

A Critical Approach towards Sustainable Development Models - A Review

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Abstract – Scholarly attention and corporate interest in sustainable development have risen considerably in recent years. This is vividly depicted by the number of papers published and the new additions and discoveries done annually on this matter. As a result novel models to describe sustainable development came into being. To support the field further, the paper offers a literature review on different models presented by analysts and organizations, their applicability and capacity to generate knowledge and discusses a range of methodological problems related to these models. In preparing the paper 47 papers were reviewed and interpreted. Academics involved in the field of sustainable development might find the review useful, as it outlines major models presented in the field, their pros and cons and in which aspects the future models should be developed stimulating further research.

Keywords – Approaches, Models, Review, Sustainable Development, Constraints.

I. INTRODUCTION

By the end of the last millennium, the term ‘sustainability’ became one of the most spoken, argued and important subjects and an overall guiding principle for human development. It is embraced by huge business, governments, social reformers and environmental activists, all of which put their own interpretation on what sustainable development means. Its success extends from the underlying reflections on existential problems of mankind perceived at that time: increasing concern over exploitation of natural resources and economic development at the expense of environmental quality.

When it comes to the definition, sustainable development is a much-debated concept with a wide range of meanings. Sustainable development, as broad political vision, was defined in 1987 by the World Commission on Environment and Development (also known as the Brundtland Commission; WCED 1987) as the “ability to make development sustainable-to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs”. Since the release of the Brundtland Commission report, this definition has been subjected to several modifications and was re-formulated according different points of views.

Solutions to the many environmental problems that the current human race is facing can be derived only when they are based on sound science and understanding, that is, on what we believe to be “true” to the best of our knowledge. These “truths” can be improved upon as research provides new insights, gain more understanding and when that occurs we can modify our solutions accordingly.

To build on a solid foundation of science, we also have to change the way we think. It is at this point we start

making use of a model. By developing models as metaphors we expect to describe some new understanding of a problem because they organize and simplify our understanding and suggest a seemingly reasonable way of solving it.

The models are often “picked up” and used without the benefit of much consideration. With the realization of the inappropriateness, i.e; with the enhancement of our understanding, of a model to describe a particular problem the model then become “outdated” and become part of the mythology of the culture. This isn’t necessarily bad. If a model is well thought out and accurate, it can be an effective way to encourage people to recognize faulty concepts, which could help shift their thinking. If the model itself is faulty, the fact that it sounds reasonable may do more harm than good. Used repeatedly, it would attain the status of fact when, in reality, it is simply another myth.

Thus, throughout the time period researchers, analysts have tried to present sustainable development in a model that captures this extremely complex concept and a new way of thinking. As a result, numerous of models regarding sustainability came into being. With the passage of time several strengths and weaknesses of these models were identified.

When went through the literature it was obvious that it lacks a single paper which includes the evolution of these models along with their identified loopholes. This paper is an attempt to sum up the different models presented by analysts and organizations, to comment on the conceptual frameworks behind the models, their applicability and capacity to generate knowledge and to discuss a range of methodological problems related to these models.

II. MODELS OF SUSTAINABLE DEVELOPMENT

A. Three Pillars models (three Interlocking Circles models)

Possibly, the most widely known model of sustainable development is the “three pillars model” (United Nations World Summit, 2005). This model has previously been represented as actual pillars (see Figure 1), as a triangle, or as overlapping circles (see Figure 2). The “pillar” names change with different versions of the models and the most common include:

- Economic, Social, and Environmental (United Nations World Summit, 2005).
- Economic capital, Social capital, and Natural capital (Dyllick & Hockerts, 2002).
- Economic growth, Social progress, and Environmental protection (Kates *et al.*, 2005).
- Business, Society, and Nature (Dyllick & Hockerts, 2002).

- Interlinkages, Intergenerational equity, and Dynamic efficiency (Stavins *et al.*, 2003)

Generally, the three pillars model takes the three dimensions of “environmental, economic, and social resources” (WCED, 1987). In this model, sustainable development is achieved once all three pillars work in unison. There are several critiques associated with this model.

