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Indicators of science participation In the Development Theory

Abdolrasol DIVSALLAR[1], Mehrdad NAZERI[2], Azadeh ALETAHA[3,*]

[1]*PhD Student of Political Science, University of Tehran, Tehran , Iran*

[2]*Department of Educational Management, Islamic Azad University, Yadegar-Imam, Shahre Rey Branch, Shahre Rey, Tehran, Iran*

[3]*Researcher and Director of Endocrinology and Metabolism Research Center, EBM Group, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran*

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Abstract. Scientific development and its role in growth and development is regarded by many scholars to be one of the most important components in defining development and underdevelopment in the modern world. The present article considers the importance and the strategic level of effectiveness of scientific development on a hypothetical theory of development as the main issue and also investigates the necessity of the science presence as a constant variable in the development theories. Furthermore, in this study, a critical approach has been taken towards the assessment methods of scientific participation in development. Consequently, in order to achieve this purpose and also to examine the participation and influence of science on development from a constant aspect, eight strategic indicators have been defined including: role of science in social evolutions, capability building in development due to science, scientific rationality and development. Scientific culture and development, role of science as essential information in development process, science and construct of power relationships, effects of science on resource-based development patterns and critical approach to science, which are able to illustrate the extent and importance of presence of science in development theory. These indicators have been selected based on the logic of scientific development, not scientific production, owing to the fact that in this study, scientific development has been distinguished from science production. Scientific development is assumed to be a constant extra-component term and the resulting effect of science on other components of the development theory.

Keywords: Development, development theory, scientific development, ration, power, national resources, social evolution, consistency

1. Introduction

Gerald Meier in the introduction section of his influential book “Frontiers of Development Economics” states: “the knowledge gap between the poor and rich countries is as significant as the saving gap or foreign exchange gap(Mir Gerald Josef Stiglitz 2006) .Scientific development and technical progress is roughly the intersection of all doctrines of development and the importance of this perspective is increasing in an upswing process. As Stieglitz states “Today, The World Bank has shifted much of its emphasis to the intangibles of knowledge, institutions, and culture in an attempt to forge a more comprehensive New Development Framework for our work(Stieglitz)

However, the following questions could to be answered; what exactly scientific development is and how we can examine the extent of its influence on development. Scientific development is a general concept, which includes three steps of: production, dissemination and utilization of science (Soltani 2009)and has three characteristics:

- It expands science which can be acquired through research and thought.
- It monitors the transferability of science through education, publication of articles and books, manufacture of products and etc...
- It is considered as the problem-solver of human societies.

* Corresponding author. *E-mail:* Mehdi4rasht@yahoo.com

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In this study, scientific development has been distinguished from science production. Scientific development is assumed to be a constant extra-component term and the resulting effect of science on other components of the development theory, whereas science production is considered to be an intra-component concept, which monitors the growth and advance of internal indicators of science. It is therefore possible to observe growth in scientific production without consistent scientific development (external relations of science with other aspects of development).

The implicit purpose inside the scientific development is the factor that increases its importance; consequently, the following question come to mind, what is the purpose of scientific development? It aims to use the outcomes of scientific method to facilitate movement from the current status towards the ideal situation. Human beings' scientific methods and manners should be regarded as a response to functional issues made by their needs, in order to have a better recognition of the empirical world and also to have the ability to adapt with it in social and physical terms (adaptive recognition) (Norouz zadeh 2010)Thus human beings' scientific manner is not only a response to struggle for survival principle, it is also a necessary reaction to update their needs properly, and level of social advancement is therefore directly related to level human beings' scientific manner. The purpose of scientific products is to enhance the ability of improving the human performance and to aid them in reaching their desired level. Scientific development occurs, when the science is produced in a targeted process and is distributed over human society, facilitating the accomplishment of ideals by human beings. If science production and dissemination fails to lead human beings to their ultimate purpose, then scientific development would not occur. Although fulfillment of scientific development requires process, but its basis is an aim-oriented concept and its main variable of definition lies in its purpose. The primary purpose of scientific development is to promote the human development rate and fulfillment of any other purposes coincided with the growth of scientific events are considered as ancillary purposes. This simple fact, is necessary for recognizing the reasons regarding the failure of conversion of scientific developments into viable and sustainable developmental processes in Iran.Some experts argue that scientific development is a result of continuous, ambitious and balanced interaction between science, technology, education and culture in a society(Zaker Salehi 2008), but others believe that knowledge application is to enhance and improve people's lives and to provide the basis for scientific development(Steven Sidman 2008a). Such interpretations affect the production and dissemination of science as components of scientific development.

In fact, the identity of scientific development is defined based on its level of participation in national development and its level of consistency. Hence, the relationship between scientific development and national development should be evaluated more precisely by analyzing set of descriptive indicators. This article tries to identify which basic indicators are able to explain the relationship and effect of scientific development on national development. Answering this question, proves. The correlation and explains the extent of relationship between science and development and it can also be used as a pattern to assess the level of science participation in development. In this regard, the following hypothesizes have been considered:

- Science and scientific development are vital and determinant processes for development of human civilizations and modern societies, and a sustainable process of scientific development is them a joint dependent variable for describing the development status.
- Science has a correlation relationship with the variables involved in the development process, thus it is necessary that some concepts and theorems of development theory address the issue of scientific development and provide distinct explanations and solutions to take.
- Scientific production is different from scientific development. While scientific production has an inner-component attitude towards growth and development of the science, scientific development emphasizes on socialization of the produced science and has an outer-component attitude towards science.
- With regard to the explanatory difference of science production (which shows the growth of science) and scientific development (which represents the application of science in solving social problems), in order to understand the level of participation of science in development, some indicators should be designed to evaluate the achievement of scientific development, which is done by assessing the indicators of science production.

1. Science as a component in the development theory

Undoubtedly, the origin of every theory and hypothesis is science and development literature is not excluded from this rule; however the role of science and scientific development in the development theory needs more analysis. The areas, in which, science has key regulations and effects on development should be identified, due to the fact that these areas, are necessary for formulating the development theories. Consequently, few questions arise whether science and scientific development are integral parts of a development theory and whether every developmental theory should necessarily consider certain challenges and concerns regarding science and scientific development, in order to succeed in achieving its goals, which is development. This argument, in turn, refers to another issue of how to investigate the success of development theories; whether certain criteria, which assess the internal structures of a theory, should be considered for evaluation of a development theory, and whether it is possible to identify basic and joint characteristics, based on perceptions of the state of development around the world, which are considered as constant principles and development theories are planned according to them.

