

Offering the Reference Model of Backcasting Approach for Achieving Sustainable Development

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Abstract

Backcasting approach is implemented through imagination and analysis of sustainable futures, and subsequently developing strategies for participation in competitive markets. It is a novel approach which is employed by only a few countries. Diversity of trends and lack of a reference model on the one hand, and its application for solving complex problems on the other hand, were the motivation to conduct the present study. In this study, 11 frameworks and some experiences of its application have been reviewed and the reference model was proposed through a meta-synthesis method. The results led to a two-dimensional model and indicated that backcasting approach can be followed in 6 stages and 4 scientific dimensions for achieving a sustainable development.

Keywords: Backcasting, scenario planning, meta-synthesis, sustainable development

1. Introduction

During recent decades, the lives of human beings have faced many transformations which enabled them to live a more comfortable and better life. Research and production of science and technology are considered as the main elements of a country's economic, social, cultural, industrial, and political growth and development. Success in these areas is achieved when a due attention is paid to research and production of science and technology in macro-level planning of the country. So far, no country has managed to reach economic and industrial development without proper scientific growth. Thus, it is necessary to prioritize research and production of science and technology as a vital element and driving force of sustainable advancement and development as well as true welfare and independence of a society. Science and technology play a fundamental role in development. One cannot predict bright future for any country without a balanced development of science and technology and participation in competitive market. Sustainable development of a country depends upon the development of science and technology without which no country can hope to play a significant role in the future of the world. One of the important signs of development in developed countries is lack of back-warded or less-developed area, so that all parts of the country appear developed (Khatoonabadi, 1385).

Development requires an expansive planning and a providential road map for realization of a desirable future. One of the main approaches of futures studies is backcasting. Having a very strong normative nature, this approach visualizes a desirable future (the one we want to reach), so it is related to the issues of sustainability. Backcasting is implemented through imagination and analysis of sustainable futures, and subsequently developing plans, strategies, and paths for achieving them (Holmberg, 1998). According to Dreborg, when environmental conditions complicate the problems which are then affected by the common trends influence, it is necessary to make major changes in the environment. In this situation, if time and place allow for radical changes, backcasting can be used for creating a synthetic solution (Wilson, 2006).

In this paper, first, the research problem and methodology are presented. Then, the literature, consisting of the history and use of backcasting approach in technology and the role of backcasting in achieving sustainable development is reviewed. Subsequently, the frameworks proposed by researchers in the area of backcasting are provided, and finally, a reference model for implementing backcasting through meta-synthesis is proposed.

2. Research problem and methodology

Backcasting is one of the futures studies methods in which the uncertainty condition plays a significant role and the desirable future is in a long term outlook. Then, plans are made for achieving desirable future using appropriate, and

sometimes synthetic, methods. Since, today's dominant trends might change in the long run, using common methods, such as forecasting, would not be effective in this situation. Therefore, Backcasting is considered as a method which takes uncertainties and changes into account. It is used for solving complex social problems. In other words, a futures studies project is called Backcasting from future to present when it deals only with specific social problem. There is no single method for implementation of back casting, and it is possible to use a combination of methods like scenario writing, path analysis, forecasting, mutual effects, experts' panel, etc. Backcasting from future is an approach which increases creativity by directing the focus on the far future and keeping distance with the present situation. Hence, Backcasting is not necessarily a specific method and is not performed through one single method (Mollb and Padovan, 2008). Of course, the validity and justifiability of a Backcasting study depends on its justifiability and use of scientific methods. To select such methods, one should refer to common methods in relevant scientific disciplines. Methodology and its stages are very important in successful implementing a method.

To the authors' knowledge, so far, no in-depth study based on backcasting has been conducted in Iran. In addition, the books and papers in this area have not addressed this issue clearly; thus, the present research intends to present a framework for the implementation of backcasting based on the existing studies and experiences of other countries, so that while removing the drawbacks and enhancing the strengths of the existing models, it can be used in different areas as a reference model.

In this research, meta-synthesis method is used for comparing, interpreting, translating, and synthesizing various frameworks. Compared with quantitative meta-analytic which relies on the quantitative data of the literature and statistical methods, meta synthesis method is based on qualitative approaches which do not necessarily involve much literature on the subject.

This method is used to produce interpretive translations, ground narratives or theories by integrating and comparing the findings or metaphors of different qualitative studies (Beck, 2002). This method is used to integrate multiple studies in order to create new comprehensive and interpretive findings and enlarges qualitative findings by evaluating the uniqueness of an individual study into a comprehensive whole (Clemmens, 2003). It has been used in social sciences.