The first one is the assumption that the “pillars” are independent constructs. Some authors argue that humans are biological entities and hence human resources are also environmental resources. Therefore, society and environment cannot be showed as independent of each other (Thatcher, 2014). It is also argued that the overwhelming majority of resources that humans use come from nature in the form of ecosystem services (Costanza *et al.*, 1997) and it is thus impossible to separate human development from environmental development (e.g. by destroying ecosystems for agriculture, we probably destroy access to natural resources like wood, food, and medicines).

This separation distracts from the fundamental connections between the economy, society and the environment. It leads to assumptions that trade-offs can be made between the three sectors, in line with the views of weak sustainability that built capital can substitute for natural resources and systems (Neumayer, 2003). This neglects the fact that no number of sawmills will substitute for a forest, no amount of genetic engineering can replace biodiversity and it would be a miracle constructing a replacement for the ozone layer (Wackernagel and Rees, 1996).

One of the effects of the three sector separation as identified by Giddings *et al.* (2002) is encouraging a technical fix approach to sustainable development issues. This focuses on pollution control, lower resource use and greenhouse gas trading rather than dealing with the deeper issues or identifying the connections between society, economy and the environment. Technical solutions in the economy, such as changing interest rate, benefits or taxation are seen as ways to move the economy towards sustainable development. These are attractive to some extent as they can be introduced fairly quickly and do not involve a more fundamental examination of the relationship between the economy, society and the environment. Giddings *et al.* (2002) further say such a sectoral approach can divert attention from asking core-problems related to sustainable development such as those about the nature of our society, what the policy priorities are, how decisions are made and in whose interest. Thus, the wider social issues often fall off the sustainable development agenda.

Second problem associated with the model is it does not incorporate a time dimension which is a core component of the WCED (1987) definition (Thatcher, 2014). In addition to different labels for the “pillars”, there is also a lack of agreement regarding the content of each “pillar” (Kates *et al.*, 2005), where sometimes the same pillar is defined in fundamentally different ways (e.g. natural resources are defined as intrinsically valuable or they are defined as valuable insofar as they provide ecosystem

services to humans in the system), or new pillars are predicted.

As a consequence of these critiques, Stavins *et al.* (2003) suggests that the three “pillars” should actually be: interlinkages (between the three dimensions), intergenerational equity, and dynamic efficiency (i.e. that the consumption of resources will vary as a consequence of behavior, technology, and availability).

However, approaches aiming to balance these three pillars have been criticized since they involve different types of values (Eg: biodiversity, beauty of landscape vs. costs, profits vs. equity, health and cultural values) that are not directly commensurable with respect to each other (Mieg, 2010). Furthermore, controversial interests of different stakeholders often conflict within a single pillar of sustainability (i.e., social conflicts; economic conflicts; conflicts over environmental issues; or preferences), and therefore balancing their interests regarding one pillar is sometimes more in the foreground than to balance social, economic, and environmental aspects (Kyburz-Graber *et al.* 2006).

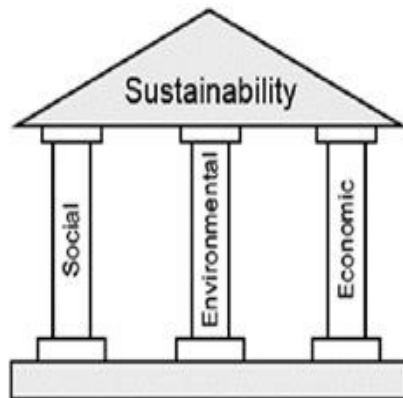
When talking about sustainable development most of the time either the environment or the economy is given priority (Giddings *et al.*, 2002). Although the Local Agenda 21 agreements at the Rio Conference included issues to do with social and economic development, strengthening participation and ways of implementation (Grubb, 1993), most LA 21 plans in Britain pay attention primarily on environmental issues (Durham, 1997; Northumberland, 2000). This focus of LA 21 on the environment can be a weakness, as this often means it is considered as peripheral by both local and national government, who usually concentrate on economic issues. According to Giddings *et al.* (2002) many English and American environmentalists give priority to issues of the countryside, wild animals and wilderness with the aim of preservation from people, with less concern about the urban environment. This outlook has its roots both in a view that sees the environment independent from humans and an anti-urban tradition.

