Designing conceptual model of sustainable technology assessment with overall policy approach in the field of technology development

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ABSTRACT

One of the latest innovations in sustainability is compliance with the principles of sustainable technological issues. The important issue is the use of technologies whose performance is based on the principles of sustainability. So implementing a holistic model of technology assessment is obtainable. This paper tries to study patterns, identify all the factors affecting sustainable technology. According to the objectives in the field of technology, the components and dimensions will extract and classify. Based on the results of research "economically", "Human, Social and Cultural Rights", "technical, and organizational performance", "politically and legally" and "Environmental and Resource Management", are 5 dimensions in assessing the impact of sustainability on technology assessment. According to the above-mentioned aspects, conceptual model has been developed. It is hoped that in future research and the development of its indigenous taken effective steps in achieving sustainable development.

KEYWORDS*: Sustainable development, sustainable technology, sustainability principles, conceptual model

INTRODUCTION

Technology has various definitions from different scientists' view which mainly contains general definitions, overall, and specific dates. One of the best definitions is use of technology, experience and human skills for meeting human needs. Technology can be a source of goodness or be harmful, and this depends a lot to management style and pay attention to its all aspects. Assessment and prediction technology foremost is a tool for enlightenment about the consequences of the development and deployment of technology in the country. Most governments have had a national technological strategy. Which shows their plan and design and priorities for investment in technology and to maintain and repair them According to various considerations (political, social, economic, military, cultural and environmental). In planning for technology development, usually paid less attention to technology and sustainability issues. Most importantly, the development of technology, can even change the way of our live. Perhaps that might jeopardize national security in the long term. Following are some of the statistics of the world and Iran about devastating damage of lack of attention to the topic of sustainability in the technology. Iran environment day to day sees worse days.

- World Environmental Performance Index (EPI) for Iran shows that we has won rank 114 and in the last two years we have had 36 stairs descending among 132 countries in the world.
- Air pollution and damage caused by driving each year has 400 million dollars loss for the economy.
- Two-thirds of Natural Resources of Iran has been destroyed over the past half century. Annually 10 thousands hectares of forest and gardens in the large cities and 100 hectares of grassland become desert and the dilapidated.
- World Food and Agriculture Organization (FAO) has announced that Iran is one of the 70 developing countries in the world with low forest cover, and this little forest cover, faster than the rest of the world is waning.
- Each day more than 40 tons of municipal solid waste is generated in the country that are buried without a plan and pollute ground waters.
- More than 3,500 deaths per year due to air pollution in Tehran.
- In 2011, about 900 tons of pollutants has been entered the Caspian Sea, while in 2009 it was 500 thousand tons.
- During 2011, approximately 900 million cubic meters wastewater has been entered the Caspian Sea that 117 million cubic meters of it was untreated water.
- For each cubic meter of water consumed in the world, two kg agricultural product are produced. Whereas in Iran, every cubic meter of water per unit of production is only 900 grams. With continuing this trend in 1400, agriculture is still considered as a problem. Per capita for consumption of water in Iran is 191 liters, but in the world it is 150 liters per capita this means that Iran is consuming about 40 liters more than the global per capita of water.

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Due to limited capacity and ecological efficiency in the world, developmental views focused on the issues of sustainable development. As we know, the goal of sustainable development is meeting the needs of the present without compromising the ability of future generations to meet their own needs. In this regard, technological issues are considered very important due to their influence on future generation life. Based on the discussion, the issue of stability is highly regarded technology. Term sustainable technology should be used very cautiously. The term is sometimes confused with environmental technology. While the second term pay little attention to the social and economic aspects of sustainability. Also in sustainable technology assessment, socio-economic changes that will arise as a result of applying these technologies should strongly be considered. In addition, stable technology in comparison with environmental technology, in long term view will be considered the short term conditions. Point to note in the context of sustainable technology, existence a way to assess and compliance with the principles of sustainability. Therefore, given the different technologies in our country and also the need of the country to manufacture or transfer of modern technology, it is essential at the beginning, the technology will be assessed and if they compliance with sustainability indicators, the production, use, dissemination, or transfer will take place. For this purpose it is essential that principles and indicators of sustainable development in this area is properly used. One of the most important resources in this field is upstream documentation in the country. One of these documents is the general policy of the development of technology. Hence, using the material, we can develop a model for evaluating sustainable technology. The main issue in this research is addressing different angles of technology from sustainability viewpoint. It means that in addition to the economic issues, social, cultural and environmental issues in evaluating a technology should be considered. Hence, with mentioned approach, try to develop a model for evaluating a technology developed in the field above.

