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TOWARDS FET CONCEPT: PATHWAY TO EVALUATION OF FORESIGHT EFFECTIVENESS, EFFICIENCY AND VALIDITY

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TOWARDS *FET* CONCEPT: PATHWAY TO EVALUATION OF FORESIGHT EFFECTIVENESS, EFFICIENCY AND VALIDITY[4]

The increasing diversity and interdisciplinary nature of science and technology in a globalised world are exerting mounting pressure on national research and innovation locations to develop clear profiles. Among many instruments to meet this challenge is the systematic analysis and continual monitoring of scientific, societal and technological trends – often done using Foresight. Foresight is expected to provide a reliable basis for the future structuring and profiling of the national research and innovation landscape. Foresight is a complex process which is also reflected in the discussion of the effectiveness, efficiency and validity of Foresight.

In the recent years various aspects of Foresight evaluation have seen researchers' attention across different national and corporate schools of Foresight. Ranging from Foresight exercises' impact assessment (measuring effectiveness and efficiency of Foresight – summative evaluation) to results verification (validation, windtunelling / wind tunnel testing of Foresight – normative evaluation), separate approaches to the problem at hand exist. However, academic and professional literature on the specific topic is rare, as a problem of openness of methodologies also exists. Aside from these factors, there seems to be a consensus that Foresight science is actively developing and there currently are many gaps in available evaluation methods, which brings us to looking further into the supposed gaps.

The paper discusses in depth the effectiveness and efficiency in the light of Foresight and the meaning of both for the validity of Foresight.

JEL Classification: O22; O32

Keywords: effectiveness, efficiency, validity, Foresight; Foresight Evaluation Triangle

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1 Introduction

Science, technology and innovation (STI) policy-making often lags behind knowledge and technology development and diffusion. Havas et al. [2010] argue that targeted Foresight can be used to leverage forward-looking policy-making by supporting a more fundamental rethinking of STI policy. Accordingly Foresight provides the opportunity to analyse and assess a broader environment in which STI is embedded, especially by including weak signals analysis. However, the challenge remains to specify and quantify the impact of Foresight.

The meaning of Foresight goes far beyond studies to explore trends in specifically defined scientific and technology fields. It is a complex process that involves the analysis of uncertainties. On the one hand a wide variety of subjects have to be considered; on the other, various stakeholders have to be involved in implementing Foresight. It follows that Foresight is a participatory process which brings together participants from science, industry, government, administration and other areas of society to identify and evaluate long-term developments in science, technology, industry and society in different scenarios Thus scenarios have become a common result of many Foresight studies in the last decade [Gomez-Limon et al., 2009].

Foresight has numerous characteristics. It is used to forge new partnerships, build networks, encourage direct interaction between people, develop consensus on national priorities, and to identify generic technologies and priorities for national infrastructure with respect to research topics and infrastructure for innovation (financial, fiscal and regulatory structures, education and skills, career development, buildings and equipment). Hence, Foresight requires the continuing commitment and active participation of stakeholders [Anderson, 1997]. The process dimension of Foresight highlights the way Foresight operates, especially the involvement of stakeholders and actors (mainly expert and knowledge holders), the targeted use of stakeholders and the continuous update and refinement of the process itself to take the stakeholders interest into consideration which are in many cases likely to change in course of Foresight [Amanatidou and Guy, 2008; Gokhberg, 2013]. Thus the quality and validity of Foresight is strongly dependent on the knowledge and information collected and processed during Foresight [van der Steen and van Twist, 2013].

In this regard it is reasonable to outline the meaning and understanding of the terms in discussion, e.g. technology, information and knowledge. Technology includes materialized technologies, explicit technological knowledge and implicit technological knowledge. Materialized technologies are products and processes, machinery and equipment and materials and components. Explicit technological knowledge includes both documented subject and more general know-how. The former includes handbooks, training programs and databases while the latter refers to patents and publications. Implicit technological knowledge is personal experiences and personal competences. The different types of information and knowledge have diverse features implying that a variety of methods are needed and used for detecting, collecting and processing the knowledge and information. Thus, the effectiveness and efficiency of Foresight are determined by the respective types of knowledge and information used in Foresight because the information and knowledge characteristics are important determinants for the choice of methods.

Moreover, the accessibility of knowledge and information continues to increase which impacts the complexity of information and knowledge collection and processing. In line with the increased accessibility and availability of knowledge and information sources the appearance of information is changing. In the digital world driven by internet applications and social media people increasingly exchange ideas and views; at first sight these ideas may seem to be independent from Foresight but they are in fact a rich asset if analyzed properly. In this regard new methods have evolved which are already used or will be applied in the near future in Foresight. Such methods are mainly based on semantic analysis of documents and texts. These basic thoughts need to be taken into account when analysing the effectiveness and efficiency of Foresight and hence the impact of Foresight.

To make Foresight effective in terms of impact it is broadly recognized that a precondition is the absorptive capacity of stakeholders and the initiators' [Havas et al., 2010]. Brown et. al. [2001] find that Foresight initiated by public bodies, e.g. governments or governmental institutions, is not likely to affect the innovation activities and management of organizations. They conclude that Foresight might support the initiation and implementation of innovation activities which were already on the radar of organizations but not yet started because of reasonable uncertainty about their potential. Hence, the combined knowledge of numerous experts in assessing the potential of innovations may support organizations in setting their priorities for innovation projects. However there is no final evidence for the eventual impact of Foresight in different shapes on company innovation activities. In order to find such evidence Foresight is frequently evaluated thus receiving considerable attention in the academic community in the last years.

The overarching rationales' for Foresight evaluation are seen in accountability, justification and learning of Foresight in different shapes (Georghiou, Keenan 2006). Accordingly evaluations are confronted with the challenge to assess the real impacts caused by Foresight which are firstly diverse and secondly these impacts occur with a time lag which eventually makes it difficult to attribute the impact to a certain Foresight (Georghiou 1998). Moreover Foresight needs to be reflected in the context it is done instead of being assumed an independent exercise, e.g. in the first instance in the context of the STI policy mix but secondly also in the broader context of policy measures surrounding STI policy (Georghiou, Keenan 2006). In this respect Foresight itself is a STI policy instrument which leads to decisions with lasting impact (Georghiou 1998). The evaluation of efficiency and effectiveness typically involves a highly complex multi-input/output structure (Emrouznejad et al 2008). Johnston's (2012) demonstrates the complexity of Foresight evaluation when showing his Foresight impact schema which covers four main Foresight impacts fields, e.g. awareness raising, informing, enabling and influencing. These fields however are not fully mutually exclusive but at least partially overlapping.

The assessment of Foresight often aims to merely measure the achievement of initial goals and objectives [Amanatidou and Guy, 2008]. It follows that effectiveness is the most commonly applied measurement objective. Besides the achievement of initial goals, impacts of Foresight projects are often considered in evaluations which frequently follow Foresight. However, the impacts of Foresight are anticipated and expected to a reasonable extent. Possible or indirect impacts may also evolve as spillovers from the actual Foresight. Such impacts can be seen for example in increased or modified cooperation of Foresight participants, in the adjustment of Foresight participants' innovation strategies. Amanatidou and Guy [2008] group the impacts in three areas, namely the creation, diffusion and absorption of knowledge, social capital and networking and the evolution of strategies to cope with or escape from the negative consequences of a 'risk society'.