Theory is a set of related concepts, theorems and regulations which provides a systemic view regarding a phenomenon by recognizing the relationship between different variables as well as predicting and explaining the outcomes. A development theory attempts to identify variables that affect the development phenomenon and explain the relationships between them, in order to achieve a set of descriptive and prescriptive concepts and theorems that provide basis for enhancement of development.

Social theories are classified as scientific, philosophical and behavioral theories (Azad Armaki 2008).Although development theory is a scientific theory, it involves aspects of conceptual and ethical thinking. Belief in the fact that science can make the world a better place is at the heart of social theory of development. However, the issue addressed in this article focuses on whether scientific development is considered as a fixed concept in the theory of development. Azad Armaki considers constituent elements of the social theory as concepts, relationships among concept, interpretations, explanations and analysis, communication with external reality and logical consistency and believes that lack of any of these elements, leads to failure and collapse of a theory (2003a). Scientific development is one of the permanent basic concepts of any development theory and it can be considered as one of the common denominators of all theories of development.

Excluding scientific development from a development theory leads to devaluation of the theory and producing a new theory without taking scientific development into consideration, as one of its basic concepts, is like a stillbirth. Development process does not have a single path; however, it has some basic and common principles, which is the intersection of all development theories and solutions. A development theory is built in three distinct layers (figure 1). The first layer of a development theory is the basic concepts and joint principles, which is characterized by its relative share in all theories. The second layer consists of variable concepts, explanations and priorities, which create the different and distinguished feature of each development theory. Finally, the solutions layer, which is based on the function of previous layers and provides certain strategies. Science is located in the first layer.

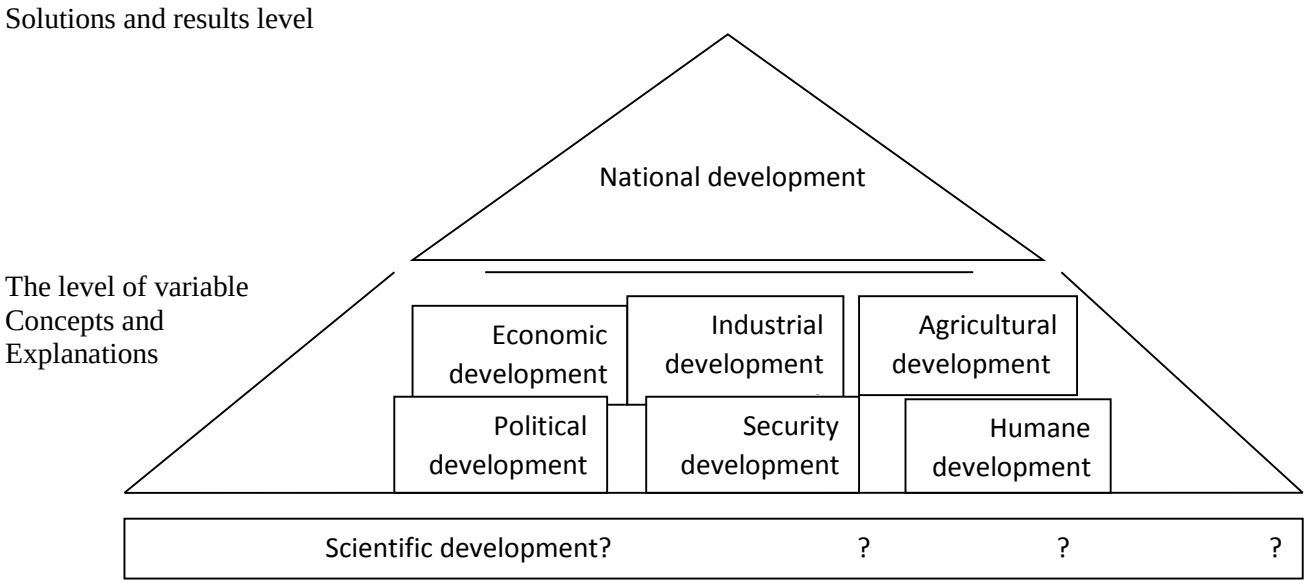

Figure 1. Probable levels of a development theory.

Development theory should provide precise explanations based on indicators of science and scientific development. The essential explanations, which indicate the validity and effectiveness of a hypothetical development theory, are as follows:

- Regarding underdevelopment, a theory, in addition to analyzing the scientific development in certain levels, should also identify and analyze the resulting consequences of scientific underdevelopment.
- Development theory should be able to apply science as a basic concept in theory, and while explaining the relationship of science with the other related basic concepts, it should also provide specific analyzes of how science interacts with other social sub-systems.
- Development theory should be able to provide specific solutions to enhance the level of scientific development.
- Development theory should be able to anticipate and manage possible conflicts in social system arising from the growth of science during development process.
- One of the key indicators of success in all development theories is to address scientific development, while ignoring it would dramatically reduce the coefficient of success.

2. Internal and External relations of science and development process

Conception of science as an essential component in the development theory and consequently the development process creates a fundamental question; what probable connections are established between science and development process? In response to this question, we should consider science as an active component of development theory and investigate the structural relations between science and other components of development. However, the expected relationships between science and the other components of development process are not the only form of relationship available between science and development, due to the fact that science as an independent component has its own internal issues.Large internal transformations within science refers to specific internal structure of science however these internal transformations, to some extent, affect the other components within development theory. Thus two levels of relations could be defined between science and development: Internal and External relations. Internal relations refer to the changes within science as a component of development.

Internal relations which are limited within science and explain dynamics of science do not have direct effects on other variable in development theories. However, dynamics within science, has indirect effects on other components of development. The growth of scientific indicators such as volume of article production, number of students, amount of inventions and most scientometric indicators, mainly analyze the internal relations of science explain its dynamics.