2. Background and Necessity

In the late 60s, the term and concept of technology assessment emerges in considering its negative effects. Until then, it was thought that technology is only factor for advancement of society, and has several benefits. The term technology assessment in general is related to Philip Yagar space science adviser to Space Science Committee of the House of America. So when it was diagnosed with technology in addition to the positive aspects, the negative results as well, technology evaluation campaign was formed all around the world. Today, the technology is a general concept among legislators, politicians, administrators and others. Indeed, technology assessment, including all the permanent efforts to identify, analyze and evaluate the effects of the application of existing or emerging technologies in the various sectors of society. Indeed, technology assessment is a tool to identify positive and negative aspects of technology and help to choose the most appropriate technology. As mentioned subject of technology sustainability is one of modern topics in the IT field. Motto TA (technology assessment) is that new technology should be better than the previous technology. Otherwise there is no need to its existence. The following table describes the main approaches to TA that has been developed by UNEP.

Table 1. The main approaches to TA

phylosophy	method	Goal	Approa.
If technology is known, future will be known.	More quantitative methods	Describe technological	Heuristic
Understanding the impact of technology is possible	Analytical (expert opinion)	Technology impact analysis	Reaction
Technology can have positive impact if organized as a learning process	Dialogue and debate (workshops and conferences for agreement)	Involving the social elements in the analysis	Active
Participation of interested parties in technology formation	Intervention (meditation and discussion)	Analysis of the social dynamics of technology	Manufacturer

It is Point to note that being the best does not refer only to the scientific aspects of a technology. But it focuses on social – economic and environmental aspects, this point is important that most models of technology assessment mainly on the assessment of physical and economic costs and benefits are arising from the use of technology. Like Nunavut and Turgol approach. In the field of sustainable technology other social, cultural, environmental aspects are also important. Hence, the assessment should also be mentioned sights. Considering the current situation and discuss the issues of sustainable development today, such as the design with the approach of the Cradle to Cradle (C2C),

ecological efficiency, environmental footprint, waste management and the need for compliance with the latest technology and technology discussions, is shown. So if there is a measure for evaluating sustainability of manufacturing in the country, it will facilitate the achievement of sustainable development. Continuously it has been tried most important researches be done and existing models in fields of technology assessment in general and then research in the field of stable technology assessment can be considered. Then according to existing researches, conceptual model to develop a research framework is offered. About researches in the field of sustainable technology assessment models can be pointed out that within the country comprehensive model has not been developed for this purpose. One of the researches in 2013 is related to University of Cambridge that Mr. Mike Ashby provided a model in this context. The following is a brief description of it. A superficial look at sustainable development is that only environmental capital be preserved. However broader look at the issue represents that 3 capitals which include net production capital, net human capital and environmental net capital that is shown in figure.
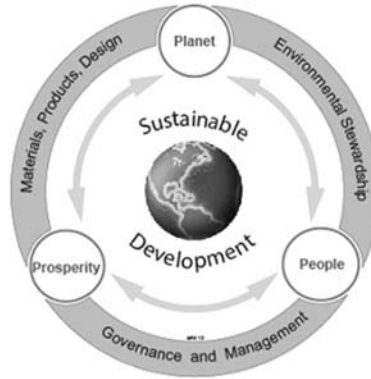

Figure 1 - Components of Sustainable Development

According to the study, to evaluate sustainable technology six areas should be examined include as following.
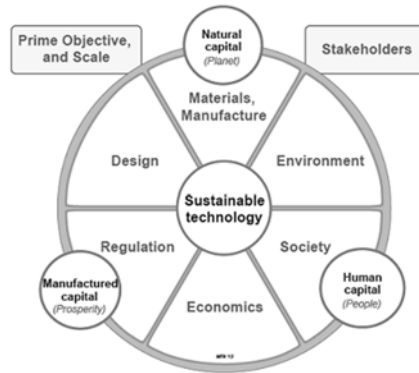