Repeatedly in the academic literature effectiveness and efficiency are quoted as object of evaluation of Foresight but despite the frequent use of the concepts of effectiveness and efficiency a broad range of understandings of the terminology and the concepts exists. However so far the terminology “effectiveness” and “efficiency” remains slightly unclear because little or no definition of the underlying concepts have been developed. Hence, a closer investigation into the concepts is required to understand the eventual effectiveness and efficiency of Foresight. Consequently the paper aims to contribute to the understanding of Foresight evaluation by answering the obviously general research questions:

- What can be generally understood by effectiveness and efficiency?
- How can effectiveness and efficiency affect the validity of Foresight?
- What are the interrelationships between effectiveness, efficiency and validity of Foresight?

This paper aims at providing conceptual responses to these research questions. It’s not in the scope of this paper to test the conceptual thought empirically. The paper is structured in five sections. Section 2 discusses the assessment of effectiveness and efficiency of Foresight in the light of recent work on evaluation of Foresight. Section 3 analyzes the challenges and success factors of Foresight studies, section 4 the quality management and validity. Finally the findings are discussed in section 5.

2 Effectiveness and Efficiency of Foresight

Efficiency is a commonly accepted and widespread form of control of the reasonable use of resources invested for a given purpose. Efficiency is a measure which was used originally for the assessment of technical applications aimed to bring things under managerial and economic control. Its use is commonly related to efficiency measurement of technical applications and of management [Alexander, 2009]. In technical terms, such as in engineering, efficiency is an expression which measures the transformation and use of inputs, raw materials, and components into a system. A system then is supplied with input materials including power, gas or water. Eventually the output from a system is measured. Usually the energy incorporated in the parts and components of the system is calculated and compared with the energy in the output. Efficiency hence expresses the ratio of energy included in the output and the energy invested in the generation of output. Energy here is the synonym for inputs of possibly different forms. The underlying rationale is to determine if the system is generating value in terms of energy. In principle the system can achieve full efficiency expressed by the factor of 1. In real terms, efficiency hardly achieves such values and moreover, there are restrictions in measuring the input necessary to assemble a system. In addition, inputs needed to generate outputs are not always fully measurable. Efficiency is measured to achieve the most possible output hence systems are always the subject of ongoing engineering to gain additional output or lower required input. For this purpose quantitative indicators are used to measure and control the operation of technical system. These indicators are taken from a model built for designing an optimal technical system, which is of course limited by the available knowledge of the underlying system and natural principles. The ideal model is commonly referred to as the benchmark which sets the optimal efficiency (e.g. expressed by efficiency degree 1).

Based on an efficiency measurement in technical / engineering domains, analogies to measuring efficiency in managerial terms appear. The managerial point of view considers efficiency as an indicator of the quality of processes in organizations. The definition of processes hereby is broad, covering manufacturing, procurement, development, accounting and other service processes to name a few. The difficulty however lies in causality and plausibility. For example, there are direct interrelationships between single processes while at the same time there are hidden (indirect) interrelationships and inherent path dependencies of processes. Management efficiency implies the control and quantification of resources and hence requires sophisticated and detailed accounting in technical and in managerial terms. A special challenge lies in converting resources which are necessary to initiate and operate processes from a qualitative into a quantitative dimension. The choice of indicators to measure efficiency strongly determines the eventual validity and range of interpretations. In sum, efficiency describes the way of doing things, for example 'doing things right.' To date, measuring efficiency is mainly driven by control, steering functions, and mechanisms.

Effectiveness means achieving a set target and thus by definition does not consider the use of resources required for achieving the target. In this sense effectiveness describes the achievement of goals, for example 'doing the right things.' In this respect, effectiveness expresses two dimensions: 1) the degree of achieving the objectives and outputs set and 2) the degree of choosing the right approach towards meeting objectives and goals.

As long as the output achievement is considered for measuring the effectiveness of operations, the benchmark leaves reasonable room for manipulating the effectiveness indicator by changing the investment into processes or projects which target the desired outcome remains [Mitcham, 1994; Khripunova et al., 2014].

The strong orientation on control and steering of processes enables a clear, up front distinction of efficiency from effectiveness. However individually considering the indicators is inherently dangerous because it neglects the systemic view; for example, it ignores the dependency of efficiency and effectiveness. Moreover, efficiency indicators do not allow for much manipulation and are rather narrow and targeted, whereas the effectiveness indicator leave reasonable room for manoeuvre. For that reason effectiveness and efficiency should always be considered equally important. Otherwise the analysis would be misleading in the mid to long term. With the increasing efficiency in managerial terms technical efficiency thinking reached a new dimension. While engineering efficiency was neglected early on, the evolving scarcity of resources has led to greater awareness of efficiency. In this respect resources are not only raw materials and natural resources but also – perhaps more importantly – time and human resources competences and capabilities [Alexander, 2009]. Competitive pressures which have increased as a result of globalization have made efficiency in all its dimensions (technical and managerial) even more important.

To assess the effectiveness and efficiency of Foresight, Cuhls and Georghiou [2004] conclude that real-time evaluation using similar methods as the Foresight study are recommendable. Measuring of the effectiveness and efficiency of Foresight turns out the main elements comprehensive evaluations of Foresight from many different perspectives. Sokolova and Makarova [2013] propose that a comprehensive evaluation model needs to involve the development of an evaluation model, the extensive use of quantitative methods and the elaboration of evaluation scales. Moreover economic indicators need to be included in the evaluation and transparency of evaluation results increased.

It follows that for evaluating Foresight, including its effectiveness and efficiency, the process dimension plays a crucial role. Moreover, the power and influence of stakeholders are important for the effectiveness and efficiency of Foresight; hence they should be included in the evaluation [Amanatidou and Guy 2008]. In addition Foresight evaluations need to be embedded in the broader environment of the National Innovation System and the STI policy making processes to derive respective conclusions about their effectiveness and efficiency since Foresight is usually determined by the interaction of stakeholders with their environment.

The definition and choice of evaluation criteria for assessing Foresight is commonly not a one-time event. Instead the criteria are mostly adjusted to the specific characteristics of each study [Harper, 2013]. Amanatidou and Guy [2008] describe four major groups of factors which affect the impact and results of Foresight. Institutional structures and settings (including the configuration of actors and institutions and communication between them) as well as the governance and policy-making culture (including levels of commitment) are influenced by the communication lines and styles of Foresight. Social and cultural factors in relation to public participation and the perceived utility and eventual impacts of Foresight exercises create expectations and the will to change by communities. Moreover the nature of innovation processes and the 'innovation system' in which these processes are embedded (including the state of development of extant 'knowledge societies') are influenced by Foresight activities in different shapes. Regardless of the eventual outcome of Foresight, participants always gain value added. Value gained might be cultural by opening horizons and questioning existing attitudes and approaches, or it might be learning value by accessing new knowledge and gaining inspiration from exchanges with peers who have not been previously involved in exchanges. In this regard, the understanding of Foresight is broadened to include the different impacts Foresight can have on communities and the systems in which it is embedded. Thus it can be argued that participation in Foresight contributes to knowledge creation and, more importantly, to knowledge diffusion and to some extent it also helps extend the absorptive capacities of individuals and organizations which are commonly referred to as characteristics of the knowledge economy and society. Moreover, the networking dimension from Foresight is strengthened and supported because the participants are sharing common interests and the awareness of uncertainty which is a major characteristic of the Foresight results. This understanding allows to concluding that the results and impacts of Foresight are significantly broader than assumed.