For creating a good systematical approach for experts to synthesizing qualitative studies and realizing underlying themes and metaphors, Meta-synthesis is recommended. It is a worthy tool to facilitate theory-building procedure through systematic synthesis in the management science and policy making. In this study, we are interested in the backcasting Models process and are attempting to synthesize a comprehensive model which describes the entire procedure. Since the concept of back casting and its effect on sustainable development is almost a new area and is constantly evolving, there are not many papers focusing on this topic. So, this method might be an appropriate method for achieving a comprehensive synthesis of backcasting based on translations between limited qualitative frameworks.

Besides, despite meta-analytic approach, meta-synthesis relies on the understandings of the researcher and translation of qualitative studies into each other. Translations do not only refer to individual interpretations; rather, they reveal the differences among studies and enable the researchers to understand how various

studies relate to each other (Beck, 2002; Saghafi, et.al., 2009). In this respect, the present study is consistent with the 7-step approach of Nobelt and Hear which involves the following stages: 1. Initiation; 2. Making decision on the topics relevant to study; 3. Reviewing the studies; 4. Determining the relationship of studies with each other; 5. Translating studies into each other; 6. Synthesizing translations; and 7. Describing the synthesis. The seven stages of Nobelt and Hear can be categorized in three main phases, namely, Identifying the research question and selecting the related studies, synthesizing translations and offering the synthesis and new metaphor.

In the first stage the question of research and the relevant studies to the topic are identified and selected.

In the synthesizing translations stage, first the studies are collected and their relationship to each other is determined. Also, the similarities and differences among them are identified and a new framework is developed which not only indicates the major concept of personal interpretations, but also specifies a comprehensive subject compared to any of the frameworks alone (see Table 2, 3 and 4).

In the final stage, offering the synthesis, the new metaphor which is the Backcasting framework is offered together with figures and complete explanation for better understanding (Noblit, & Hare, 2000) as you can see in Table 5. After developing the stages of Backcasting framework, the experts panel is used for revalidation of the results.

3. The history and introduction of backcasting approach in the area of technology

Forecasting and Backcasting are two distinct approaches, the distinguishing feature being uncertainty (Sundeeep, 2009). If there is uncertainty or unpredictability in a given society, Backcasting would be an appropriate approach to be used. For instance, if global warming and population growth rate interact with each other, and we would like to acquire some knowledge on the traffic increase rate, then we encounter some uncertainties which necessitate the use of backcasting.

In the econometrics-based forecasting methods, uncertainty is measured through sensitivity-analysis and determining the results of the model in relation to changes among external variables (Haiyan, 2003). For a long term outlook, sensitivity analysis would not be responsive, as in such situations, the functional relations assumed in the forecasting model would change in the long run presenting challenges to generalizations concerning the long term future.

The decisions and objectives of human beings in a given situation depend on existing knowledge, but future knowledge can disturb the balance of existing solutions and choices and even lead to the creation of new choices (Granovetter, 2005). For example, could anybody have a proper understanding of the use of the internet for simultaneously sending information from one part of the world to another, before the invention of this technology? Hence, the human-made causal model is not sufficient for predicting a totally novel idea. Popper (2008) believes that if there is something as developing knowledge, one cannot predict future well, so a scientific forecast, whether human or programmed computer, would not be able to predict its future results through scientific methods. This uncertainty cannot be resolved by research studies, because it is part of the life's ambiguities. Therefore,

the long term progress of the society is not predictable either.

Considering the above-mentioned points, the question is “what added values are offered by futures studies?” The point is that if the main goal of futures studies is to develop a comprehensive conceptual framework for discussing the future, such studies would be very fruitful and less vulnerable facing the unpredictable changes as they provide the possibility of creating new choices for reaching a desirable future.

Backcasting studies were first conducted in 1970 on the energy sector of Sweden and then in 1976 were used by Amory Lovins as “analysis looking into the past”. He, as a member of the counselors committee of “The American Council of Renewable Energies”, in the analysis of supply and demand models of electronic industry, referred to it as an alternative from the traditional methods of planning (Wangel, 2011).

Following him, John Robinson (2003), a professor from British Columbia University in Canada, published a paper entitled “Backcasting from future to present: a recommended method for analysis of politics in journal of “Energy Politics” and further extended the idea of Amory Lovins. Both of them wanted to show that the future demand for energy is a function of today’s political decisions, and it is better to prevent undesirable events by envisioning desirable futures and trying to realize them (Robinson in Wilson, 2006). Particularly, facing the environmental challenges, this approach can be applied to find ways to prevent the failure of trends and testing the possibility of new paths along which the sustainable development is obtainable (Robert, 2005).

Backcasting is appropriate for situations where the long term goal (sustainable development) is not attainable through common trends. Inclusion of an objective in this approach has transformed it into a clear normative approach (Kok & et. al., 2011). Prior to the emergence of Backcasting in 1970, discovering normative futures through forecasting was described as normative forecasting (Quist & et. al., 2011).