On the other hand, external relations of science, refers to those internal dynamics of science which has effects outside the boundaries of science and has implications on other variable of development. In this respect, external relations of science explores effects of science dynamics on important variable of development. In fact, when scientific growth obtains a social consequence and internal transformations of science creates social actions, the outer component so called external relations of science is established in order to analyze the connections of science dynamics with development

In classical literature, two concepts of scientific production and scientific development describe the above relations. The concept of science production, which has emerged from the scientometrics literature, questions and examines the growth or decline in the status of science and identifies the status of internal transformations of science in a certain period of time. However it does not necessarily evaluate the correlation between these changes and their social implications. From this perspective, science production is a concept, which analyzes the internal relations within science and provides an assessment of internal processes occurring within science. whereas scientific development not only evaluates the internal relations of science, but it also investigates the social patterns on which scientific development has disseminated in society, even moreover it examines, what the effects of science dissemination and expansion of scientific view are on social life and achievement of social goals. In this respect, the concept of scientific development identifies and explains the external relations of science with the other elements involved in social development. Detailed analysis of scientific development is achieved by analyzing the relationships of outcomes of science with other components involved in development process. Therefore, scientific development indices are essentially different from science production indices provided by scientometrics literature.

These relations and the relevant concepts can be explained with an example; All scientometric studies of USSR during 70s and 80s showed that the science production indicators are on the rise. Internal relations of science were thoroughly managed, which had led to enhancement of scientific power [Statistics and reports of scientific and technological growth of USSR in that period of time, confirm this claim]. Nevertheless, there were arguments among experts about whether the scientific growth of USSR had any tangible impacts on society and whether it has a reasonable relationship with the requirements of improving living conditions. Soviet officials neglected the fact that the positive growth in science shown by scientometric indexes is an internal dynamic of science and if not coupled with appropriate policies to manage external relations of science with other development variable, would not have any social values No effort was essentially being done, in order that growth of scientific production leads to scientific development means growth in technological innovations and enhancement of scientific indices were not introduced into the community to solve the social problems by different policies such as commercialization, de-militarization etc.

The above example shows that reliance on indicators of science production is not able to thoroughly explain the effects of scientific growth on development, due to focus on internal relations of science, whereas the indicators of scientific development are able to analyze the participation of science in development more precisely, owing to the fact that necessary social demands have been taken into consideration in their articulation. The indicators of science production essentially fail to describe the relationship between science and society in a proper way, whereas the indicators of scientific development are social indicators that accurately consider the effects of science on development. Therefore it is necessary to use both internal and external based indicators to identify the level of science participation in a sustainable development process. However, the problem is that the indicators based on internal dynamics of science (science production indicators) have been adequately expanded, while the indicators based on external relations of science with various development variables (science development indicators) do not have the necessary transparency and interpretability. This article evaluates the second group of indicators.

3. Analysis of common indicators of scientometrics from the perspective of development

Detailed indicators are available to rigorously assess the growth or decline of scientific productions, which offer different characteristics according to various schools of scientometrics. Different models have been provided by different institutions such as UNESCO , United Nations regional commissions, United Nations Development Program (UNDP) and United Nations Conference on Trade and Development (UNCTAD), Organization for Economic Co-operation and Development (OECD), the statistical office of the European Commission, the Council for Competitiveness and model offered by Russian and American institutions. Available models are able to accurately assess trends and fluctuations inside science and provide proper estimate on science production. Each of these models provides a set of measurable quantitative indicators that enable us to understand the internal transformations of science and technology and help policymakers to propose strategies and policies on scientific growth and prosperity.

However, these indicators are not the proper measures for understanding the social impact of science especially on development. In other words, despite being quantitative and having sufficient accuracy, their essence and subject of study is specific about internal dynamics of science, in a way that they fail to establish a meaningful relationship between science and development The fact that is, these indexes are not socialized enough. Although it can be generally argued that improvements in indicators of science and technology in a country leads growth and development, however, the existing indicators cannot aid in identifying, which social development indicators change and improve concurrent with the growth of science production. It is somewhat difficult and impossible to make a direct link between the growth of existing indicators of science and technology assessment indexes and the development status, due to the nature of these indicators.

The Organization for Economic Co-operation and Development has codified the majority of the existing assessment guidelines and indicators of science, technology and innovation, which have been generally used for codifying regulations and guidelines of scientometrics in many countries and international organizations. Indicators published through various instructions by the Organization for Economic Co-operation and Development can be briefly stated as: the index of research and development (Frascati instructions); Innovation Index (Oslo guidelines), innovation indicators in developing countries (Bogota instructions) , indicator of human resources (Canberra instructions), technology balance of payments, patents Index.

Detailed examination of the provisions of the above-mentioned 6 indicators and guidelines descriptor clearly indicates that the proposed indicators in these guidelines have been designed to measure the growth or decline rate in production of science and technology, and according to their characteristics and capabilities, each can show an aspect of internal transformations of science in each country and region. None of these indicators attempt to link technical measures of scientometrics with its social measures; Thus, they are unable to explain how an indicator such as research and development, relates with social or cultural development, and in addition, this model cannot provide a proper estimation and analysis of the impact of science on various aspects of national development.

Indicators of Organization for Economic Co-operation and Development, one of the main principles of the UNESCO criteria for the reporting of science which is presented annually to the United Nations Statistical Commission (Table 1). Likewise, a more careful look at the UNESCO criteria reveals a similar situation, in which, indicators consider the analyzes of science production with internal approach.

Table 1. Science and Technology Indicators of UNESCO.

Mass indexes of UNESCO	Main measures of each indicator
General knowledge indicator	Institute's information including the type of organization and the type of its main activity
The research and development manpower's indicator	Gender-segregated personnel of research and development, segregated by the employing department and the job, segregated by the employing department and gender, segregated by qualification and employing department; segregated by qualification and gender; segregated by scientific domain and employing department, segregated by scientific domain and gender
Indexes of expenses	sum of research and development expenses according to monetary unit : segregated by the capitalization source
Indexes predicting research and development status in the next 2 and 4 years	Including the collection of sub-scales of researchers (segregated by the subject) and the expenses of research and development (segregated by the subject)

The technology achievement index is one of the most important indicators that in addition to assessing the internal state of science production, attempts to establish a reasonable relationship with development, which was first discussed in the report of the United Nations Human Development program. This indicator allows determining the ability of countries for creation and dissemination of technology, and how human skills have been increased according to that ability. (ESWCA; 2003)(A. H. Nouruzi Chakli, Mohammad; Nour Mohammadi, Hamze Ali 2010b; Nouruzi Chalaki 2010). furthermore, it investigates four aspects, including: creation of technology, dissemination of new innovations, dissemination of old innovation and the resulting humane skills (UNDP; 2007)(2001). Although technology achievement index is important for human development, it only measures access to technology and does not consider how these accessibilities have led to human development (Chalaki 2010; A H. Nouruzi Chakli, Mohammad; Nour Mohammadi, Hamze Ali 2010a).Hence, although technology achievement indexes is one of the most socialized indexes of scientometrics, it is unable to establish a precise relationship between science and development, and is considered to be deficient in this term.