Foresight has many different goals. However, measuring and assessing the effectiveness and efficiency of these studies requires knowledge of the underlying motivations to conduct Foresight and the respective goals. Each Foresight is in principle unlike any other. This is reflected in the motivations, and definitions of goals and ambitions that initiators and stakeholders have.

In most cases people conduct Foresight to prioritise research investment by research funding agencies or councils, link basic (blue sky) and applied research closer, to change the research climate at public universities in particular, and provide a stimulus for the strategic and organisational reshaping of national innovation systems. Hence, the major related goals of these Foresights are strengthening national competitiveness by identifying core fields for investment into research of different types and innovation and supporting future thinking, developing a culture to conduct Foresight. The ultimate goal is to strengthen national economic performance sustainably by expecting that future oriented thinking contributes to and strengthens the national economy. Most Foresight consider it important to develop and establish a Foresight culture at country level while simultaneously wishing to refocus priorities for publicly funded research. Almost all studies share the ambition to develop measures conducive to innovation and advantageous to all stakeholders. Furthermore, the intention to strengthen research interdisciplinarity and multifunctional cooperation among different actors and the need to gain new insights for long-term technology policy definition are frequently quoted goals of Foresight studies. It is increasingly common that one goal of Foresight is to identify long term societal needs and derive support for policy-making based on program planning that support innovation and technology policy.

Foresight which is accomplished neither effectively nor efficiently represents a direct threat to the innovation culture of a country or corporation. With the announcement and execution of a Foresight study high expectations are created among participants. If the results do not correspond to expectations due to a lack of authority or support during the process, many participants may in consequence permanently lose confidence.

3 Success factors and challenges

Foresight is commonly initiated and launched in project form. Nevertheless, viewing Foresight from a process perspective instead of a pure project perspective with independent sub-projects helps to more clearly understand the requirements on each element / process stage of Foresight [Öner and Beşer, 2011, Vishnevski et al., 2014]. Hence, the work packages of Foresight are a flow of activities. It is clearly indicated that the quality of the outcome of each work package determines the quality of the next work package thus the overall Foresight process. This means that quality management needs to be an integral element in Foresight including the need for overall attention to the process-oriented elements of the project. Therefore, quality management and the related process view on Foresight can be considered a success factor and also a significant challenge to Foresight.

PREST (2006) showed that the absorption of Foresight based findings by the initiator improves when responsible staff members are engaged actively in different forms. Yet, the overriding message is that anyone who wants to obtain the benefits of Foresight has to be involved in the process as an active participant which involves possessing the competences and capabilities to understand and interpret the Foresight results appropriately to derive the respective measures and concrete actions for implementation [Smith and Calof, 2010]. Thus, it is urgently necessary to assure constant transparency and openness of the Foresight study process which turns out to be the condition for a lasting commitment of all Foresight participants hence the quality of the attainable results. Transparency means also that topics treated in the context of such studies with a comprehensible procedure are identified primarily by the experts involved. Inducing politically or otherwise motivated topics would cause a foreseeable defence reaction by experts and would jeopardize the independence of the given study. Thereby the clear promise for the use of results by the responsible persons is just as important to use the results in the political discussion and with political decisions and/or to use the results as inputs for the development of promotion strategies. Accordingly, early development and communication of an implementation program is essential. Successful Foresight studies require clear incentives, in particular for the experts and Steering Group members. Instead of monetary incentives, assignment of responsibilities and public appearances compensate. There is a strong path dependency between the effectiveness of Foresight and the initial obligation of target groups to implement the results. In addition, setting clear incentives for stakeholders, regular meetings between project team and stakeholders and transparent selection of topics determine the effectiveness of Foresight studies. Regular exchange between project teams and stakeholders as well as setting clear incentives for participants, the independence of the responsible organization, guaranteeing the acceptance among stakeholders, evaluations and the early development of an implementation plan positively correlate with the efficiency of the Foresight study. Foresight has to take into account the increasing interrelationships between different science and technology fields but also between STI, economy and society [Habegger, 2010]. Resistance of political decision makers potentially form the strongest obstacle both for effectiveness and efficiency, thus despite the independence of the responsible organization politicians must be involved or informed at least regularly [Meissner, 2014]. Moreover, the role of national funding organizations should be re-examined as possible doubts about such institutions in relation to Foresight can negatively affect Foresight' effectiveness and efficiency. Finally, it is important that the institution responsible for implementation is involved in the Foresight at an early stage.

It proves essential that the acceptance of the Foresight study results, irrespective of the eventual outcome, is guaranteed from the beginning despite the long-term goals. Such a problem concerns both political decision makers and the population.

The general success factors and challenges can be broken down to the individual phases of Foresight. This is even more important since the overall performance of Foresight results from the design and implementation of the individual phases. Also it needs to be kept in mind that the phases and related success factors and challenges shown in tab.1 are not necessarily independent and in the real application often times only hard to distinguish. Therefore, the success factors and also the challenges need to be considered overarching with varying importance and meaning at the individual stages.

Tab. 1: Success factors and challenges of Foresight studies

Dimension	Key success factor	Challenge
Motivation for Foresight studies	• Trigger for Foresight is community oriented thinking in the national context • Collaborative identification of future areas for innovation involving the public and private sector	• Exclusive focus on reallocation of resources for public research
Preparation, framework conditions and strategies	• Analysis of foreign experiences • National benefit analysis • Structured approach	• Overly strong emphasis on selected foreign examples and experts
Actors involved and their role	• Government agencies to be involved but not represented in core team; independence from policy makers • Equitable balance between science, economics and policy / administration as target group	• One-sided focus on a single target group
Organisation and budget	• Strong position of Steering Group within national innovation system • Small project group • Mid-sized budget and short duration	• Long duration and lacking flexibility of organisation ('business as usual' syndrome) • Weak position of Steering Group within national innovation system

	• Communication of the importance of interdisciplinary thinking and competences of all participants • Clear responsibilities	
Selection / use of instruments	• Combination of different instruments, especially well balanced portfolio of qualitative and quantitative instruments • Transparent documentation and careful evaluation and interpretation of results • Thorough selection of instruments and management of interfaces between instruments • Limited number of instruments applied • Avoid unnecessary complexity	• Instruments not adjusted to needs and expectations of experts and other participants • Large number of different instruments applied, especially instruments used by diverse panels and working groups hence the comparability of panel results is questionable • Criticism of selected instruments and methods towards reliability of results