According to Wangel (2011), basic forecasting must be made to determine the goals of technology development (e.g. in spatial programs of Apollo). When complex social issues are concentrated upon, use of Backcasting approach would be very fruitful. In other words, a futures studies project is called Backcasting from future to present only if it addresses a specific social problem and suggests solutions for it. Here, some instances of social conditions in which Backcasting can be used are listed:

- The outlook of the long term future is so long that there is not enough time for creating new effective trends.
- The main trends affect each other or are changing, because they are the basis of forecasting.
- The main issue has been created by external factors and the market factors cannot solve it.
- Facing a complex and multifaceted problem which affects different sections and levels of the society.
- Continuous change and improvement are not enough and a need for a major breakthrough is felt (Wangel, 2011).

Undoubtedly, the major instances of problems consistent with the above-mentioned features are “sustainable development” and “social justice” (Kok & et. al.,).

4. The concepts of sustainable development

In 1987, the Brundtland commission launched “sustainable development” (SD) as a broader and ethically-directed development concept (Soderbaum, 2007). Since then, many attempts have been made for developing the indices of sustainability (The World Bank, 2003).

The Brundtland report, ‘Our Common Future’ (Soderbaum, 2007), and the many documents from the Rio Conference in 1992 reflect the opinions of politicians and the other stakeholders and focus on three sets of dimensions emerged: the economic, social and environmental dimensions specially in developing countries (Stephen and Grant, 1998).

The well-known Brundtland commission considers sustainable development as a progress toward realization of the future generations’ needs. Environmental economists consider sustainability as the ability of country to provide lifelong welfare for society (Kulig & et. al., 2010). Sustainable development deals with the promotion of human welfare throughout time. The opportunity and ability to improve life are enhanced through access to sanitation, education, requirements of comfort, family and social relations, and participation in society. Also, physical security and political and civil freedoms constitute other aspects of welfare (The World Bank, 2003). Proponents of sustainable development have not still reached agreement on a single definition of sustainable development. However, it is clear that sustainable development must replace or modify other ideas, for example: Do we need specific Sustainability Assessment framework and if so; what are the options? The options are sustainability in economic, politic, energy, or other elements? (Söderbaum, 2011). Three groups of issues were emphasized in the discussion of 1990s as the basis of development. The first group is economic reformation for stability of macro economy. The second group involves the need for powerful institutions and governments for enhancing the implementation of law and controlling corruption in all its manifestations. And, the third group is the need for social justice and involving people in decisions affecting them and their local and national society through civil institutions.

Regarding the impact of public participation on the security, economy, and social development, realization of it is one of the requirements of sustainable development. In other words, development is sustainable when it paves the way for people’s political will to be exerted through public participation. Achieving sustainable development requires interdisciplinary studies and subsequently, development of various economic, environmental, scientific, technological, and political dimensions. The highest level of success for developing the sustainability measurement indices has been in economic and environmental areas. Social indices such as transparency, trust, and dispute are still at the initial stages of development. The fact that social indices are less developed reflects the lengthy discussions on the concept of social sustainability (The World Bank, 2003). Also, the relations among these indices and sustainable development and governance have not been well considered in scientific studies (Jaeger, 2005). Information and communication technologies (ICT) provide the best ground for accessing information for social participation and political life. Such technologies facilitate rapid sharing of information, group interaction, communication, and cooperation. They engage people in political discussions and familiarize them with political opinions and

events which affect their societies. Application of ICT for communication and cooperation is regarded as an opportunity for offering civil rights to people. Electronic government creates a space in which people have more civil participation. Thus, e-government indicates the control of government over governmental processes (Gunter, 2006).

it can be concluded that factors such as economic stability, public participation economical, social, and environmental justice are the key elements for creating sustainable development.

5. The role of backcasting in achieving sustainable development

The focus of Backcasting on sustainable development was manifested in 1987 as “our common future” and in early 1990, was directed toward discovering a sustainable future, participation of stakeholders, shaping their support, following, and implementation (Quist & Vergragt, 2000). Participatory Backcasting was developed in early 1990s in Netherland. This type of Backcasting is used for achieving the sustainable needs in the future through Backcasting involving the participation of stakeholders, future outlook and using creativity for reaching the patterns and mentalities beyond the present time (Quist & Vergragt, 2006 a).

Achieving the sustainable development requires fundamental changes in the existing production and consumption systems, especially in the developed countries. Such changes in systems level refer to industrial changes while concepts like sustainable system innovation or the shift toward sustainability are also used. Such system changes require a combination of technological, cultural, social, institutional, and organizational changes. In any case, sustainable system innovation (or sustainable industrial transformation) is a very complex phenomenon due to the inherent uncertainty of future, inherent ambiguity of stakeholders, and their different value and mental frames (Quist and Vergragt, 2006 b).

In Sweden, Backcasting is recognized as a method for strategic planning to reach sustainability of companies (Holmberg, 1998). To summarize, since the end of 1980, Backcasting has been expanded to cover issues related to sustainability and different levels such as regions, companies, and social technical systems (Robinson & et. al., 2011).