Based on the specific requirements of each region, the United Nations evaluates science, technology and innovation in different parts of the world, under the supervision of regional commissions. The economic and social commission for western Asia is one of the United Nations agencies, which designed the indicators of science, technology and innovation for western Asia with the co-operation of countries of the region. This commission declares five indicators according to science and technology sub-systems, including; indicators of research and development , bibliometric indicators, indicators of intellectual property, indicators of higher education, indicator of technology balance of payments, indicator of international trade of high-tech ,science and technology indicators linking trade agreements and social indicators(A H. Nouruzi Chakli, Mohammad; Nour Mohammadi, Hamze Ali 2010a).

The last indicator appears to be the most important measure that evaluates the link between science and technology and social indicators, since it shows the admission of innovation processes by a particular nation and allows to assess their potential ability in creating new capacities(2003b)and investigates the possibility that social issues be affected by introduction of a particular innovation (Chakli 2010). However, this indicator only considers information technology as particular innovation, and therefore, relations of science and technology with the social indicators are limited to information technology. Consequently this indicator is unable to establish a precise link between indicators of growth and production of science and social indicators.

Likewise in Iran, scientometric indicators that evaluate the state of science and technology in the country, take the internal relations of science and technology into consideration. The first and second major assessment of science and technology of Islamic Republic of Iran (2003, 2009) evaluated human indicators, financial indicators, indicators of scientific structure, and indicators of scientific

performance and scientific productivity. Also Nowruzi Chalaki and colleagues, in their research study of the state of science and technology assessment in Iran, refer to 8 main indices including: financial indicators (14 indicators),qualitative evaluation indicators (24 indicators), indicators of science (5 indicators), indicators of structural parameters (15 indicators) , human resource indicators (39 indicators) , performance indicators (14 indicators), indicators of technology (17 indicators), and productivity indicators(11 indicators) (Stewen Sidman 2008b). all the above 8 groups of indicators and their 149 sub indicators focus on the internal state of science and technology and attempt to show various aspect of science transformation. however, they are not able to provide an analysis and explain how the growth of these indicators is related to the changes in the status of social development(A. H. Nouruzi Chakli, Mohammad; Nour Mohammadi, Hamze Ali 2010b).

Thus from the developmental aspect, important weaknesses could be identified in the existing indicators of science and technology, which analyze the state of science production and evaluate the internal transformations of science. As a result these indicators are unable to provide a proper explanation on how science is participated in the process of development Main critiques of current indices used for assessment of science and technology and determination of its role in development could be summarized as followers:

1. The conventional indicators of science and technology assessment while provide a detailed analysis of internal dynamics of science, show interactions between internal dynamics of science with other variables of development. The main logic for designing the conventional indicators of science and technology assessment was to recognize the internal transformations of science, without considering its effects on development. Therefore, understanding the level of participation of science in development process requires the design of new interdisciplinary indices that have the ability to go beyond mere analyze of internal transformations of science and technology, in order to explain the relations of science with culture, society, security and other components of development.

2. The common indicators of scientometrics, are unable to show how rise and falls in various science related issues affects development processes and improves the status of development, due to absence of reasonable link between common indicators of scientometrics and social development.

3. The common indicators of science and technology assessment generally analyze impacts of science on economic aspects of development and ignore other aspects of development such as social, humane and cultural aspects.

4. The major issue and challenge arising from reliance on these indicators for recognition of relations between science and technology is a general belief that growth in the common indicators of science and technology assessment, inevitably leads to growth in the national and social development status. In other words, in some cases, growth in the above-mentioned indicators of science is being used to show the improvements in the status of development; However, even if growth of science and technology is proven by the existing indices, it would still be incorrect to claim that improvement in the status of development is caused by the scientific growth, unless, the growth of science and technology are carried out to achieve social development. Such defects in the existing indicators of science and technology assessment, degrade the growth of science to the level of an advertising tool, and could endanger national development plans.

5. Common indicators of science and technology assessment are prerequisites for determining science participation in development; however, they are not sufficient for this purpose. The conventional assessment patterns of science production are the initial stage for analysis of science participation in development. It appears that quantitative statistics gathered by these indicators are inputs for another analytical framework, which is based on extensive social indicators. This analytical framework consisted of qualitative social indicators, is used for analysis of the process of scientific development using quantitative data (products of first stage) and show the rise and fall in the state of science production affects the development indicators and strengthens the different aspects of development.

5. Indicators for evaluation of science participation in the development process

The previous discussions raised this question; if the common indicators of scientometrics fail to show the level of science participation in the development and to provide a proper analysis of their relations, then what indicators are appropriate for showing the structured relations between science and development? In other words, in case of growth of which social indicators related to science growth of development rate can be expected. The indicators assessing the participation of science in the development should have several important features characteristics;

- These indicators are areas of development which can be influenced by science and should demonstrate the areas, in which, the development process is affected by the inner transformations of science component.
- The new indicators, on the one hand, are affected by the inner component changes of science, and on the other hand, they are affected by the development process and approximate these two together.
- The new indicators are the outcome of addition of target element to the conventional indicators and question the purpose of the changes regarding the rise or fall in each of the scientometric measures. For instance, in regard to the growth of bibliometric indicators, the following questions are proposed; what is the purpose of this growth? And what is the result in the national culture?
- The new indicators are generally qualitative and analytical.

5.1 science and social changes

Development is considered a structural process based on exogenous perspective and a multidimensional social dynamics towards the improvement of quality of life in material and spiritual terms based on endogenous perspective. On the other hand, scientific development is also a kind of social dynamics based on mental and intellectual dynamisms. If the social dynamics or in general exposition, development, is interpreted as a variable of change, then some key questions arise; what are the bases and sources of change on social levels? What basic factors form the necessary conditions for minor and major changes? What orientations of change do these factors establish? Are these science derived changes able to create social changes?