Source: [Meissner, 2008]

4 Quality Management of Foresight Studies: Ensuring Validity

4.1 From summative to normative Foresight evaluation

This section of the paper studies whether existing Foresight theory and methodology covers Foresight windtunelling against advanced technologies from a system point of view and whether existing methodologies, if any, can be easily adapted to the corporate world. The literature on Foresight evaluation and Foresight verification in particular – when reviewed separately from pure research evaluation literature – being rare, the creative summary of existing approaches represents crucial interest in terms of moving towards understanding of the state of theory and methodology of Foresight windtunelling. In their classic article, Horton [1999] notes Foresight results' verification as being crucial to a successful Foresight process. For the application of Foresight to Horton emphasizes that following the first two phases of Foresight which deal with trends and expected developments projected onto the context of the organization, the third phase involves evaluation of the overall understanding of the strategy. Horton further speaks about Foresight verification as the measurement of Foresight exercise efficiency, limiting her vision of Foresight verification to impact evaluation. However, in the same classic article published in the first issue of the Foresight Journal, the author touches upon the problem of smaller organizations not having sufficient resources to organize Foresight and argues that outsourcing Foresight exercises could be productive when tailored to the organization's needs. What was not however touched upon in the article is the fact that both when outsourced or conducted in-house, Foresightexercises might not be accurate from the technology point of view; thus, Foresight verification against technologies could then be seen as a remedy against the lack of expertise of in-house advanced technology experts (or lack thereof, being an obvious problem for small enterprises and startups for example) and the risks of outsourcing of Foresight exercises associated with quality. This simple yet crucial idea derives from Horton's argument that some businesses do not possess enough resources to conduct quality Foresight exercises while giving the author's emphasis on Foresight evaluation as a separate step of Foresight a fresh look.

Contributing to the theory and methodology of strategic Foresight, Fink, Siebe and Kuhle [1999] develop a concept of future scorecards. As the authors put it, the future scorecard is an instrument of strategic Foresight serving as a part of a controlling system producing 3 types of recommendations, namely recommendation to select a different pattern of operational behavior ('Change your operation!'), to select a different pattern of strategic behavior ('Change your strategy!') and to transform the approach to long-term planning ('Change your view of the future!').The concept of a future scorecard by Fink et al [1999] included 4 types of strategic development 'bettermetrics': performance indicators, change indicators, critical market indicators strategy premises.

Building on the three types of recommendations and four types of indicators, Future scorecards represent simple ready-made Foresight verification tools. However, there is no evidence that the cards ever transformed into practical tools for Foresight verification remaining at the conceptual level. Proposing their systemic vision of the Foresight process, [Miles, 2002] introduces the five steps of Foresight. In his vision, which later became a classic, the author includes evaluation as a separate phase along with scoping, participation, generation, action, and renewal phases (fig.1).

Fig. 1. Systemic vision of the Foresight process

Source: [Miles,2002]

Specifically, Miles included defining indicators, determining goals, evaluation processes and mechanisms into the Foresight process structure, arguing that it is vital to:

- Establish systems to document Foresight processes and outputs;
- Evaluate achievement of and change in objectives, management effectiveness etc.

The author noted that evaluation can be real-time or occur after the main Foresight process; and within post-foresight evaluation the author distinguished between post hoc evaluation and success story analysis, seeing the two as independent steps of evaluation. Furthermore he emphasized that Foresight evaluation tools and skills need to be developed in-house so that the sold-to party could independently evaluate the results of a Foresight exercise and not delegate evaluation to a sponsoring or management organization: "It is useful for independent evaluation capabilities to be developed, with evaluators who are not heavily beholden to or reliant on specific clients, and who are able to draw upon experience and good practice gained from evaluation of different sorts of programme". Miles further argues that an independent evaluation system is needed for the sold-to party, noting that there are always dangers of the 'capture of evaluators'.

Wonglimpiyarat [2006] published a paper on Technology Foresight building on the experience of the national-level Foresight exercise in Thailand. Describing the steps of a Foresight process, the author speaks about Foresight evaluation as a separate step (fig.2). While in his field experience-induced vision of the Foresight process evaluation remains as a separate step, the author speaks of the evaluation step in terms of by how far the goals of the exercise were achieved.

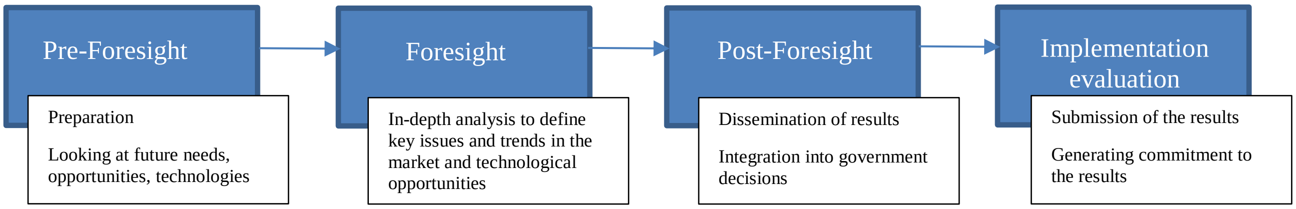

Fig. 2. The Foresight process
Source: Wonglimpiyarat, 2006

In his conceptual paper Schwarz [2007] voices a concern that future studies 'need further improvement and that there is a need for integration of the methods of futures studies as a holistic approach, designed towards the special needs of organizations'. In particular, Schwarz notices: '[…] futures research should be applied depending on the context, for instance organization, objective and other possible aspects. As is the case with other scientific disciplines, […], it is difficult to apply 'golden rules' or find theoretical and empirical connections that are universal in nature'. Although future studies deals with immeasurable phenomena, Schwarz later notes that the roots of futures studies in management allow for the scientific evaluation approaches to futures studies. Representing a cognitive challenge for the futures studies, in his vision Foresight evaluation is in fact a crucial issue.

Popper [2008] opened a discussion of systemic selection of Foresight methods. Basing his analysis on 886 Foresight cases, the author introduces his diamond of methods to become a fundamental conceptualization of futures studies. The Foresight Diamond represents various types of Foresight methods such as generic methods (literature review, expert panels, scenarios, trend exploration/megatrends, brainstorming, interviews etc), simulation-centred (modelling, simulation, gaming), targeted (Delphi, SWOT analysis, patent scanning etc) and other methods. What is vital, Popper includes such specific technology-centred Foresight methods as key/critical technologies and technology road-mapping as methods to use for a Foresight exercise.

What is of interest is that in Popper's quest for the logics of Foresight methods selection, Popper comes to a conclusion that in fact a selection of method(s) can occur 'intuitively, by insight, impulsiveness, inexperience or irresponsibility of practitioners'. Thus, in the context when methods are chosen by intuition, the Foresight verification step can be seen as a way to ensure that despite of the logics of method(s) selection, the results of the Foresight are/can be boosted to rigorous. However, if among the methods listed there are some which would not at all tolerate inexperience, irresponsibility, impulsiveness and insight, these are key/crucial technologies and technology roadmapping which in the recent years have become a vital pillar of the majority of Foresight exercises (see, e.g., EFMN Archive of 40+ Briefs for hundreds of Foresight projects) in the role of a sub-method or step as part of an overall Foresight process. In this light, Foresight results verification against advanced technologies indeed represents one of the most acute challenges.