The idea of including a positive integration of the three sustainability pillars is needed to effectively facilitate sustainable development has been expressed in the sustainability strategy of the Government of Western Australia (2003). It states that sustainability requires ‘new synergies to be identified as well as “systems thinking” to produce simultaneous outcomes for the economy, community and environment’ (Government of Western Australia 2003), and ‘economic, social and environmental factors be integrated seeking mutually supportive benefits with minimal trade-offs’ (Government of Western Australia 2003). From this point of view, the main challenge of sustainable development as defined in the Brundtland Report (WCED, 1987) would be to fulfill the needs of current and future generations through simultaneous environmental, social, and economic improvement. Many such synergies have been discovered and investigated by researchers or acknowledged in public discussion.

According to Gurung *et al.* (2008) high environmental

quality, scenic beauty, and biodiversity allow for regional economic income through sustainable tourism from which local communities may profit ; sustainable construction causes for reduction in the use of nonrenewable energy resources and hence economic savings (e.g., Vatalis *et al.*, 2011), and the development of innovative technologies for generating power from renewable energy sources such as wind or sun is recognized to bear the potential to generate workplaces and generate economic growth while saving nonrenewable resources and reducing CO2 emissions (e.g., Dalton and Lewis 2011).

Nevertheless, Hansmann *et al.*(2012) report that it has not been systematically examined so far, which aspects of the three pillars are generally connected with each other in practice in ways involving such positive synergies. The metaphor of balancing the three pillars does not appropriately account for the complex interrelationships between human activities and the environment as conceptualized in theories on human–environment systems (Kates *et al.*, 2001; Scholz 2011; Schoolman *et al.*, 2012).



Source: Thatcher (2015)

Fig. 1. An example of the “three pillars” model of sustainable development.



Source: IUCN (2006)

Figure 02: Overlapping circles model

B. Prism Models

Recently, alternative models to the triangle of sustainability have been proposed. Among those the most

interesting ones are prisms and eggs (Keiner, 2005). The ‘prism of sustainable development’, or sometimes called the four pillars model, adapted from Spangenberg and Bonniot (1998) stipulates four dimensions:

- Economic dimension (man-made capital)
- Environmental dimension (natural capital), and
- Social dimension (human capital) as the base for
- Institutional dimension (social capital).

Other four-pillar models include the basic three-pillar model but separating social capital into social capital and cultural capital (Nurse, 2006), Scerri and James’ (2010) circles of sustainability (which includes economics, ecology, politics, and culture), or the MAIN prism (i.e. environmental, economic, social, and institutional).

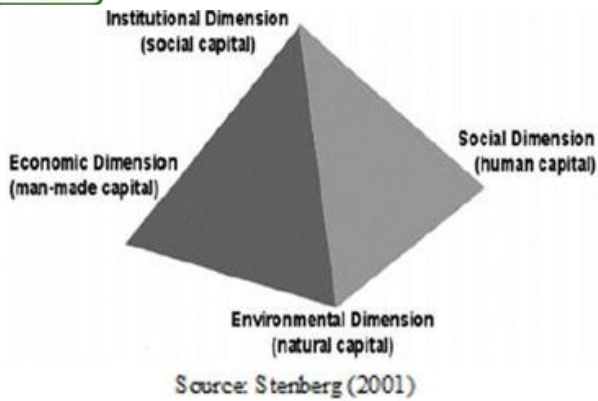
Hamedani (2014) explains that in Spangenberg and Bonniot’s prism model (1998) the inter-linkages such as care, access, democracy, and eco-efficiency have to be looked at closely since they show the relation between the dimensions which could translate and influence policy. In each dimension of the prism of sustainable development, there are imperatives (as norms for action). Indicators are used to measure how far one has actually come in comparison to the overall vision of sustainable development (Keiner, 2005).