Apparently, most sociologists acknowledge about whether scientific and technological development have led to social change. Nicolas de Condorcet, one of the intellectuals of the Enlightenment Period, in an overview regarding historical image of the development of human mind states that the nature of science and its reliance on the facts and observation, in addition to its openness to criticism and revision, has automatically turned into social development and transformation (Rouche 2008).. Gay Roche confirms by the fact that the industrialization, urbanization, increased production, speed in transportation and communication and etc., are only the extrinsic demonstrations or apparent manifestations, and in fact, in the inner layers, the complex human social life has been affected during Enlightenment period and Industrial Revolution and (Durouche 2008). However, Marx might be the first modern intellectual, who emphasizes on the importance of science and technology in changing the relations of production and eventually classes and communities, in terms of Marxist theory of modes of production. Marx (1847) argues that "Social relations are closely bound up with productive forces. In acquiring new productive forces men change their mode of production; and in changing their mode of production, in changing the way of earning their living, they change all their social relations. The hand-mill gives you society with the feudal lord; the steam-mill society with the industrial capitalist. Lewis Mumford, Patrick Geddsen and Toffler are among other intellectuals who emphasize on the transformer nature of scientific development and classify societies on the basis of science. Henry Januer maintains that "we consider technique (science and technology) as an independent variable that all the other aspects of history are overshadowed by it and move in its direction(Mahmud Sari-ol-Ghalam 2008b).

Scientific development has created two fundamental effects in the community regarding three areas of science production, dissemination and utilization, and it directs the changes by guiding the social dynamics. Strengthen thinking and «thinking based on insight and knowledge» are the first effects of scientific development. The second effect refers to creation of precise awareness and understanding of the environment and how to deal with it. The penetration and institutionalization of these two effects in the underlying layers of society, changes the behavioral pattern of social sub-systems such as political, administrative and economic system and etc. both cognitively and functionally. Cognitive changes of these sub-systems are the product of thinking based on knowledge, and their functional changes are the result of better recognition of the environment. Therefore, along the changes in the level of recognition and function of social sub-systems, the orientation of social dynamics is altered, and a context of sustainable qualitative and quantitative changes for improvement of quality of life is created. In this process, scientific development is the main factor for changes and formation of social dynamics.

Scholars such as Kroeber and Barnett also confirmed the social changes caused by science and investigated the alterations made by dissemination of information, techniques, awareness and innovation on social levels. Despite the importance of history of scientific development in the human civilization and rise in its significance, many scholars consider it as an independent variable in development theories.

2.5 scientific capability building and development

Science and scientific development are among the most fundamental motives factors of national capability building and It is not irrelevant to claim that the capability building has been the most important role of science in the national development. National capability building occurs in two forms; the first form occurs by converting the potential capacities into actual capacities, and subsequently, converting the actual capacities into added value and improvement outputs. A third form can be added to the previous forms, which is specifically manifested in the capability building process of science and it includes new capacity building (potential and actual). Scientific development can create new capacities on a national level, which can potentially develop added values or actually create values. Capacity building resulting from development of science occurs on all individual, organizational and social levels. Scientific progress alongside new capacity building facilitates convertibility of the existing potential capacities into actual capacities and ultimately added values and prominently participates in the traditional patterns of capability building.

3.5 scientific rationality and development

Sari-ol-Ghalam in his book *Rationality and the Future of Development in Iran* states that if for any reason, science does not penetrate into the field of thought and action of a community or fails to integrate rationally with its values, then improvement should not be expected, moreover he insists that utilization of though and science in any activity refers to rationality. He also interprets that "rationality will be institutionalized, provided that the thoughts and behaviors of citizens and politicians are established according to science, study and public interest."(Mahmud Sari-ol-Ghalam Sari-ol-Ghalam, Mahmud). consequently, development is a dependent variable of science, and the most prominent aspect of science refers to the rationality of a community. Hence, Science promotes rationality, and subsequently rationality participates in national development and progress by intensifying the scientific growth. Sari-ol-ghalamstates elsewhere that "the basis of rationality is the regulation of behavior and personality, as well as regulation of thought and intellectual trends and no nation, regardless of historical background and cultural structure, can ignore this basis in relation to the principle of growth and progress(.Haji Hashemi 2006). It is inferred that scientific development can lead to expansion of rationality on national level and provides basic contexts for national development through science production and integration of science into a rational education system. Therefore, as development involves improving recognition, organization and planning, and science, as deductive reasoning of thought and action (extension of instrumental rationality and philosophical rationalism), is the main basis for success of development theories.

The concept of rationality in development can be classified into two types of instrumental and philosophical rationality, and the other rationalities fall below (Ritz 1999).However, as mentioned before, these two types of rationality themselves rely upon science and even scientific rationality.

Philosophical rationality considers the immaterial aspects of development and refers to the content of intellectual structure of a community and much of it is rooted in the history, beliefs, norms, identities and values of a society. Philosophical rationality deals with the intellectual and epistemological processes.

However, thought in the broad sense and including its imprecise limits such as cognition, is considered to be in the category of science according to idealistic scientism approach; therefore, philosophical rationality is also based on scientific basis and regarded as an effect of science.

On the other hand, instrumental rationality refers to the material aspects of development and is defined as utilization and application of the most appropriate instrument for achieving the most desirable demands and objectives. Ritz believes that instrumental rationality has some several features such as being calculative, efficiency of instruments and ability to predict (Sari-ol- Ghalam 2002). Instrumental rationality basically leads to knowledge-seeking, efficiency, orientation to order, optimization and idealism in the development. As Sari-ol-Ghalam states, instrumental rationality itself is based on science and efficiency and is completely under authorization logical thinking(Mahmud Sari-ol-Ghalam 2008a).Instrumental rationality is based on scientific grounds, which creates the spirit of reasoning, study, research and discussion, and makes decisions, communications, argumentations and logical judgments. In fact, science is the context for consolidation and current of instrumental and philosophical rationality, and institutionalizes rationality in the community, and in this way completes the development cycle.