Van der Duin [2009] emphasizes the role of evaluation in the futures studies, noting that the applied character of futures research as an applied science does not interfere with the use of evaluation and reflection. However, he formulates his vision of Foresight evaluation: 'Reflection also plays an important role in futures research, because most futures researchers, due to their experience with and knowledge of futures research projects, are in a good position to assess the quality of a futures study. However, with regard to both evaluation and reflection, it is important for the futures researchers to have hands-on experience in conducting futures research'. Although the author emphasizes that they are unable to prove it, he further notes: 'When I read reports and articles in various scientific journals I doubt whether the authors in question have some experience in carrying out futures research'. Further building on this argument, the author proposes to use experience-based "critique" (the active approach to expressing criticism) instead of simply criticizing as a Foresight verification strategy: "Promoting futures research as a science first of all means gaining experience and gathering first-hand knowledge as to what valid futures research constitutes. Evaluating and reflecting from the outside, without commitment or experience, is not very productive and denies the precarious stage in which futures research (still) finds itself".

Fuerth [2009] looks at Foresight from a system approach, differentiating between the Foresight system and the policy-making system. In his concept of anticipatory governance which they see as a super system, they further introduce the concept of the feedback system to "gauge performance and manage institutional knowledge" (tab.2).

Tab. 2. Fuerth's Model of anticipatory governance

Foresight system
Networked system for integrating foresight and the policy process
Feedback system (performance, institutional knowledge)
Open-minded institutional culture

Source: Fuerth, 2009

Building on Fuerth [2009] to look at the Foresight from the evaluation perspective (feedback system), one of the most widespread methodologies to conduct Foresight is *trend extrapolation*. Based on the principle of extrapolating current trends into the long-term perspective, in general it is used by the majority of practitioners.

However, some researchers phrase out criticism of the methodology. As some practitioners accept the approach, although widespread, does not allow effective ways to take into non-linear events. Indeed, this methodology is colour-blind towards wildcards. Of special interest are the technology wildcards, or disruptive technologies which are a special subject of Foresight studies which very often has the capacity to drastically change the future context and cause panic among those who drafted and approved strategic planning documents.

With regards to picking up emerging issues to construct a vision of the future, Kuosa [2010] presents an alternative philosophy to traditional Foresight approaches. While the traditional trend extrapolation approach which implies working with the so-called prolonged present, the author proposes an environmental scanning and pattern management-based sense-making tool to work with weak signals, emerging issues, drivers and trends. The hypothesis by Kuosa is simple'…if there is a grand transformation process on the way or if there is a new emerging pattern or phenomenon, such a process will certainly be reflected in many different ways'. In Kuosa's logic, the signals on the future are scattered around various simultaneous and overlapping sources in the present and the goal is to pick up the weak signals through a scanning process creating patterns of the future with their sense-making tool. Kuosa notes that his tool can be used as a sense-making tool 'for any kind of analyses'. In fact, applying the weak signals approach to Foresight evaluation, especially to Foresight verification against advanced technology, could be an effective way to evaluate Foresight results. Especially the ones produced in the trend extrapolation logic, since a verification framework or tool built around picking up technology signals in the present would, following Kuosa's logic, be a helpful tool to analyze Foresight results.

Further looking at tools which can be used for Foresight evaluation, Tevis [2010] sees it as a key step in strategic (goal-oriented) planning. In his work the author proposes evaluation of what they calls an ideal design model against potential future scenarios. At the core of the method lies a mapping tool for actions and events determined prior to this step. He also sees goal-oriented planning as a supporting tool to strategic Foresight: 'Scenario planning, however, can evolve to support a creative Foresight and approach to the future by recognizing the power behind enactment theory and applying a goal-oriented approach to the scenario planning process. Using goal-oriented scenario planning an organization can match the world it wants with the world it expects to see.'

Botterhuis et al [2010] introduced a scenario typology for anearly-warning system of futures developments, signals, and weak signals (EWS) noting that scenarios could be used as lenses to identify information in the environment of an organization from a broad perspective. The authors argue that scenarios as an explorative method of futures studies are 'better able to pick up various signals than predictive approaches to futures research that examine the future from just one perspective; the scenarios make sure that apparently isolated weak signals can be linked to possible long-term changes'. The authors present the scenario method arguing that 'detecting and interpreting (possible) changes should always take place within the context of a futures exploration (i.e., a set of scenarios), in order to give the signals structure and meaning'. The early-warning system proposed allows for a potential change-centred approach to searching for signals through scanning and monitoring specific content of the scenarios. The aim is not to miss the important seeds of change. The authors further argue that the key criteria for an early-warning system are representativity, significance, periodicity, validity citing a Dutch government case carried out on the basis of the following steps:

1. Determining the starting point.
2. Selecting empirical sources on the basis of the four key criteria.
3. The movement along the horizontal axis.
4. The movement along the vertical axis.
5. Combining the first four steps to determine where we find ourselves at the moment."

In fact, the question on what would be the significant and valid sources to build a Foresight exercise upon are vital to answer during the evaluation phase.Along with the valid sources, the pitfalls of Foresight represent interest from the evaluation point of view. In the context of research by MacKey and McKiernan [2010] who looked at futures studies as a creative process, creativity-induced dysfunctions in the scenario-planning process were identified, namely heightened expectations and confusion, pride and passion, creativity to excess.

In the context of an earlier work by Van der Duin [2007] who looked at factors explaining wrong technology futures predictions describe several clusters of factors (tab.3).

Tab. 3. Factors explaining wrong predictions

Clusters of factors	Factor
Too much emphasis on technolog y push	• Fascination with the exotic: o bias toward the optimistic and a disregard for reality o Price-performance failures: many technologies deliver lesser benefits at greater costs than anticipated o Too much influence of people with a financial stake in new technology
Influence of contempor ary thinking or interests	• Enmeshed in the Zeitgeist, too much focused on one technology and its presumed benefits • Ultimate uses unforeseen: forecasters rarely anticipate applications fully • Market researchers survey wrong people, i.e. companies producing new technology • Expectations may be biased by the broader cultural concerns of the time
Neglect of change	• ‘Assumption drag’: using ‘old’ assumptions in predictive models • Ultimate uses unforeseen: forecasters rarely anticipate applications fully • Sudden new trajectories in technological developments may trigger shifts in future images • Forecasts about new technology often positioned as replacing old technology • neglect generation of new activities by assuming that pool of existing activities is exhaustive
Neglect of social change	• Shifting social trends: o changing demographic trends and social values not well considered o Too much stress on ‘functional thinking’ and neglecting the ‘fun’ of doing things, such as shopping o Viewing the societal embedding of new technologies as unproblematic o New technology promises high societal gains but proves later to be unrealistic

Source: Van der Duin, 2007

Van der Duin noted that applying lessons learned from the identification of these pitfalls is, however,a ‘tricky thing’.