Figure 2 - Areas of Sustainable Technology Assessment

Table 2. The definitions in the field of sustainable technology assessment

Domain name	Definition
Materials and Construction	Supply chain risks, demands the life cycle, recyclability
Design	Product performance, functionality, safety
Environment	Energy efficiency, conserve resources, protect clean air, land and water
Rules	Awareness of compliance With national and international .treaties, laws, circulars, etc.
Society	Personal health, education, housing, employment, justice and happiness
Economy	Project costs, recoverable profits

Other studies that have been done in the field of sustainable technologies is the topic of sustainable technologies balance sheet by Alan C Brent which is raised at the World Congress of renewable energy in 2011 in

Sweden.Nowadays issue of renewable energy technologies (RET) is considered.At the end of article general indicators in the areas of sustainable technology assessment presented in the 5 areas of economic, environmental, social, technical and policy.Items associated with each indicator is provided in the following figure.
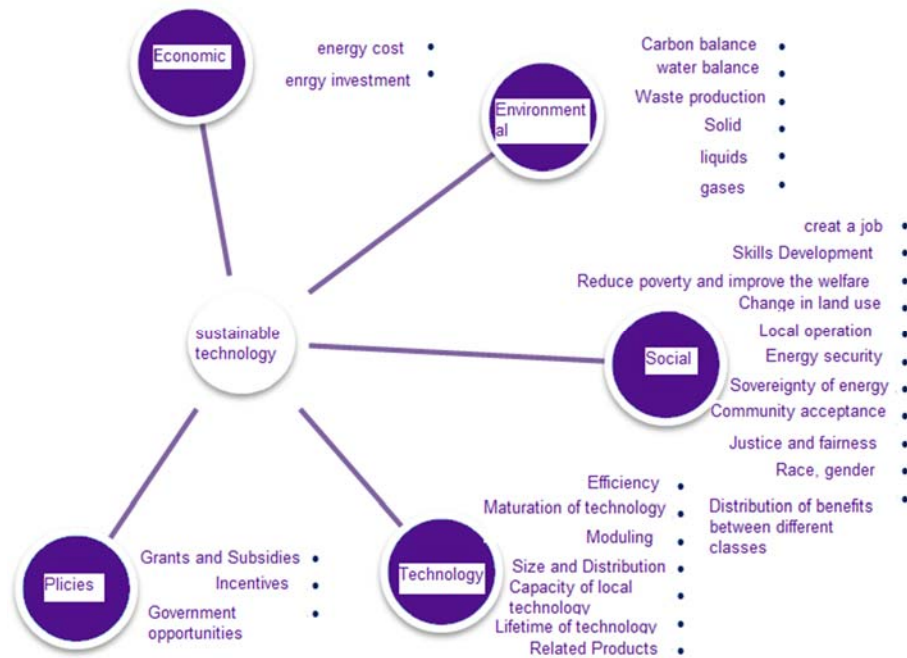

Figure 3. Evaluate areas of sustainable technology (RET)

In another study conducted by the UNEP and as the use of technology sustainability assessment methodology has been published, it is said that in the 1990s, environmental issues have been added to the development issues called EST (environment related sustainable technologies) and then ENTA (Environmental Technology Assessment) was introduced by the United Nations. The purpose of ENTA, the potential impact of environmental and social - economy issues is on technology. To this end, the proposed rates for the use of sustainable technology assessment methodology is presented that can be seen in the figure below.
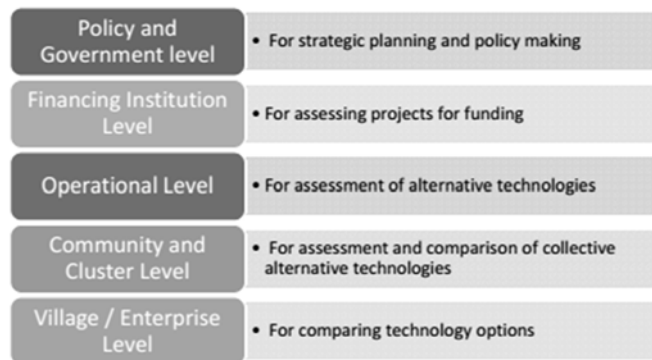