Criticizing this prism of sustainable development, Kain (2000) argues, that ‘the economic dimension tends to include assets emanating from all four dimensions, thus, adding confusion to the description and analysis’. Consequently, the same author proposes a ‘MAIN prism of sustainable development’ (Figure 4). In this model, he uses the terms of mind, artefact, institution and nature in order to relieve the prism from the burden of expressions as social and economic, which seem to be more confusing than explanatory.

Combining Kain’s MAIN prism model with the general prism model we can come up with following idea. The environmental dimension (nature) comprises all natural capital, which may be subdivided into stocks of non-renewable and stocks of renewable resources. The economic dimension (artefact) represents all man-made material assets, resources such as buildings and roads. The social dimension (mind) can be perceived as the awareness of the individual subject (worldview, knowledge, and experience). The institutional dimension encompasses the organization of our society and the relation between people (Keiner, 2005).

The two prism models point out the impossibility of man-made capital, social capital and human capital increasing at the same time at the same amount. The concentration has to be on the interaction between the four dimensions. When taken all four dimensions simultaneously, sustainable development can be achieved (Stenberg, 2001).

The prism model of sustainability suffers from the same criticisms as the three-pillar model. These models assume that the different components/dimensions are independent and that there is no time dimension built into the model, which is an essential component of the WCED definition (Thatcher, 2014).



Adapted after Spangenberg & Bonriot (1998) and Valentin & Spangenberg (1999)

Fig. 3. The prism of sustainable development.

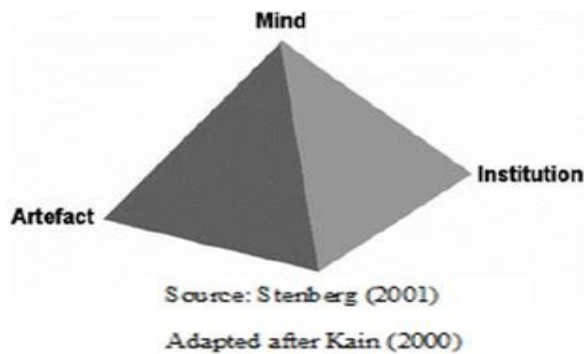
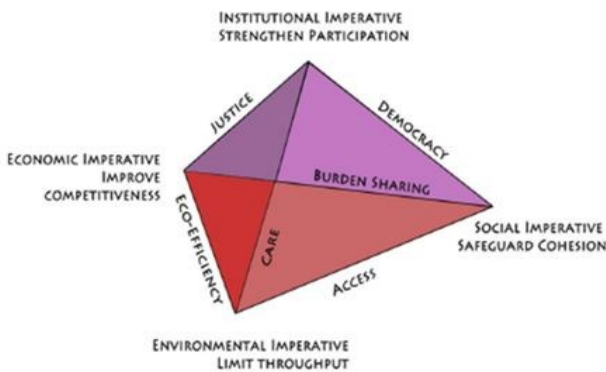


Fig. 4. The MAIN prism of sustainable.



Source: Spangenberg, Wuppertal Institute (1998)

Fig. 5. A version of prism of sustainable development.

C. The Egg/ 3 Nested Dependencies Model

The prism models can be criticized since they pay too little concern to the environmental dimension (natural capital). Environment can be recognized as the prerequisite for the development of human well-being. This view requires a model of sustainability, which puts the environment in the center (Keiner, 2005)

In conceptual terms, the International Development Research Center (IDRC, 1997) proposes to replace the graphics of three pillars or entangles circles of society, economy, and the environment with the 'egg of sustainability' (Figure 9), originally designed in 1994 by the International Union for the Conservation of Nature, IUCN (cf. Guijt and Moiseev, 2001).