Öner and Beser [2011] designed a survey questionnaire to invite Foresight experts to a Delphi study of pitfalls in corporate Foresight projects. The project resulted in authors’ classification of problems that occur during Foresight exercises at the six stages of Foresight: foundation, planning, organizing, controlling, execution, and feedback/continuity (tab.4).

Tab.4. Classification of pitfalls in Foresight projects

Stage	Pitfall
Foundation	1. Insufficient support for the corporate foresight project
	1.1 corporate foresight project plans are not aligned with the business plans
	1.2 principles and policies of corporate foresight project work are not defined
	2. Poor corporate foresight project definition
	2.1 goals for the corporate foresight project are imprecise
	2.2 limits of the scope of the corporate foresight project are not set
	2.3 levels of ambition for changes to people, systems and organization are not in balance with the new technology to be introduced
Planning	1. planning level is uniform; the plan contains too much detail for some users, and too little for others
	2. planning tools are unwieldy
	3. planning range is psychologically unsound
	4. planning method discourages creativity, and encourages bureaucracy
	5. planning estimates of time and cost are over-optimistic
	6. planning of resources overestimates their competence and capacity
	7. corporate foresight project calendar omits lost time
	8. plan omits activities
Organizing	1. Alternative organizations for the project are not considered
	2. distribution of responsibility is not defined
	3. Key resources are not available when required
	4. Key resources are not motivated
	5. Line managers are not committed
	6. Communication is poor
	7. corporate foresight project manager is a technocrat, rather than a manager, so he can not delegate, coordinate, and control
Controlling	1. corporate foresight project manager and his team do not understand the purpose of control, they do not understand the difference between monitoring and controlling
	2. plan and progress reports are not integrated
	3. no well-defined, formalized and communication between corporate foresight project manager and project members
	4. corporate foresight project manager has responsibility, but no formal authority
Execution	1. complexity of coordinating a variety of resources is underestimated
	1.1 The task of achieving cooperation between unacquainted people is not understood
	1.2 Different people work with different rules and procedures
	1.3 technical methods are too complicated to be fully understood by the users
	2. Changes to the plan or specification are uncontrolled
	3. Activities are not completed and documented before others begin
	4. Targets of time, cost and quality are unbalanced
Feedback and	1. Corporate foresight project is not successful
	2. Corporate foresight project results are not communicated into the corporation

continuity of the foresight project	3. After the execution of the corporate foresight project, the project managers are withdrawn from the support and responsibility of the project
	4. Foresight projects are not redesigned/tuned according to the needs and expectations of the stakeholders
	5. For future implementation, the corporate foresight results are not looped into the project definition and company knowledge base for readjustment
	6. Instead of creating new knowledge for the future, managers are mainly stuck with the old ones
	7. Corporate foresight project is not re-applied at predetermined time cycles

Source: Öner, Beser, 2011

While Öner and Beser's survey-based classification results are of great methodological interest, the mentioned results did not so far translate into a Foresight evaluation method which would allow a system verification of Foresight results to avoid these pitfalls. This in itself is non-efficient since the classification includes a reference to technology-related pitfalls — the levels of ambition for changes to people, systems and organization are not in balance with the new technology to be introduced. The problem is of special importance to the corporate level and deserves further elaboration.

Tapinos [2013] looks at the corporate context for Foresight to acknowledge that there is currently no research on scenario planning at business unit level, and that most of the existing theory on Foresight concerns corporate level interventions whose stages are roughly similar, but their execution differs according to the requirements of the Foresight exercise undertaken or to the way uncertainty is conceptualized by those practicing the scenario planning. In any case, the problem of Foresight verification per se and verification against advanced technologies has not been further developed by theorists and methodologists to translate it into practical tools to windtunnell Foresight results.

Looking at the research area from a different approach, Foresight evaluation can be interpreted from the approach of weak signals analysis, as a way to build panoramic awareness for advanced technologies. As Mendonça et al [2012] note, the pitfalls of Foresight in decision-making 'are connected (although not exclusively) to insufficient information about relevant events and the evolution of trends, inability to calculate the complete consequences of actions, inability to know all the alternatives and decision paths'. The authors specifically note: 'A weak signal can be an early warning about threats but advanced fragmentary information may also concern opportunities. If a weak signal related to an opportunity has been taken into account it might induce positive results and, if not, negative results in terms of opportunity costs (unexploited opportunities)'. The point made by the authors is that weak signal surveillance despite inevitable limits of knowledge can help avoid strategic traps. In this context, designing methods which would strategically search for weak signals, in particular in the area of advanced technologies, represents practical interest in terms of improving the quality of Foresight results.

Van der Steen and van der Duin [2012] give their summary of the dilemmas of Foresight evaluation. The authors identified several aspects of evaluation listing *quality*, *success* and *impact* of the Foresight exercise as the three key dimensions to evaluation. The authors note that the more structural and systematic evaluation can result in an increased level of trust in futures research, which may in turn lead to more future oriented strategy, policy and decision making. In this context, the authors argue that evaluation should be seen as more than a burden of accountability —'albeit important as accountability is — but as an investment in the credibility and impact of the profession'. Having engaged into a quest for common denominators in Foresight evaluation, the authors summarize the dilemmas of the research field. Arguing that these dilemmas will 'to a large extent define the agenda for evaluation of futures research for the coming years', the authors note that futures studies are very often not about the either-or, but about and-and reasoning, the solution of the dilemmas is being left for the individual researchers to resolve by continuous practice since a researcher is the one who at the end of the day holds the responsibility for the outcomes. The authors however emphasize that evaluation is vital since 'regardless of the nuanced claims of futures researchers themselves, and some users, inaccuracies 'stick' with policy makers and decision makers and define the image of futures studies'. The creative overview of the state and perspectives of Foresight evaluation by Van der Steen and Van der Duin represents great interest, however, it does not specifically deal with the issue of technology, nor does it touch upon the corporate dimension of Foresight.

Piirainen et al [2012] attempted to further develop the issue of system evaluation of Foresight. A so-called systemic evaluation framework was proposed for discussion to the community. However, again, the theoretical elaboration proposed touched upon would not specifically take into account technology. Their research proposed a framework which prescribes principles of form for systemic evaluation of futures studies. The authors argue that, although 'oftentimes validation and evaluation can feel like a burden', involvement of the Foresight participants in the process is a good practice since it raises credibility by showing the participants the procedures for conducting Foresight research, the data used and giving them the opportunity to examine the assumptions themselves. Thus, the authors emphasize that 'carefully designed evaluation and validation procedures can be a strength' in a serious futures research effort rather than a necessary evil and a burden'. While the authors themselves concentrate on designing an open evaluation framework for the futures study community, they have not offered any tools for technology-specific Foresight verification. Further elaborating on the problem of corporate Foresight evaluation, the authors note that by rehearsing or exploring the future 'the organization is strengthened in order to become more agile and proactive and it should also gain experience in the process of multi-disciplinary collaboration that should be embedded in the futures studies project'. This, as the authors envision, enables the organization to strive systematically for innovation and sustainability.