Figure 4 - Proposed levels for the use of technology assessment methodology

To define sustainable technology screening criteria, an example has been suggested in the study that includes 7 areas. Briefly areas include: the lack of constraints on policy, in line with national and international treaties and agreements, define achievable goals, having a positive social impact, durable economic impact, environmentally acceptable performance, Maturation of technology.

Figure 5 - Screening Criteria for Sustainable Technology
In order to achieve the above-mentioned areas, criteria with 4 classification defined that can be seen in the table below.

Table 3 – indicators and sub criteria for evaluating sustainable technology

	Compliance With environmental laws and regulations and standards		**Investment**
Technological	The allowable amount of waste production	**Financial**	Operating and maintenance costs
	Access to Technology		Repayment period
	The availability of expertise and capacity requirements for the design and operation		The value added
	The use of local materials for construction and operation		Investment attractiveness
	country availability of technical assistance during commissioning and operation		Access to financial cooperation
	The same applications and operating records		Common Benefits
	The ability to adapt to local conditions	**Environmental**	Added support services (power, water, etc.
	Ability to adapt to future requirements		Environmental greenhouse gas emissions
	Repeatability		Noise, vibration and smell
social	Create job		Space and infrastructure requirements
	Acceptance of local cultures		Help manage the environment
	Improve quality of life		Net carbon emissions
	Improving occupational health and safety		
	Local technical skills and knowledge base		

In order to achieve the goals set out in Vision 1404, the general policies of the system in various areas of the country have been developed. One of these policies is general policies of system in development of technologies area that includes 4 main areas. These areas are as follows:

1.   Development of technology to enhance Iran's position in world technology, production of knowledge, wealth and increase national power
2.   Strengthening the capacity of national infrastructure and technology in country
3.   Explain and promote the cultural foundations of technology
4.   Efforts to preserve cultural values, social and Islamic principles in the use of technology

The criteria for each material above is as follows:
1.   Development of technology to promote Iran's position in world technology, production of knowledge, wealth and increase the national power through:
1.1   Strengthening national commitment to the growth and development of technology
1.2   Policy and strategic planning and management system reform and support for advanced technology, under the supervision of the presidency
1.3   Priorities in support of technology based on requirements, advantages and capabilities of the country
1.4   Emphasis on training efficient, creative and committed human resources, identify elite, Talent, retain and attract human capital and promote a spirit of self-esteem and self-reliance

1.5   Strengthening and organizing cooperation between universities, research institutes and academies with industrial and technical services of government and non-government sectors

1.6   Reform and complete laws and regulations, especially in areas of trade and customs, aimed at changing the importation of goods and services from outside to technology transfer process, knowledge of design and construction for production in the country and plan to create the right balance between hardware and software components in development of technology

1.7   Strengthening support of all devices from increasing technology capacity in the country

1.8   Protection of intellectual property and strengthening for development of applied research and development and innovation in different fields of science

1.9   Promoting the Academy's role in providing correct orientation in technology development and scientific prosperity

1.10Strengthen international cooperation, with emphasis on human resource development, strengthening software parts of internal technology, attract capital and Iranian and non-Iranian elites, marketing for Iranian technology to promote quality in accordance with World Indices

2. Strengthening infrastructure and national capacities of technology in the country based on

All seriously to improve the quality of basic science and learning practical skills and creative morale boost in all stages of educational system and institutionalization of research and science direction to research in the field of technology

2.2 The development of new technology based on new industries and services with the aim of strengthening the independence, meet local needs and making appropriate share of the global market

2.3 Modernization of industry, reform and complete available technology capabilities based on continuous review

2.4 Creating an efficient information technology system including collection, storage, processing and notification

2.5 The emphasis on increasing the share of GDP through the appropriate budget allocation and financial and moral encouragement of non-governmental sectors and set the parameters for the development of research, evaluation and monitoring in implementation of policies