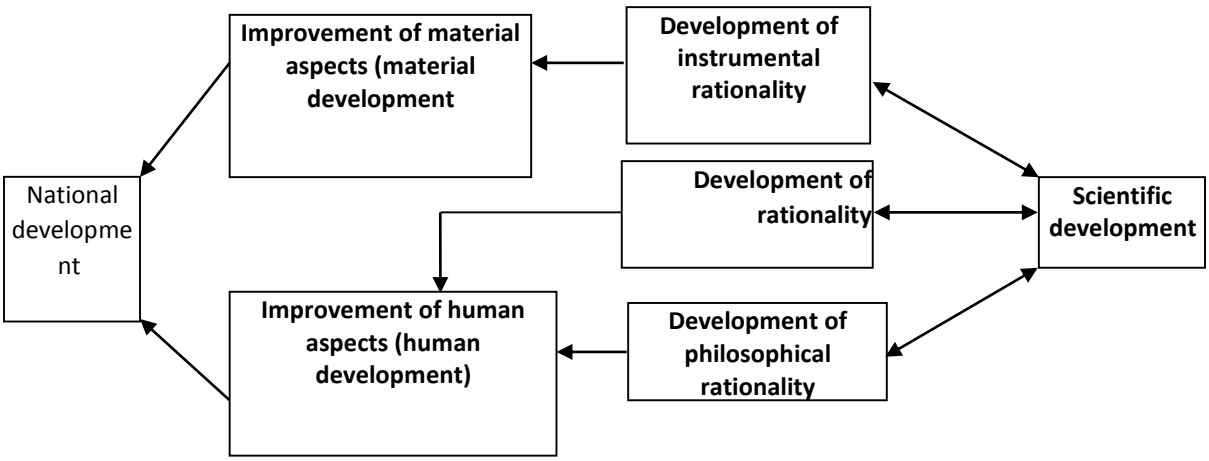

Figure 2. Science and rationality in the course development.

3.5 scientific culture and development

Development, in order to improve the objective aspects (abundance of basic needs and providing secondary needs) and the subjective aspects (in accordance with values and ideals of a nation) requires methods to achieve these improvements. Ina positivist and idealistic look, science is the shelter and source of improvement methods required by development processes. Development needs a scientific community to extract these methodic requirements and achievement of the scientific community needs a scientific culture.

Scientific culture provides a context for scientific growth and development. Once a community has a scientific culture and approximates to a scientific community, indicators of science production start to rise and demand for science, and subsequently rate of science consumption increase. In these circumstances, the application of science to solve minor and major problems of a nation reaches its highest level and solutions for improvement are set based on scientific propositions. Thus scientific

development (science production, dissemination and consumption) causes growth and development of scientific culture and movement towards a scientific community.

Scientific culture promotes the status of intellectual elite (thinkers, scientists and intellectuals) among people and in this way, increases their influence over instrumental elite(the owners of wealth and power), and allows a rise in the penetration of scientific propositions in national decision making and in addition, the developmental orientations to be made based on scientific knowledge. Sari-Ol-Ghalam believes that scientific culture is composed of five essential characteristics of scientific thinking, production, reasoning, personality and behavior, and thinks that angels of scientific culture could be found, provided that the public culture of a community accepts the scientific perceptions, gives a respectable position to science and respects analysis(Haji Hashemi 2006).

Alignment and coordination between national culture and scientific culture is undoubtedly considered to be the fundamental prerequisite of development. In an ideal situation, national culture evolves based upon the scientific culture, instead of being fixated on the basis of traditions, imaginations of predecessors and unpolished values. The institutionalization of science, thinking, reasoning and scientific character, results in scientific spirits and converts nation into a scientific community. One of the characteristics of scientific community is that it replaces other deductive methods with objective logic. If a community aims to move from the previous situation for the better, firstly, the idea of improvement should be generalized and logic should rule over behaviors, decisions and communications(Ghavam 2010).Therefore, scientific community belongs to a nation, in which scientific culture has been embodied, and adjust thought and method of development based on science. Development and achievement of ideals materializes in transition from a scientific culture to a scientific community.

5.5. Scientific development as the necessary information in the development process

The internal structure of science includes data, information, knowledge and awareness, and information in two aspects of content related information (information, knowledge and awareness) and physical information (data and communication), is close to science in terms of nature. it can be argued that science is the product of informative functions (data reception and processing) by the instrument of thought. This close relationship and fundamental similarity between science and information can be used to explain the role of science in the process of national development, in other words, explaining the role of information in the process of development, describes the role of science, indeed. Accordingly, in order to evaluate the role of science in the development theory by assuming the similarity of science and information, we tend to analyze the role information in the development process and in this way; the origin of science in the development will be explained.

Easton's systems analysis and functional analysis of social systems by Parsons provide proper patterns for recognizing the role of information in the development process. Information (science as its internal component) is the major constituent of feedbacks between data and inputs of a social system in the Easton's systems theory and Therefore, they are converted into an essential function, which its disruption could imbalance the social system. Information in Easton's systems analysis of political life (and other social sub-systems) plays a key role in critical periods, for instance, Information (knowledge and awareness) is a key factor in maintaining a balance between system and environment; furthermore, it is the most important instrument for conveying concepts and patterns from inputs to data, and vice versa, and also creates a subjective and even an objective connection between them. In addition, information is highly effective in the ability of a system to reproduce its essential patterns including norms and methods. The emphasis of Easton and Parsons on the importance of maintaining social patterns and the ability of input-data system in the adaptive reaction towards the pressures of

environment shows the important role of information as a factor in shaping the ability of a system in reaction to the environment(Ziyayi 2009).

Therefore, recognition of a social system primarily depends on recognizing the information and knowledge in that community(Div Salar 2009) and evolutions of a social system would be more tangibly understandable by analyzing the evolutions of science and awareness. Development as social alterations and evolutions, changes the levels of information or science and knowledge in a community, thus changes in the levels of information (science) leads to alterations in the level of development, and in this aspect, development is a process, affected by social knowledge and manifested in the form of a social learning process. In such circumstances, information is considered to be an essential function, and scientific development is regarded as a process that tends to promote the quality and intensity of this essential function in the social system, in order to provide grounds for changes in the social balance or movement towards higher levels of desirability.