Many questions have been raised about the use of an appropriate system for such complex issues, the way of making desirable and attractive changes (e.g. innovation system, industrial and technological policy, or paradigmatic shift), the way of discovering, initiating, and implementing, and the role of different stakeholders. According to Quist & et. al. (2002), providing information about systemic innovation requires integrating new approaches which at least include the combination of the following factors:

1. A large number of stakeholders and actors of various social groups, such as the government, companies, public interest groups, and knowledge-based organizations which are shared not only at the time of defining the problem, but also when looking for solutions and developing the outlook document.
2. Integration is created not only in the environmental components, but in the economic and social components, as well.
3. The supply and demand chain is considered as a production and consumption system (Quist & et. al., 2002).

shift management is a method for grasping the emerging changes at systems level. Also, Backcasting is used as an approach in line with the above requirements and in response to the questions raised (Quist and Vergragt, 2006 b).

In the Netherland, participatory Backcasting was identified, tested, and suggested for discovering sustainable innovations at system level. Backcasting can be considered as the initial approach for describing a roadmap for establishing a favorite future. The normative Backcasting scenarios explain how a favorite future can be reached. Before defining, planning, and following activities, the strategies developed for a preferred future are identified. People employing Backcasting should be aware that this approach can be used as a strong potential in planning due to its normative nature and characteristics (Partidario, 2002). Robinson discussed that Backcasting is not only used for achieving desirable future, but also for avoiding undesirable future, as well. Also, Backcasting is used for sustainable transport systems, establishing sustainable companies, and investigating future in Sweden (Robinson, 1990). Dreborg points out that traditional Backcasting is based upon the major trends, so it is unlikely to develop solutions based on the failure of trends. Modern Backcasting approaches, due to their normative nature and problem-solving properties, are more appropriate for long term problems and sustainable solutions. In addition, in Backcasting studies, the goals and interests of policy-makers in creating images of the future as a background for formation of ideas must be taken into considerations in decision-makings. Dreborg, at a meta-conceptual level, shifts attention from the step-by-step method of Robinson to Backcasting based on the assessment of constructive technology. He distinguishes between the analytic and oriented constructive aspects of backcasting (Dreborg, 1996).

Matson suggests that Backcasting and forecasting trends are complementary, so Backcasting is used, particularly when the common trends move toward an undesirable state. In such situations where the desirable outlook is compared with the forecasting, a step is added to backcasting. If, according to forecasting, the outlook seems unlikely, the estimations suggest another Backcasting model which envisions the future or scenarios of the realization of images (Höjer and Mattsson). That is to say, Backcasting fills the gap between the forecasting of probable trends and realization of the desirable outlook of the future through imagination and scenario-writing.

One of the outstanding features of sustainability is its multi-faceted systematic nature which involves environment, welfare, human development, justice, and the economy –all of which are mostly regarded as the long term social goal. In some instances, for the sake of transparency or revision, it is considered as a quantitative goal, and sometimes the emphasis is only on the importance of continuous and stable economic growth (Quist, 2007). The fundamental changes in today's production and consumption systems are necessary for sustainable development, especially in the developed world. At

systems level, such changes refer to the industrial changes, using concepts like sustainable system innovation or the shift toward sustainability (Quist, 2009).

The contemporary societies are faced with the challenges of realization of sustainable development and must confront sustainable and complex problems. Sustainable development extensively leads to the reduction of environmental loads, reduction of the use of resources, fair distribution of wealth, and makes a balance among environment, economy, and society.

On the other hand, addressing complex issues related to sustainability requires participatory approaches. Such methods must take long term systemic orientation and a comprehensive concept of sustainability into account. Hence, the stakeholders must have necessary knowledge in this area. Participatory Backcasting is an approach with the potential of discovering and systemic assessment of sustainability-directed innovations (Weaver & Jansen, 2000).

In this regard, it is clear that Backcasting needs a systemic view for achieving sustainable development, therefore a combination of technological, cultural, environmental, social, and economic factors must be taken into consideration. These factors can be classified into four categories at the following table. Quist and Vergragt argued that considering the oriented and analytic aspects of backcasting, backcasting studies can provide an input for sustainable development of political processes in the sectors where political actors are involved. Therefore, the audiences of Backcasting studies are political sectors like political parties, government officials, municipalities, organizations, companies, and the public who need appropriate information (Quist and Vergragt, 2006 b).

Table 1. *Different Areas of Sustainable Development*

The sources extracted	Areas
(Quist and Vergragt , 2000) (Quist and Vergragt , 2006a)	participation of stakeholders (Human development)
(Robert,2005) (Mattias & Lars-Göran, 2000) (Weaver & Jansen, 2000)	Environmental development
(Quist and Vergragt , 2006b) (Quist, 2002)	Economic development (fair distribution of wealth and reduction in the use of scarce resources)
Quist and Vergragt , 2006b) (Quist, 2002)	Social development (welfare, implementation of laws, and reduction of corruption)

6. General frameworks of backcasting

Different frameworks of Backcasting have been proposed by various scholars. These frameworks express the processes of implementation of Backcasting in

general. They can be used for conducting Backcasting studies in various areas with different subject domains.