As Keiner (2005) describes the egg of sustainability elucidates the relationship between people and ecosystem as one circle inside another, like the yolk of an egg. This implies that people are within the ecosystem, and that finally one is entirely dependent upon the other. He further says that just as an egg is good only if both the white and yolk are good, so a society is well and sustainable only if both, people and the eco-system, are well. Social and economic development can only occur if the environment offers the necessary resources: raw materials, space for new production sites and jobs, constitutional qualities (recreation, health, etc.). Hence, ecosystem is regarded as a superordinated system to the other dimensions of the triangle or prism models: social, economic and institutional. These latter can only prosper if they adapt themselves to the limits of environmental carrying capacity.

Hypothesis of IUCN: sustainable development = human well-being + ecosystem well being

The above hypothesis presented by IUCN implies that the environment is not the superordinate system, since it allows that sustainable development can occur if human well-being goes up more than ecosystem well-being falls. Thus, the equation does not show that humanity's wellbeing depend on ecosystem well-being and sustainable development as a whole (Keiner, 2005).

A similar egg has independently been proposed by Busch-Lüthy (1995), placing 'economy' and 'society' instead of 'people' in the yolk. This is problematic as it may evoke that people are being rendered subordinate to the needs of the economy.

These various versions of the egg model are fundamentally the same as the three-pillar or four-pillar model in content except that the human subsystem is considered as a single subsystem with multiple components (i.e. health and population wellbeing, wealth, knowledge and culture, community, and equity) and is entirely dependent on a healthy ecosystem. (Thatcher, 2014)

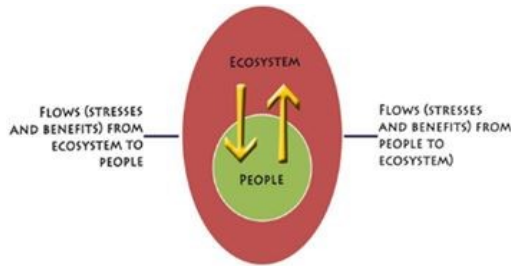
From an ecosystem services (Costanza *et al.*, 1997) perspective the egg of wellbeing model makes inherent sense as the environment provides all the resources necessary for human survival and wellbeing. However, this model faces challenges from those who place greater emphasis on human wellbeing.

The concentric circles model is similar to the egg of wellbeing model except for the fact that there are multiple levels of subsystems; the largest circle is the natural environment which encapsulates the subsystem of human society, which in turn encapsulates the subsystem of the economy. In essence, as Thatcher (2014) suggests the concentric circles model is a modification of the three circles model but emphasizes that each circle is constrained. The egg of wellbeing and the concentric circles models both address the concerns about the interdependence between the subsystems, but neither model addresses the issue of the time dimension.



Source: Guijt et al. (2014)

Fig. 6. Egg of sustainability.



Source: Hamedani (2014)

Adapted from Robert Prescott-Allen, IUCN (1995)

Fig. 7. Egg of sustainability.



Source: Moore (2000)

Fig. 8. Concentric circles for sustainable development.

D. Atkisson's Pyramid

The Atkisson Pyramid process assists and speeds up the progress from identifying the vision of sustainability, through analysis and brainstorming and agreements on a credible plan of action. (Hamedani, 2014)

The structure of the pyramid guides through the process of first building a solid foundation of understanding, searching for and collecting relevant information and ideas, and then concentrating and narrowing down to what is important, effective, doable, and something that everyone can agree in.

Hamedani (2014) in his thesis explains that the Atkisson's Pyramid is a blue print for the Sustainable development process and it includes five steps as;

- Step 1: Indicators- Measuring the trend
- Step 2: Systems- Making the connections
- Step 3: Innovations- Ideas that Make a Difference

- Step 4: Strategies: From Idea to Reality
- Step 5: Agreements: From Workshop to Real World

This model was designed with the expectation of helping groups of people to move quickly up the sustainability learning curve, from basic principles and frameworks, to system analysis, to innovative strategies for action. Along the way, groups practice cross-sectorial teamwork, make linkages, generate dozens of new ideas, and work toward an "Agreement" which is a set of actions they agree to follow through within the real world. (Atkisson, Believing Cassandra (Earthscan, 2010). The same process can be continued for the other two components- Society and Economy and then we can come up with the Agreement by making interlinkages between all the three components.