Science and awareness, in the form of internal content of information, and information as an essential function in the social system, have a dual role in the process of development. In the one hand, as a stimulating factor, provide the social actors with reasons and incentives for moving from the current status to a desired state, and on the other hand, they are considered to be a vital necessity in the process of change, and acting like guide in this process by providing the necessary situational awareness and recognition and facilitating interaction with the environment.Therefore, the information field (data, science and knowledge) in one aspect, has a provocative and abstract role in the development process, and in another aspect, has a pragmatic and practical role(Abdolrasool Divsalar 2012) In total, scientific development as the development of informative process in a social system, affects the national development by following methods:

- Scientific development enhances the intensity and quality of the performance of essential functions of information in the social system.
- Scientific development conveys a new conception of ideals and social orientations, from the giant stance of motivation to the diminutive stances of action, by improving social knowledge and awareness, and provides the necessary motivation and energy to begin the process of change by creating an interaction space between these layers.
- Scientific development plots rational and beneficial reactions regarding environment, and facilitates management and controlling of environmental feedbacks on a social system by enhancing the level of awareness and recognition of social actors.
- Scientific development by instrumental and technical development, provides the social actors with the necessary operational capabilities to implement their new mentalities.

6.5 Science, power and development

In explanation of relations of power, science and development may be the first step for defining development from the perspective of power. Development is the ability to achieve a desired level of satisfaction and coordination in the life of a human community. In this aspect, development is indebted to potency, capability and as a result to power, and nation's development is perceived as national strengthening. On the other hand, power itself is a dependent variable to several components such as knowledge (science and information). In fact, the development process is the process of strengthening the components of power on a national level. The deep relationship between science and power has been regarded by many intellectuals such as Michel Foucault, Bertrand Russell, and etc. Although the relationship between science and power in terms of priority over each other requires a detailed discussion, there is no doubt about the existence of a reciprocal augmentative relationship. In the one hand, science is the source of power and survival power requires science, and on the other hand, power is the constructor of the type, nature and direction of science growth. On this basis, scientific development undoubtedly leads to regulation of power relations on social level, enhancement of fortifier component son national level and consolidation of power.

In explanation of the nature of scientific development, its effectiveness is considered to be an important issue. The level of Effectiveness of scientific development refers to practicality of science and its ability to change the environment. Effects arising from science production, dissemination and utilization are called scientific effectiveness; therefore achievement of scientific development needs effectively, and it can be explored in the perspective of Lass well regarding the relationship between scientific power and political strength. Harold Lass well's believes that as the scientific power of a country rises, its political strength will subsequently increase and acquisition of power would become possible by science (Moradiyan 2009)In other words, scientific development should be able to enhance power on a national level and provide grounds for national authority in order to achieve effectiveness. Power arose from scientific effectiveness, in addition to being a source for production of other types of power, is one of the elements of national power, which is at the disposal of authorities for supporting national objectives and policies. Thus a new aspect of the relations between scientific development and national developments arises, which in summary can be interpreted as the role of scientific development in promotion of national power. This approach, by connecting science and power on a social level, considers the changes occurred in the course of power, which has scientific source and the ability to lead the community to its objectives, as a basis for development. Science can change the structure of power and thus become involved in the development process by affecting four main areas of social power including economic, force (military), cultural and processing (management) power. Bagheri believes that if the relationship between science and power is considered as a range, the non one side, there are major powers with high level of scientific development, and they are therefore able to stabilize their production of wealth, and on the other side, there are weak powers that lack science and technology, and are unable to convert science into power (Bagheri 2009).

Consequently, in order to explain the importance of effectiveness of scientific development on national development, the main areas of power affected by scientific development should be discussed. The most important areas are (Abdolrasool Divsalar 2013).

- Scientific development leads to change in the resources of power acquisition on individual, organizational and social level, provides new resources, and alters the distribution of resources of power.
- Scientific development goes beyond the role of a secondary fortifier factor and becomes a basic element for production of power in the information age.
- Scientific development (science, knowledge and awareness) as a centroid, affects the processes of converting national potency into power, and level of scientific development determines the capacity for conversion of potency into power.
- Scientific development becomes a factor for capability building and excellence of power.
- Scientific development leads to change in the functionality and application methods of power, and in addition to introducing new instruments for exertion of power, breaks the monopoly of the traditional instruments.
- Scientific development alters the flow of power on a social level.
- Development of science and information changes the rate of development through a series of changes and alterations in the relations of power according to the following pattern.

Scientific development ⟶ changing the relations of power changing ⟶ the level of development

7.5 scientific developments and its role in the source-oriented development patterns

If development is defined as a product of intelligent utilization of resources and capacities of a nation, subsequently changing them into functional added values and finally allocating the resulting outputs in line with the demands of state-nation according to desires emerged from the social attitudes and values, then traces of scientific development will be evident in three critical stages of this process.

The model above shows that the first point of impact of science on development process is seen in the processing systems of resources. The basic inputs in the form of resources (tangible and intangible) and national capacities convert into outputs or added values in transition from a processing system. The most important component for creation of added values and conservation of existing resources is designing, implementation and application of processes for optimal processing of resources on a national level, which itself is a dependent variable to science. In fact, science as an independent variable, to a large extent imposes the status and quality of processing of resources, thus scientific development leads to enhancement of power and quality of processing of resources. Scientific development is the most important and basic component of the changes in added values and functional outputs in the development, and acts by controlling the processing factor status.

In the second stage, the pattern for designation of outputs from national resources processing is influenced by the existing science and knowledge. The demands of nation-government are a series of desires and ideals provided by the society and the main configuration for designation and distribution of outputs and the added values of the national resources processing is controlled by it. Scientific development affects the perception and framework designs of nation-government demands, and also affects the implementation of framework. In other words, scientific development enhances the ability to manage optimal designation of added value or the ability to manage distribution of the resources output.

Environmental factors and the way they are being reacted to are designative components for the proper function of this model and for the success of developmental activities. In fact, the reaction to the actions of environmental factors is dependent on the levels of recognition of these factors and perception of their functional features. Scientific development provides an instrument for optimal reaction to the environmental factors by giving this information.

8.5 critical approaches to science

Studying the necessity of using scientific development in the development theories can be interesting from the critical point of view; moreover it can be used as an index in assessing the science participation in development. Two major points will be discussed in this section: The necessity of managing the rates of scientific development in the national development process, and the counter development role of science due to lack of accordance with the other social sub-systems.