There is no common reference framework in numerous methods of backcasting. Therefore, these models need to be analyzed. In this study, 11 backcasting approaches have been investigated. These models include Kok (Kok & et. al. 2011), Zimmermann (2012), Svenfelt (Svenfelt et.al., 2011), Höjer (Höjer & et. al., 2011), Gomi (Gomi & et. al., 2011), Quist (Quist & Vergragt , 2006a), Clement (Wang & Guild, 1995), Geurs (Geurs and Wee, 2004), Aumnad Phdungsilp (2011), and Segalàs (2011) and Ochi indicate different applications of Backcasting from different perspectives (Carlsson-Kanyama, 2013). Due to limitations of space, these models are not described here; only the approach proposed by Cook on the application of Backcasting in the project of fresh water of Europe is investigated.

This method involves the combination of participatory Backcasting and exploratory scenarios in the project of fresh waters of Europe. It includes the following stages:

The process of developing scenarios consists of seven stages: The first stage: discussing the borders of scenarios; the second stage: discussing the present situation and the main influential factors (politics of water, evaluation of water, population, global integration, public participation, technology); the third stage: discussing the uncertainties of these factors; the fourth stage: the relation among key uncertainties and present scenarios; the fifth stage: developing the story considering the present uncertainties and scenarios; the sixth stage: revising results; and the seventh stage: finalizing activities.

The process of Backcasting involves five stages: the first stage: selecting the outlook as the final point (provision of sustainable water considering the life quality and economic interests); the second stage: discussing the barriers and opportunities for reaching the end point (direct relationship between scenarios and back casting); the third stage: defining the milestones and short term objectives for reaching the end point; the fourth stage: identifying actions for reaching the milestones through using opportunities and overcoming the barriers; and the fifth stage: determining the strategies (Sundeep, 2009).

7. Analysis of different back casting approaches through meta-synthesis

In this section, the results of the second stage of meta-synthesis, i.e. “identifying the relations between the investigations and summarizing the results” are provided. Here, the strengths and weaknesses of the above-mentioned methods are presented to prove their lack of holistic approach. Then, the dimensions and components of the identified models are indicated in a matrix, so that they can be used for developing the final approach. The strengths and weaknesses of the approaches are shown in Table (2). The results reveal that none of the approaches are sufficiently comprehensive.

Table 2. *The Strengths and Weaknesses of every Framework*

	Author	Strengths and weaknesses
1	Kok	Despite taking requirements of Backcasting into account, this approach cannot be a complete model as it does not take the mutual relations among the factor into consideration.
2	Zimmermann	Although this model uses the participation of stakeholders for drawing the future, it does not consider the propelling forces, uncertainties, and their mutual relations.
3	Svenfelt	In this model, although stakeholder groups are used for developing strategies, the main factors, uncertainties, and their mutual relations are not determined.
4	Höjer	It is an appropriate model, but does not consider uncertainties, propelling forces, and their mutual relations clearly.
5	Gomi	This model does not pay attention to the main stages of back casting.
6	Quist	This model is so simple that it does take into account the main stages of back casting.
7	Clement	This model is relatively appropriate but does not state the stages of Backcasting clearly.
8	Geurs	It is complete model which takes into account the processes and stages together with in-depth explanations.
9	Segalas	In this model, the goals, key factors, and strategies have not been specified clearly.
10	Aumnad	A superficial model which does not pay attention to the main stages of back casting.
11	Ochi	A rather weak model which does not consider the basic stages but pays attention to the participation of stakeholders.

In the second stage of meta-synthesis, the different stages of 11 models selected were presented in a matrix. Also, the different stages of the models were coded for use in later stages. For example, R22 refers to the second stage of the second approach, i.e. Zimmerman's model.