Touching on the value of results of Foresight, and its ultimate goal to become policy recommendations, Rijkens-Klomp [2012] builds on Habegger [2010] dwelling on the barriers to Foresight in terms of quality: if Foresight lacks analytical rigor, the trustworthiness of the results can be challenged and it will be difficult to translate them into policy recommendations.

Moving on with the specific approaches to assessing Foresight, Johnston and Cagnin [2011] introduce the terms *summative evaluation* (measures impact of Foresight impact evaluation) and *normative evaluation* (how to improve impact of Foresight). In the context of this paper, Foresight verification (Foresight windtunelling) can be considered normative evaluation as against advanced technology contributes to well-informed collective futures negotiation, not bettermetrics of a given Foresight project's impact. In this sense a vision of Johnston and Cagnin [2011] is crucial: 'While bettermetrics are obviously useful, and should be pursued, there is a case that at this stage of the evolution [of the Foresight science], the greater emphasis should be on improving the processes that influence impact". Johnston [2012] mentions summative evaluation, which has been lacking attention in the literature. It needs to be mentioned that normative evaluation of Foresight – into which Foresight verification falls – has seen *even less* attention and the literature is indeed rare.

In an attempt to find a technology-specific evaluation tool, we look for Shen et al [2012] who introduce a set of criteria for technology potential evaluation which could be of broader use. While the set of criteria is a technology-specific evaluation tool, it is not proposed as a tool for Foresight results verification against advanced technologies, nor is it simple and scalable enough for corporate environments (tab.5).

Tab.5 Description of technology evaluation criteria

Criteria	Descriptions
Technological merit	
Advancement of technology	• Level of advancement of the proposed technology compared with existing technology
Innovation of technology	• Innovation level of the proposed technology
Key (role) of technology	• Whether the proposed technology is critical for product or industry development
Proprietary technology	• Whether the technology project will generate a proprietary technology position through the intellectual property rights
Generics of technology	• Whether the proposed technology is a generic technology to industry
Technological connections	• Whether the proposed technology is applicable for many products; the more technological applications, the higher technological connections
Technological extendibility	• The extent to which the proposed technology has the potential for further technology development
Business effect	
Potential return on investment	• The potential return on investment in the technology
Effect on existing market share	• Whether the technology can enlarge the existing market share
New market potential	• Whether the technology has the potential to create a new market
Potential size of market	• The potential size of the market in which the products apply the technology
Timing for technology	• Whether this is the right time to develop the technology
Technology development potential	
Technical resources availability	• Access to which the technology can obtain technical resources
Equipment support	• Extent that technology could be supported by existing facilities
Opportunity for technical success	• Opportunity of success for proposed technology and whether there are any similar successful technologies

Risk	
Commercial risk	• Potential commercial risk of the applications
Technical risk	• Potential technical risk of the technology development
Technical difficulties	• Whether the applications could be mass produced

Source: Shen, Lin, Tzeng, 2012

While Shen, Lin and Tzeng [2012] noted that technology evaluation is 'one of the most significant methodologies in innovation and technology transfer, utilized for screening new ideas and assessing whether products and technologies are innovative', the authors did not further propose to use their classification and classification-based tools for Foresight windtunelling, with particular reference to corporate Foresight.

Various researchers have attempted to create tools to study technology deployment innovation capabilities. Lucheng and Wenguang [2009] proposed general procedures to assess industrialization potential of emerging technologies based on technology Foresight and fuzzy consistent matrix (tab.6).

Tab. 6. The industrialization potential assessment indexes system of emerging technologies

	Technology factors	***Market factors***	***Qualification factors***	***Conformity factors***	***Effective factors***
Criteria	• Advancements of technology • Possibility of becoming technical standard	• Market risk • Customer surplus value making	• Industrialization infrastructure • Industrialization human resources	• Extent of accordance with S&T policies • Extent of accordance with industrial policies	• Extent of saving natural resources • Job opportunities creation

Indices	• Possibility of obtaining intellectual right • Possibility of becoming leading technology • Duration of profit making after application	• Market potential. • Expected profit rate • Increase rate of new customers	• Industrialization funding • Industrialization technical guarantee	• Extent of accordance technology foresight • Extent of accordance with social development planning • Extent of accordance with consuming culture	• Extent of promoting S&T development • Extent of improvement in quality of life • Extent of driving related industries • Extent of environmental protection

Source: Lucheng, Wenguang, 2009

Advanced technology selection criteria and indices were proposed by the authors to be used by policy-makers alongside with Foresight practitioners. Looking in the same direction, Wonglimpiyarat [2010] described the experience of Thailand's national innovation index which was proposed as a Foresight tool in terms of technology application (tab.7). Based on the criteria, an Innovation Index was developed for the government of Thailand. In particular, innovation capabilities of technologies were included in the index. Technology development and application were studied in detail at the stages of organization, process, service, product, marketing innovation capabilities. The role of technology assessment for Foresight was specifically emphasized '…the index for measuring the national competitiveness could help link the past, present and look into the future…and improve the Foresight process'.

Tab. 7. Dimension of innovation capability index

Dimension of innovation capability index	**Description**
Organisation innovation capability	• capability to accept new things, provide new knowledge to employees • reveals the ability to create innovations in various sectors and accept changes at all levels
Process innovation capability	• capability to adjust the process at all levels concerning the production process, inventory distribution, logistics, and ancillary supporting activities of accounting, purchasing, financial departments.
Service innovation capability	• capability to bring new knowledge or technologies to develop the new service, resulting in a significant improvement in the production or delivery of goods or services
Product innovation capability	• capability to bring new knowledge or technology to develop new product innovations, increasing revenue at all levels
Marketing innovation capability	• capability to implement a technologically new or improved product/process for the operating market of the firm

Source: Wonglimpiyarat, 2010

Recapitulating on the problems of normative Foresight evaluation, in particular against advanced technologies, although the above mentioned technology evaluation criteria have not evolved in a technology Foresight windtunelling tool, they represent great interest from the Foresight windtunelling point of view.

From this desk survey the challenge arises to develop and test a systemic strategic Foresight verification (windtunelling) method, which would consider the impact of advanced technologies, already existing among the Foresight windtunelling methods to ensure validity of Foresight exercises.

5 Discussion and conclusions

The academic discussion around Foresight evaluation typically looks at quality, success, and impact of Foresight [van der Sten, van der Moin 2012]. The methodologies, e.g. indicators and criteria to measure these dimensions are reasonably well developed. Thus far the literature review does not provide a sufficiently well developed systemic Foresight verification methodology, which considers the interrelationship of effectiveness, efficiency and validity of Foresight. The practical applications are also fragmented and it is impossible to find evidence for existing tools for Foresight verification. The desk survey on the theory and methodology of Foresight evaluation thus resulted in the conclusion that there currently exists no systemic Foresight verification method which would consider the impact of advanced technologies at hand and ensure validity of a Foresight exercise in terms of technology.