2.6 supporting the production and export of products based on indigenous and traditional technologies

2.7 Support the establishment and development of Science and technology towns and parks

3. Explain and promote the principles of cultural development of technology through:

3.1 increasing social understanding of the importance of science and technology in the country

3.2 Reform consumption patterns

3.3 promoting standardization and improvement of quality in the production to encourage people to use goods made inside in public culture

3.4 The importance of the interest and talent in selection, training and employment system underlying scientific, technical and professional expertise in related employment

3.5 Strengthening and value to all occupations, especially in technical and professional occupations in the public culture of country

3.6 Technical encourage of entrepreneurial culture in the country

3.7 Promoting group work morale, job conscience and self-esteem

3.8 improve the culture to prioritize national interests over personal interests in matters relating to import and trade of goods and purchases of equipment and technical

4. Efforts to preserve cultural values, social and Islamic principles in the use of technology

One of the main objectives of this research is to find a model compilation of existing policies and standards in technology assessment to ensure its stability. So after presents the main issues related to sustainable technologies and policies in the country, as the conclusion of the discussion, the conceptual model is presented in the following

3- Develop a conceptual model

After reading the previous research in the field of sustainable technology and also upstream document review, common instances in all of them is extractable that are categorized in 5 categories that can be seen in the table below:

Table 4 - dimensions and sub-dimensions of the conceptual model of evaluated sustainable technology development

environmental and resource management dimensions	Political and legal dimensions	human, social and cultural dimensions	Technical, operational and organizational dimensions	Economic and financial dimensions
Ingredients	Compliance with human rights	Improved quality of life	Lifetime of technology	The cost of setting up and using technology
Energy (efficiency)	Conformity with the constitution and the general policies of system	Stability and hiring staff	Intelligent technology	Interest extractable
Water consumption	Compliance with national laws and regulations	Create new jobs (employment)	Commercialization capabilities	Energy costs
Biodiversity	Compliance with international regulations	Labor Relations	Level of technology (maturity)	Financing
Earth and use	Compliance with international treaties and agreements	Health and Safety in the Community	Attraction of technology for users	Energy investments
Emissions of polluted ... gases, waste, noise and	Constraints due to sanctions	Enhance the knowledge and skills	Ways of using technology	Repayment period (return on investment)
Recyclability	Government assistance (financial opportunities, such as subsidies, (.loans, etc.	Create equal opportunities (social (justice	Compatibility with manufacturing processes and organization	The value added
Protection of Sources		Generate equal revenue between population	Employee Health and Safety ((Safety Technology	Access to financial support
Conformity with the principles of green design (such as the cradle-to- (cradle design - C2C		Reduce corruption	Technical performance of technology and performance level	Labor costs
Ecological efficiency		Increase the happiness of the people	The availability of the required expertise for the design and operation	Maintenance costs
		Community acceptance	Reproducibility	
		Compliance with the culture and values of the society		
		Poverty Reduction		