Table 3. *Different stages of Backcasting models*

Author	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8
Kok R1	selecting the outlook as the final point R11	discussing the barriers and opportunities for reaching the end point R12	defining the milestones and short term objectives for reaching the end point R13	Taking actions for reaching the milestones through using opportunities and overcoming the barriers R14	determining strategies for implementation of Backcasting R15			
Zimmermann R2	Orientation of strategic issues R21	Developing the future images and factors affecting it R22	Backcasting analysis R23	Implementation and following-up for various stakeholder groups to help the realization of desirable future R24				
Svenfelt R3	Defining the problem, such as placing the rules and goals R31	Analysis of the present trends R32	Drawing one or more images of future for reaching the goals R33	Discussing about the realization of the images presented by stakeholder groups through developing strategies R34				
Höjer R4	Defining problem R41	Analyzing problem R42	Drawing images of the goals R43	Analyzing future images R44				
Gomi R5	Formation of the framework R51	Developing socio-economic scenarios R52	Gathering information about the direct choices R53	Proposing a snapshot for analysis R54	Identifying complex choices R55	Formulating choice trees R56	Putting quantitative data on the choices R57	Developing map of BCM implementation
Quist R6	Orientation of the strategic problem R61	Developing the outlook of sustainable future R62	Analyzing Backcasting R63	Complexity, design, analysis, and defining the agenda of follow-up R64				
Clement R7	Collecting data R71	Environmental scanning and organizational merit R72	Determining goals (probable future) R73	Taking necessary actions R74	Decision-making R75	Formulating strategy R76		
Geurs R8	Determining goals R81	Determining operational goals, limitations, and desirable levels R82	Describing the present system R83	Describing external variables R84	Analyzing scenario R85	Analyzing results R86		
Segalás R9	Orientation of the problem R91	Analyzing stakeholders R92	Developing scenario R93	Evaluating scenario R94	Backcasting workshops and consultation with stakeholders R95	Realization and implementation R96		
Aumad R10	Determining appropriate rules and assumptions R101	Analyzing the present situation in relation to the framework R102	Developing future scenarios and outlook R103	Developing strategies to move from present to future R104				
Ochi R11	Long term outlook is developed based on the strategic perspective and using the retrospective analyses, alternative solutions are provided to achieve the sustainable future R11	To specify the short term actions for understanding the future as the common action, R&D and politics agenda are used R112	Implementation and realization of the plan R113					

models were investigated, and the similar components were identified and presented in a matrix. In this section, the relations among different steps of the models were investigated two-by-two the results of which are presented in Table 4. If a step of a model has no equivalent in the second model, it is shown as “NULL” in the table.

Table 4. Synthesis of the equivalent components of the models to develop the different stages of the proposed model

Author	Ochi	Aumad	Segalas	Geurs	Clement	Quist	Gomi	Höjer	Svenfelt	Zimmermann
Kok	R11=R111 R14=R112 R15=R113 R12=R13=NULL	R11=R101 R15=R104 R14=R104 R12=R102	R11=R91 R03=R14 R06R15 R13=R12=NULL	R11=R81=R82 R14=R86 R15=R85 R13=R12=NULL	R11=R73 R14=R74 R12=R13=R15=NULL	R11=R62 R14=R63 R15=R64 R12=R13=NULL	R11=R51 R14=R52 R12=R13=R15=NULL	R11=R41 R12=R42 R44=R15 R14=R43 R13=NULL	R11=R31, R14=R33 R15=R34 R13=R12=NULL	R11=R21 R12=R13=NULL R14=R22 R15=R24
Zimmermann	R01=R21 R02=R22 R03=R23 R04=R25 R05=NULL	R101=R21 R102=R22 R103=NULL R104=R25	R01=R21 R02=R22 R03=R23 R04=R25 R05=NULL	R81=R21 R82=R22 R83=R23 R84=R24 R85=NULL	R71=R22 R72=R21 R73=R23	R61=R21 R62=R22 R63=R24 R64=NULL	R51=R21 R52=R23 R53=R24 R54=R22 R55=NULL R56=NULL	R41=R21 R42=NULL R43=R22 R44=R22 R45=R24 R25=NULL	R31=R21 R32=R23 R33=R22 R34=R22 R25=NULL R35, R25, R23=NULL	
Svenfelt	R01=R31, R33 R04=R36 R05=NULL	R101=R31 R102=R36 R103=R36 R104=R36	R01=R31, R33 R02, R03=R32, R33 R04=R36 R05=NULL	R81=R31 R82=R31 R83=R32, R33 R84=R36 R85=NULL	R71=R32 R72=R31 R73=R34, R32	R61=R31 R62=R34 R63=R36 R64=NULL	R51=R31 R52=R32 R53, R54=NULL R55, R56=NULL	R41=R31 R42=NULL R43=R32 R44=R33 R45=R36		
Höjer	R01=R41 R02=R44 R03=R44 R04=R42 R05=NULL	R101=R41 R102=R42 R103, R104=R43, R44, R45 R105=NULL	R01=R41 R02=R43 R03=R44 R04=R42 R05=NULL	R81=R41 R82=R43 R83=R44 R84=R45 R85=NULL	R71=R43 R72=R41 R73=R44	R61=R41 R62=R42 R63=R45 R64=NULL	R51=R41 R52=R44 R53=R45 R54=R56=NULL			
Gomi	R01=R51 R02=NULL R03=R52 R04=NULL R05=NULL	R101=R51 R102=NULL R103, R104=R53, R54	R01=R51 R02=NULL R03=R52 R04=NULL R05=NULL	R81=R51 R82=NULL R83=R52 R84=R53, R54 R85=NULL	R71=NULL R72=R51 R73=NULL	R61=R51 R62=NULL R63=R53, R54 R64=NULL				
Quist	R01=R61 R02, R03, R04=R62, R63 R05=R64	R101=R61 R102=NULL R103, R104=R62, R63	R01=R61 R02, R03, R04=R62, R63 R05=R64	R81=R61 R82=R62 R83=NULL R84=R63 R85=R64	R71=R62 R72=R61 R73=R62, R63					
Clement	R01=R72 R02=NULL R03=R23 R04=R25 R05=NULL	R101=R72 R102=NULL R103=NULL R104=NULL R105=NULL	R01=R72 R02=R71 R03=R73 R04=NULL R05=NULL	R81=R72 R82=R71 R83=R73 R84=NULL R85=NULL						
Geurs	R01=R31 R02, R03=R32, R33 R04=R36 R05=NULL	R101=R81 R102=NULL R103=R32, R33 R104=NULL	R01=R81 R02=R82 R03=R82 R04=R84 R05=NULL	R81=R81 R82=R81 R83=R81 R84=R81 R85=NULL						
Segalas	R01=R41 R02=R43 R03=R44 R04=R42 R05=NULL R06=R52 R04=NULL R05=NULL	R101=R91 R102=NULL R103=NULL R104=R94	R01=R41 R02=NULL R03=NULL R04=R84 R05=NULL	R81=R41 R82=R43 R83=R44 R84=R42 R85=NULL						
Aumad										