Fig. 9. Atkisson's pyramid model.

E. Amoeba Model

The Amoeba Approach is a model used to visually assess a system's condition relative to an optimal condition. The model takes a circular pattern with various indicators positioned around the outside. (Hamedani, 2014). Lines radiate from the centre to the indicators, on a continuum from unsustainable (in the centre) to sustainable (the outside of the circle). A circle would indicate the optimum conditions. He further declares that this type of model allows simultaneous assessment of different indicators, and easy comparison between components of the system. "The Amoeba Model" is a powerful technique for accelerating the innovation process and training to be far more effective in achieving Sustainable development (Atkisson, Believing Cassandra (Earthscan, 2010).



Source: Atkisson, Believing Cassandra (Earthscan, 2010)

Fig. 9. The amoeba model of sustainability.

F. Three Legged Stool Model

This is also often called as the ‘triple bottom line’ perspective. It is a simple way of picturing sustainable development. It represents the environment, the economy and society by the 3 separate legs of the stool. If a leg is more or less important (i.e., shorter or longer) than the others, the stool will be unstable (but perhaps still be usable at least for a while). If any leg is missing, then the stool simply will not work. But if all three legs are the same length (i.e., environmental, economic and social considerations have been given equal weight), the result will be a well-balanced stool which will serve its purpose indefinitely - a sustainable stool (Scottish Environment Protection Agency 2002).

Users ranged from local, regional, and national governments (e.g., Berry 2002; Dobriansky 2002) and businesses (e.g., Price 2000; Procter & Gamble 2001) to international organizations such as the World Business Council for Sustainable Development (World Business Council for Sustainable Development 2002), World Health Organization (Bruntland 2002), and the United Nations (United Nations Environment Program 2002) who make use of this model emphasize two main points.

- (1) To achieve sustainable development, we must consider the environment, social well-being, and economy as the legs sustainable development stands upon.
- (2) We must consider each leg equally—although the three legs are separate, they are of equal importance.

Many argue that this model may be a good accounting tool but not an effective or realistic way of characterizing sustainability. Fundamentally the triad model is based on a triangle of forces in balance. To achieve environmental sustainability we need to change both society and the economy. We cannot have a stable triangle where we are trying to sustain all three systems in their existing state.

The paradox we face is that we need to find ways to “curb consumption while spreading the capacity to consume”. This paradox at the heart of our attempt to achieve ‘environmental sustainability’ and is glossed over with the idea of the ‘three-legged stool’.

It is satisfactory that the environment is finally to be considered up there alongside the economy. Indeed, most of our western decision-makers still regard sustaining development at the expense of the environment as “sustainable development” (Dawe *et al.*, 2003).

However, as suggested by Dawe *et al.* (2003) using the three legs of the stool as a model for sustainable development will not help solve these problems because, in this model, humanity is once again placed outside the environment. Similar to the current neoclassical economic model that has no connectivity to the biosphere (Daly, 1996) this model also fails to show our place within the biosphere. The worst part of the model as explained by Dawe *et al.* (2003) is it says that we can continue to tread our current path, business as usual only if we could find an equal balance between our economic needs, our social well-being, and the environment. The fault here is humanity can have neither an economy nor social well-being without the environment. Thus, the environment is

absolutely not and cannot be a leg of the sustainable development stool. It should be the floor upon which the stool, or any sustainable development model, must stand. It provides the foundation for any economy and social well-being.



Source: Hummel (2016)

Fig. 10. Three legged stool model.

G. Capital Stocks of Sustainable Development

Serageldin & Steer (1994), a study group of The World Bank, developed the ‘capital stock model’ with the basic idea, if we live off the interest and not the capital, the basis of prosperity is maintained. Nevertheless, if we consume the substance, our means of survival is endangered in the long run. The definition of ecological capital for the planning process includes bio-diversity, landscape, mineral resources, clean air and healthy water. Human and social capital are associated with health, social security, social cohesion, freedom, justice, equality of opportunity and peace (Keiner, 2005).