The rate of scientific development and its accordance with the rate of scientific development is a delicate point which is not seriously considered in general. It is assumed that rise in the scientific growth is the most ideal situation in the circuit of scientific development. However, whether these changes caused by the high rate of scientific growth are manageable and whether immunity can be provided from the probable critical results of such a growth is still a question. Ghazi states about this issue in the introduction of his book *the principles of political science*:"rapid scientific development in the industrial and developed societies which have already passed the critical stages can be beneficial and can help them to achieve their economic targets(Muris Duche 2008a), however, these rapid changes in the developing countries might have dangerous outcomes, hinder the normal social circuit and disorganize the existing order"(Muris Duche 2008b) The pace of development is as important as the level of development. A balanced pace of development tends toward similarity and reduces the discrepancies. Duverger believes that the rapid development increases the tensions and creates aggressive alterations disorders in the social basis(Thomas 2004).Therefore, the assessment of rate of velocity in scientific development is a vital issue. The rate of velocity in scientific development should be in accordance with the growth rate of other aspects of development. This accordance doesn't necessarily mean equality in growth rates, because scientific development itself often acts as an activator of development in the other areas, thus increase in its growth rate is inevitable. Therefore, the development theory should consider some specific markers for management of rate in the scientific development, in order to control its probable counter development essence.

Another counter development aspect of science can be explored in the developmental processes of the second half of 20th century. In regard to the current resolutions of development in the past 50 years, Caroline Thomas states: "this resolution considers development as a movement from traditional

economy to the modern industrial economy which takes place by creating social and economic changes in the south, similar to the changes that took place in scientific and industrial revolution in 17 and 18th century in the north. This resolution is based on a hypothesis that "if knowledge and technology is achieved, then nature would be in the hands of human beings" (Roberts 1984). Such an attitude toward scientific development, which Thomas truly refers to, has been the most important reason for the failure of national development based on science in majority of the third world countries, because in this attitude, the effects of scientific development in cultural, ideological and social aspects are ignored and economic development which itself is a product of scientific development becomes the activator of development. In other words, development is discussed with an intrinsic outlook and ignoring the extrinsic effects of science in society. The main problem of this attitude is the erroneous allocation of scientific development in the great process of development instead of science, which is a methodological mistake. Giroshe evaluated the effects of science and technology on social changes and concluded that the real effect of science and technology can't be observed unless their cultural effects have been taken into consideration.

If scientific development insists on a unidirectional domination of human over nature and ignores the balance and order between human and nature, then it would surely disrupt the development process. If scientific development is defined in the frame of economy which a sub system, acting against the other sub systems, it wouldn't able to achieve the desired similarity and would hinder the process of development. The counter development role of science would become a target for the critical approaches of development, if it is mistakenly allocated in the process of change in the social system. This issue reemphasizes the fact that all developmental theories should properly define their status in regard to the scientific development variable, so that they have the ability to control the twofold role of scientific development. Roberts states that development can merely be imagined and designed in an ideological frame (Roberts 1984) If development is unable to reproduce science based on the ideals and ideological values of a nation, then it couldn't have a positive role in the development process. In order to respond to this challenge, scientific development should be considered as a basic indicator in all the developmental theories.

6. Conclusion

This article tried to criticize the current approaches and the common indexes which are used nowadays to demonstrate the amount of scientific production and its relationship with the improvement and national development. It tried to prove that the mere use of statistical and quantitative information provided by the scientific assessment procedures would be insufficient and misleading to demonstrate the scientific development of a country because this information often consider the inner changes of science. In other words, a direct relationship couldn't be established between the growth of scientific products (which are counted based on science assessment indexes) and national development. Growth of scientific development can actively affect the national development if it has the necessary interpretive outcomes in social sub-systems which have the ability to lead social institution one step further toward improvement and development.

In this respect, the mere growth of scientific products couldn't express the rise in participation of science in the development. Proper understanding of this issue needs a thorough analysis of the collection of the intermediate indexes which can explain the areas of scientific effect on national development:

The science indicator and social changes in development: evaluation of this indicator shows the areas of social changes which have been affected by science, moreover it demonstrates whether the growth of science production has been able to cause objective and functional changes which are based on scientific thinking and proper recognition of environment respectively.

The scientific capability building indicator and development: studies the participation of scientific production growth in the national capability building process and also studies the levels of scientific growth.

The scientific rationality indicator and development: can help us to understand that to what extent science has been able to integrate analysis and reasoning into social manners, thoughts and actions of a

nation. A Scientific production which is unable to change instrumental and philosophical rationality doesn't seem to have great effects on national development. From the aspect of philosophical thinking, by studying the beliefs, norms, identities and values of a society it can be understood how these measures have been changed by scientific production and growth. Whilst from the aspect of instrumental rationality these measures mainly include accountability, functionality of the instrument and the ability to predict.

The scientific culture indicator: the main issue of the scientific culture indicator is to analyze of the scientific methods and instruments in solving the problems of a society. The two measures of scientific demand and consumption and scientific production are the main markers to assess this indicator.

Power and development indicator: the key question in regard to this indicator is whether the scientific productions are exploited to empower the leaders or whether they are instruments in hands of national development designers to achieve their developmental targets. The main issue of scientific development is the existence of functional aspects in science that are able to create changes; therefore we face the question of what the goals of these changes caused by science are? Furthermore this indicator analyzes the areas where national power is affected by scientific products.

Science indicator as essential information: the measures of this indicator will show whether the growth of scientific products has been able to provide the social figures with the necessary information, awareness and knowledge to start and continue the social development process.

Scientific development and source-oriented development patterns: provides measures to scientifically assess the management, designation and distribution patterns of resources.

Scientific development and conflicts with social sub-systems: the traditional theories of science didn't consider any conflicts or negativity between scientific development and the other social sub-systems; in contrast, the modern theories consider serious conflicts between procedures of scientific production and development. Measures of this indicator explain these conflicts; in addition they are able to assess the amount of scientific participation in development based on its positive and negative outcomes.

The rate of scientific growth and capacities for creating crisis: the capacity of social systems in absorbing and appropriately providing scientific production is the key indicator for understanding the participation of science in development. Excessive injection of science in a society, more than its absorptive capacity creates critical situations, therefore the levels science absorption should be calculated in a society and logical balance with the rate of scientific growth should be considered.

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