4 CONCLUSION

Due to the proliferation of unsystemic worldviews attempting to develop the notion of sustainable development, there is need to develop the notion of sustainable development within systems approach. The premise of this paper was that development of the notion ought to be holistic. The developed notion is based on Peirce's philosophy of pragmatism, which addresses metaphysical, axiological and epistemological issues.

**Metaphysics:** Based on the phenomenological categories, it is argued that sustainable development is a law (Thirdness) mediating between the ends (Firstness) and the means (Secondness) of a system. The ends in this case are the desirable or ideal goals a system ought to pursue to ensure its future existence, and the means are the actual processes the system is undertaking to attain the ends. Sustainable development has to work within natural and systems laws lest the future existence of the system become compromised. Based on the review of the energy and material flows of the total ecological system, it is argued that the key to sustainable development is keeping processes slow.

**Axiology:** The axiological notion of sustainable development is that developed for the systems approach. Peirce argued that for an object to be aesthetically good, it must have a multitude of parts so related to one another as to impart a simple positive quality to their totality, whatever that quality may be. It is not a state of absolute harmony and absence of strife, but rather a feeling that accompanies increasing order of harmony. Peirce also argued that the ethos ideal for the system are those consistent with the Golden Rule. "*Sacrifice your own perfection to the perfectionment of your neighbor.*" Or, "*progress comes from every individual merging his individuality in sympathy with his neighbours*" This axiological notion is consistent with that offered by leading systems theories, for example, Bossel's Partnership Path [17].

**Epistemology:** Due to the pragmatic maxim, our study of the situation should ascertain if the ends are desirable and if the means are likely to lead to the ends. In addition, the key to ascertaining whether or not the system is on a sustainable path is through the development of a systemic set of. The set of indicators is systemic if it enables us to monitor the critical elements (basic orientors) in the subsystem likely to affect the system's viability. Development of the system is constrained by the basic orientor that is at the minimum.

The notion of sustainable development developed in this paper is systemic, and it can be used as a framework for sustainable development.

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