8. Developing the backcasting reference model for sustainable development

This section is presented for implementation of the third stage of meta-synthesis, i.e. “synthesizing the data and proposing a new model”. In this stage, the new metaphor –Backcasting for achieving sustainable development – is presented with complete explanation for better understanding. Regarding the definition of backcasting, i.e. retrospective work from a specific desirable future to past to a point in the present for determining the requirements and necessary strategies for achieving the desirable future, it can be used as a mechanism for achieving sustainable development.

In this stage, the equivalent components of every aspect of different models are identified and placed in one group according to Table 5. Then, a name is given to equivalent components as presented in the second column of Table 5. In the third column, the descriptions (new metaphors) of the stages are presented using the models. Through the synthesis of equivalent components of the models investigated, the Backcasting model proposed for achieving sustainable development is presented with the following stages. This model involves 6 stages as following: orientation of strategic issues, formation of the future outlook, describing present situation and determining influential factors, drawing one or more images of future, analyzing back casting, and expanding, analyzing, and taking necessary actions. One of the innovations of this model is taking into account the mutual effects of propelling factors and uncertainties for determining key uncertainties which leads to drawing better images for achieving sustainable development. Different stages of Backcasting model for achieving sustainable development include:

Stage 1: Orientation of strategic issues

This stage involves establishing a set of goals, requirements, and defining normative presumptions required for attaining the goals. In this stage, the objective of the analysis as well as the time, space, and basic limitations of the analysis must be specified. Also, operational targets, limitations, and desirable levels can be determined for the scenario analysis.

Stage 2: Formation of the future outlook

For this purpose, different images of future in the minds of the stakeholders must be taken into consideration. To use the outlook document throughout development of future images, the potential stakeholders must be identified and experts must be invited to identify the factors affecting desirable future. The survey can be conducted through Delphi method.

Stage 3: Describing the present system and determining influential factors

In this stage, the external variables affecting the present system, including trends, driving forces, and uncertainties dominating the goal are identified. In addition, both causal relations and relations between occasional-instrumental and final-fundamental are important for obtaining better results. Recognizing causal relations validate the results and identifying occasional – fundamental relations play a major part in motivating factors and actors to act. Also, the mutual effects of different factors are studied to determine the critical uncertainties for determining better

images of the future.

Stage 4: Drawing one or more images of the future

The main goal of drawing images of the future is preparing well-planned instances of the sustainable future in order to expand the understanding of the factors and actors from the possible solutions. Another goal of this stage is to highlight the outcomes of strategic choices in society (what futures must be closed, and which ones must be kept open). These images are often presented in a way to describe the multi-dimensional situations of the future. Indeed, these images depict the desirable conditions and paths to future.

Stage 5: Analysis of Backcasting

This stage can be used as retrospection from desirable future to present time for developing appropriate strategies for future. Workshops and focused-group discussions and interviews are employed in this process. Also, group interviews with stakeholders and semi-structured interviews can be utilized.

Stage 6: Expansion, analysis, follow-up and necessary actions

In this stage, the agenda of follow-up for different stakeholder groups are defined to help realization of desirable future. They emphasize the importance of implementation and follow-up. In fact, Backcasting refers to an operational plan for present time which is designed to move toward a sustainable development. The follow-up activities can be performed in different ways.