Based on mentioned points a conceptual model can be drawn that is result of past research review in this area.
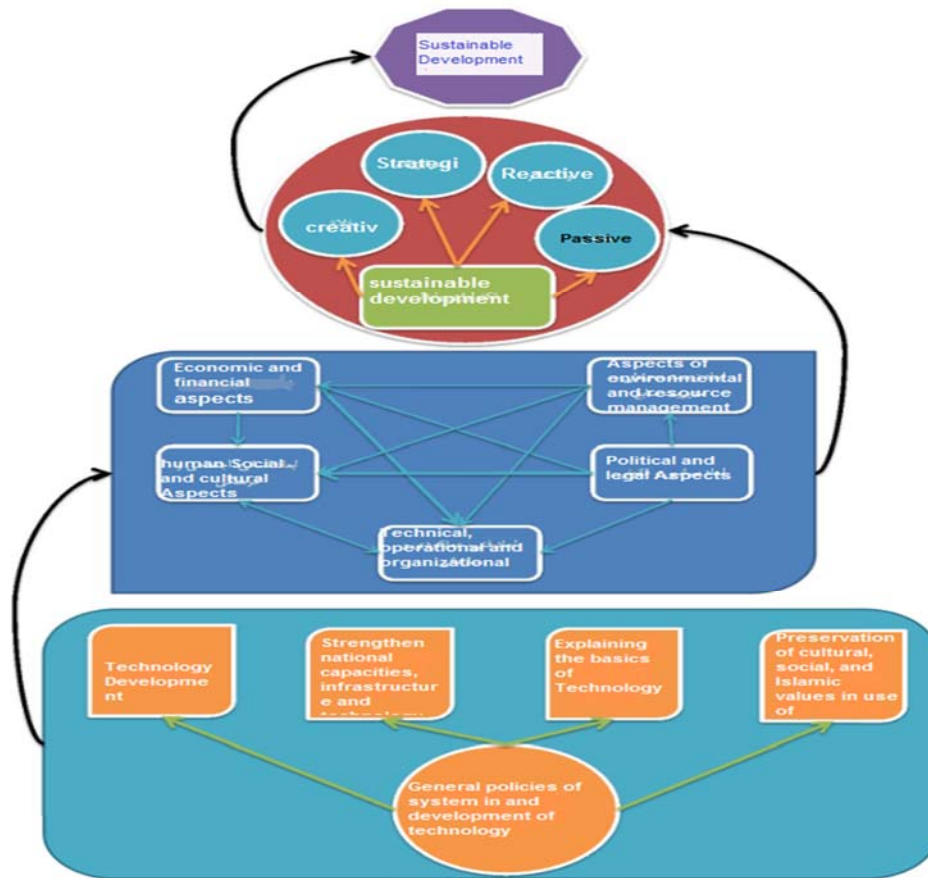
In the presented conceptual model, in general we can say that one of the themes in order to achieve sustainable development is access to sustainable technology. In order to achieve sustainable technology, the 5 components (original dimension) is considered which include: Economic and financial dimensions, human dimensions, social, cultural, technical, operational, organizational, political and legal dimensions environmental and resource management dimensions. Also, each dimensions have sub-components that due to the multiplicity of them are not depicted In the Figure. It should be noted that a technology in the field of sustainability after assessment will be divided into 4 groups. Creative, strategic, reactive and passive groups. 5 dimensions definitions set in the above model, is as follows:

Economic and financial dimensions :this dimension explain economic and financial issues associated with the technology.

Technical, and organizational performance: this dimension express functional issues from the perspective of micro technology in organizations and the use of technology in them.

Human, social and cultural dimensions: this dimension is related to impact of technology in the society and consequently, the culture and values of society.

Political and economic dimensions: this dimension from the perspective of national and international laws, regulations and policies in the country, looks to the technology.

Environmental and Resource Management dimensions: this dimension related to green management and related issues to environment is a technology.

As can be seen in the figure, the political and legal dimensions have impact on other 4 dimensions. Environmental dimensions have impact on 3 economic, social and technological dimensions. Technical and human dimensions have 2-sided communication. On the other hand, technology development and strengthening infrastructure have interaction with economic aspects and explaining and promoting cultural and technological principles and preserve social, cultural and Islamic values have relationship with human, social and cultural dimensions.

4) Conclusion:

As was mentioned, the use of technology and the importance of sustainability issues in the world today, is one of the most challenging issues. The identification of factors that could be involved in the assessment of technology from the perspective of sustainability are important. In this paper tried to develop the conceptual model of evaluate sustainable technology according to records of previous studies. Based on literature review and review of relevant records, there is no statutory instrument to assess compliance technologies with the principles of sustainable development and in line with the state policy in the field of technology development in the country. In fact, the issue of sustainable technologies in the country with macro perspective almost have been neglected. And given the global policies based on balance various aspects (social, economic, cultural, environmental etc.), it will have extraordinary importance in our country. The next step in this research is to develop a quantitative native model with the help of experts in the field of industry and technology. Thus, with formulation of indigenous sustainable technology assessment can also distinguish between stable and unstable technology, depending on their stability, provide good support for the dissemination of these technologies in the country.

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