The equation is simple:

$$CSD = \Sigma (C_{En}, C_{Ec}, CS)$$

Where; CSD=capital stock of Sustainable Development

C_{Env} = Capital stock of the Environment

C_{Ec} = Capital stock of the economy

CS = Capital stock of society

The equation for the capital stock model assumes that one form of capital can be substituted for another. For example, CSD can rise if C_{Ec} goes up more than C_{En} goes down. This is the weak sustainability view of sustainable development, which is widely criticized by ecological economists (cf. Daly, 1996; Lawn, 2000). They believe, above all else, that C_{En} must be kept intact in order to achieve sustainability. Moreover, they also believe C_{Ec} and CS should also be kept intact. Indeed, ecological economists often refer to CS moral capital and argue that much needs to be done to regenerate it should it decline (Lawn, 2000).

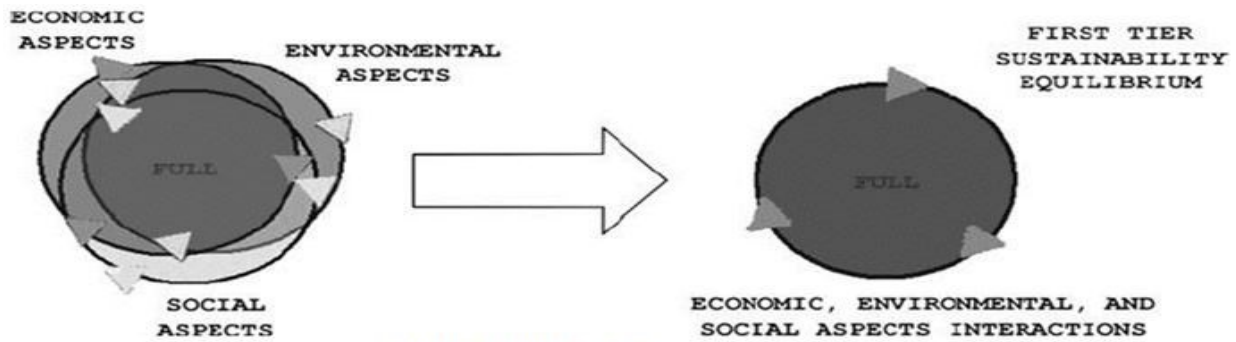
Here, it is still extremely difficult to determine what the ‘interest’ is and what the ‘capital’ is in this model. The capital stocks model is currently rarely used outside of economic sustainability authors (Thatcher, 2015).

H. Two-tiered Sustainability Equilibria Model of Sustainable Development

More recently, a holistic model of sustainable development has begun to emerge (Lozano, 2008). Lozano

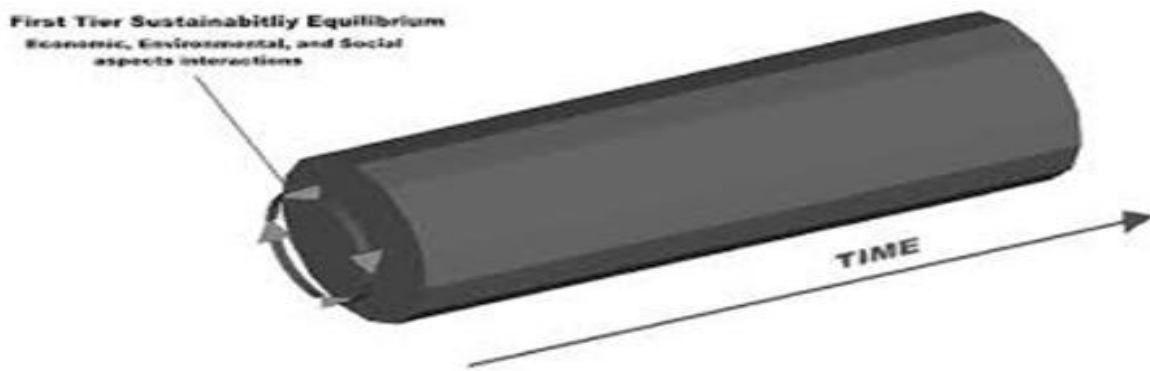
(2008) argues that the concentric circles model is highly anthropocentric and places the economic subsystem at its center. Instead, in the first step it is argued that for real sustainable development the concentric circles/ three circles should fully overlap; referred to as the “first tier sustainability equilibrium” (Lozano, 2008). This first step depicts the interdependencies at a single point in time (usually the present). In the second step, the time dimension is incorporated by depicting the FTSE as a perfect cylinder. If too much emphasis is placed on either the present or the future then the cylinder would look more like a cone (i.e. the cone would be widest at the point where emphasis is placed).