Table 5. *Synthesis of equivalent components in the investigated model to propose new metaphors for the proposed model according to 11 models*

		description the stages using the models		Aspects/stages of the proposed model(new metaphors)	
Ochi	R111	R101		1	Orientation of strategic issues
Geurs	R81	R81		1	Orientation of strategic issues
Clement	R71	R71			
Quist	R61	R61		2	Formation of the future outlook
Gomi	R51	R51			
Höjer	R41	R41		3	Describing the present system and determining influential factors
svenfelt	R31	R31			
Zimmermann	R21	R21		4	Drawing one or more images of the future
Kok					
				5	Backcasting analysis
				6	Expansion, analysis, follow-up and necessary actions

So far, the steps of back casting model have been defined. In the next stage, each of these steps is discussed in detail. Since sustainable development in every country depends upon the balanced development of science and technology and competitive market, environmental, and social development, each of these steps are explained within the following framework. It must be mentioned that if the goal of implementing the back casting is to achieve general scenarios, implementation of the first row of this matrix in collaboration with the stakeholders would suffice. If developing the environmental, economic, and social aspects is desired, a synthesis of these rows can be used according to the macro goals determined. It is clear that implementing all rows is necessary to gain a comprehensive view of backcasting.

Table 6. *The reference model of Backcasting for achieving sustainable development*

Expansion, analysis, follow-up and necessary action	Analysis of Backcasting	Drawing one or more images of the future	Describing the present system and determining influential factors	Formation of the future outlook	Orientation of strategic issues	Stages Areas
Discussions among experts to reach an appropriate conclusion	Focused workshops and discussions and interviews	Use of focus groups for drawing images of future	Using experts	Activity of specialists for drawing outlook	Cooperation for determining goals	Participation of stakeholders (human development)
Trend analysis/ experts studies	Trend analysis/ interview with experts/ investigating international laws and requirements	Environmental trend analysis and forecasting future requirements	Investigating the degree of meeting environmental requirements and voluntary programs of the organization	Taking environmental issues into consideration in drawing the outlook of the organization	attention to environmental issues in selecting goals and social responsibility of the organization	Environmental development
Trend analysis and forecasting of indices	Trend analysis/ interview with experts/expert meetings	Trend analysis/ interview with experts/expert meetings	Investigating qualitative and quantitative indices	Attention to economic outlook in drawing the outlook	Attention to economic issues in determining goals	Economic development (fair distribution of wealth and reduction in the use of scarcer resources)
Trend analysis and forecasting of indices	Investigating qualitative and quantitative indices	Trend analysis/ interview with experts/expert meetings	Attention to social outlook in drawing the outlook	Attention to social outlook in drawing the outlook	Attention to social issues in determining goals	Social development (welfare and implementation of fair laws and reduction of corruption)

9. Summary and conclusion

Achieving sustainable development requires balanced development of different aspects of science and technology. Although there is still no single meaning for sustainable development, three groups of issues are considered as the central issues of development, as 1) economic reform to stabilize macro economy, 2) powerful government for implementation of law and control of corruption, and 3) social justice and people’s participation in governmental policy making such as determining the parliament member or monitoring their behavior. Development

requires an in-depth planning for realization of desirable future and having a provident road map. Backcasting is an approach through which sustainable futures are imagined and analyzed leading to development of plans, strategies, and ways to achieve them. In this paper, by synthesizing 11 frameworks of Backcasting and investigating the aspects of sustainable development, a reference model is proposed for Backcasting based in sustainable development. This model involves six stages of 1) orientation of strategic issues, 2) formation of the future outlook, 3) describing the present system and determining influential factors, 4) drawing one or more images of the future, 5) Analysis of back casting, and 6) Expansion, analysis, follow-up and necessary action. Also, to achieve sustainable development, four levels (aspects) of 1) Participation of stakeholders (human development), 2) Environmental development, 3) Economic development (fair distribution of wealth and reduction in the use of scarcer resources), and 4) Social development (welfare and implementation of fair laws and reduction of corruption) were taken into consideration.

The output of Backcasting studies can be an input for the sustainable development of political processes where political actors are involved. Thus, the results of such studies can be very useful for political sector, too. Also, for better implementation of Backcasting the following points should be taken into account.

In stakeholders' participation, it is necessary to consider the heterogeneity, the participation degree the participation, the type, and the stakeholders' influence. Also, orientation of the problem would be useful through creative workshops of stakeholders. In determining the future outlook, guiding experts in the direction and determining competitive outlook, developing scenarios, evaluating scenario, expanding long term outlook, and then determining goals and limitations would be effective. Training stakeholders would change their opinions about the problems, definitions and solutions. It might also lead to change of methods and primary priorities. Attention to methodological aspects, such as signing cooperation contracts among stakeholders and specifying implementation plans would lead to better implementation of this approach. In futures studies, the authors intend to use the reference model of Backcasting for developing scenarios of sustainable development with the help of e-government.

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