To achieve sustainability across time means recognizing that what is done to achieve sustainability in the present impacts on the ability to achieve sustainability in the future. (i.e. a perfect cylinder). The third step therefore, involves acknowledging that sustainability is a dynamic process which requires the time dimension to (graphically) bend back on itself to form a doughnut shape or torus. This represents the notion that decisions on sustainable development in the present, form the availability of decisions of sustainable development in the future (in a continuous loop into the future). To date, there are no systematic critiques of the two-tiered sustainability equilibria model.



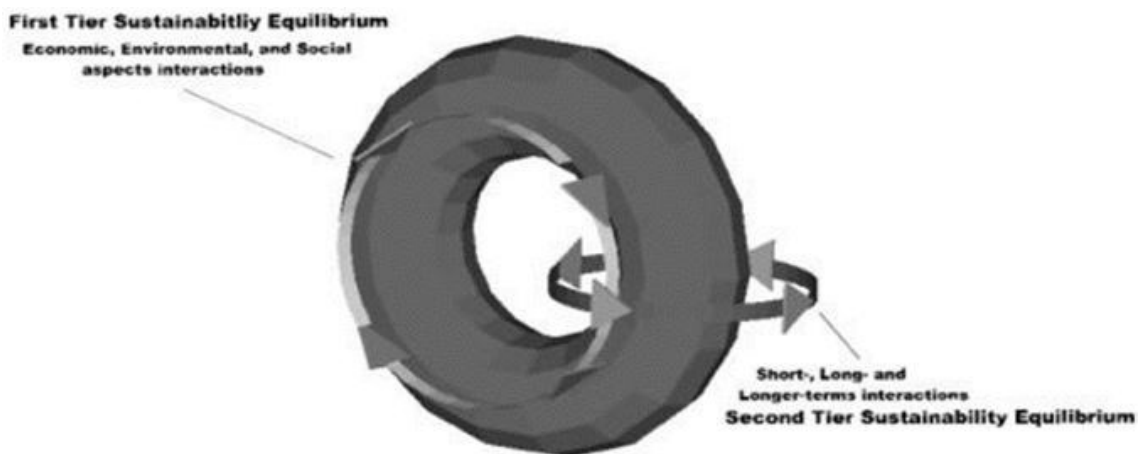
Source: Lozano (2008)

Fig. 11. Transition to the First Tier sustainability equilibrium.



Source: Lozano (2008)

Fig. 12. The time dimension in the First Tier sustainability.



Source: Lozano (2008)

Fig. 13. Two - tiered sustainability equilibrium.

III. CONCLUSION

This study has taken a broad look at models of sustainable development and the issues associated with each. It offers a conceptualization based on a literature review. Eight types of models were identified and discussed here. The most common drawbacks identified in these models were taking the three dimensions, environment, society and economy, as independent constructs, not incorporating a time dimension and paying too little concern to the environmental dimension.

Almost all the researchers have highlighted the importance of including a positive integration of the three sustainability dimensions and incorporating time dimension into the model. According to the analysts to date, there are no systematic critiques of the two-tiered sustainability equilibria model. Therefore, it can be presented as the most appropriate model to describe the sustainable development.

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