The paper shows that there is no common unified understanding of the effectiveness, efficiency and validity of Foresight. Accordingly all three dimensions are understood differently in the practical application of Foresight and especially when it comes to evaluation and impact assessment. Consequently criteria developed and used for evaluation vary between Foresight exercises which doubtless significantly impacts on the conclusions drawn from such assessments. During the last decade it has almost become common practice of Foresight practitioners to learn from others' Foresight experiences which is many times done by reviewing evaluation reports. However the terminology 'effectiveness, efficiency and validity' is frequently quoted and used but there is no real definition and explanation what these terms express and how the underlying concept was defined. Assuming that the findings from previous Foresight are taken into account for shaping current or future Foresight it appears that there is an inherent danger of drawing conclusions and developing measures which are not fully suited to leverage the full potential of Foresight. The reason is that the diverging perceptions of effectiveness, efficiency and validity do lead to different indicators and approaches used for measuring and assessing Foresight hence limiting the comparability of different Foresight studies.

To overcome this limitation the article discussed the main characteristics of Foresight as well as effectiveness, efficiency and validity to contribute to a more solid basis for assessment and evaluation of Foresight. From the analysis and a set of indicators which are suitable for assessing the effectiveness, efficiency and validity were developed. However these indicators and approaches also need to take account of the dependency of effectiveness, efficiency and validity of Foresight (fig.4).

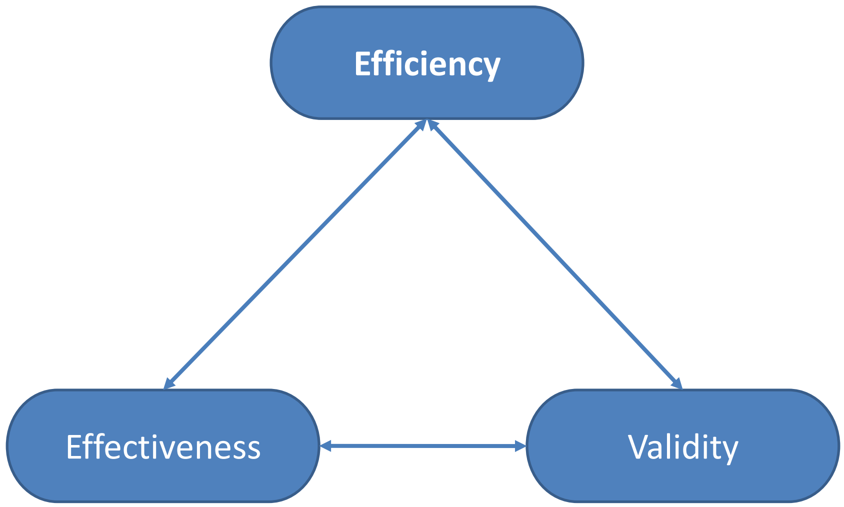

Fig. 4: Foresight Evaluation Triangle (FET)

The overarching aim of any Foresight is usually assumed to deliver valid results which given the nature of Foresight does not mean a description of the future as it can be guaranteed to appear but instead applying a sound methodology which delivers scenarios based on current evidence and the proper translation of expectations and realistic assessments of potential developments. Arguably the validity of results is determining the effectiveness of Foresight, e.g. Foresight can be effective only if it is delivering valid results. However, assessing validity requires a longer time horizon than assessing the actual effectiveness. Moreover, it appears that Foresight practitioners might be tempted to modify the actual investment budgeted for Foresight to achieve the targets hence proving the actual Foresight is effective. Still this understanding is strongly depending on the definition of the goals and aims prior actual Foresight activities. Similarly it can be argued that when it comes to assessing the efficiency of Foresight, accordingly there is sufficient potential for manipulation of the actual results by changing the data and information underlying the respective indicators. This does not necessarily imply that such is done purposefully instead this can also result from different interpretation of the respective data and information.

The measurement dimensions discussed clearly correspond with the discussion of challenges and success factors. Especially effectiveness criteria give clear indications for Foresight practitioners to formulate specific measures. The same holds true for efficiency and validity indicators introduced. However the respective indicators do not form a comprehensive set applicable to all Foresight practitioners and Foresight projects. The reason is that the scope and motivation of Foresight strongly determine the actual underlying process of organizing and conducting Foresight. Accordingly the measures to evaluate effectiveness, efficiency and validity vary which implies that the criteria used are adjusted accordingly.

From the discussion a series of factors evolve which are relevant in determining the success of Foresight. It shows that the use of the results of Foresight must be clarified using a clear action plan and communicated accordingly even before the study is initiated. Secondly, the procedure must be structured to be consistent, transparent and open, involving proactive public relations and the inclusion of various stakeholders from science, industry, administration and society. This clearly emphasizes the importance of the project team's people skills (social skills).

However although these factors are specific to individual Foresight as well as to the scope of the underlying project, a set of general key success factors and challenges can be derived [Sokolov, Meissner, 2013]. The general factors of success and challenges are common to any Foresight study regardless of country, scope and Foresight set up. Given this background it becomes obvious that the success factors need to be carefully reflected and aligned to the FET concept. This alone is challenging since the dimensions effectiveness, efficiency and validity are not always in line instead contradictory in selected constellation. To measure effectiveness, efficiency and validity tab.8 proposes a set of possible criteria which can be applied for measurement.

Tab.8: FET criteria: measuring effectiveness, efficiency and validity

Foresight characteristic		*Measurement criteria for*		
		Effectiveness	*Validity*	*Efficiency*
• Forge new partnerships		• New partnerships created	• Newness of partnerships	• Sustainability of new partnerships
• Identification of generic technologies		• Generic technologies vs. total number of technologies identified	• Evidence based identified technology	• Application coverage of generic technologies (outreach)
• Consensus development on national priorities		• Ratio of initial priorities to consensually approved priorities	• Ratio of priorities based on evidence to speculative priorities	• Degree of results implementation
• Network building		• Targeted networks with joint vision / mission	• Holistic / systemic structure of network members	• Structured vs. loose networks
• Priority setting for national infrastructure	Research topics	• Renewal rate of research priorities	• Completion rate of project priorities	• Active acceptance vs. passive delay of projects
	infrastructure for innovation	• Ratio purely technological vs. societal need induced priorities related infrastructure investment	• Targeted infrastructure development	• Investments to keep abreast of global standard infrastructure
• Commitment to action	Process	• Long term impact of process		• Share of rejected process proposals

		proposals		
	Product	• Long term impact of product proposals		• Share of rejected product proposals
• Direct interaction encouragement between people		• New interactions initiated		• Survival rate of interactions mid- to long-term
• Need of continuing commitment		• Withdrawal rate of participants		• Continuous resource commitments by participants
• Active participation		• Ratio of active to passive participants	• Value of contributions (newness, rigor)	• Share of constructive interventions / contributions

It is important to note that the criteria quoted in the table are intended to describe the meaning of indicators which need to be developed and specified for measurement. Furthermore the indicators which are eventually developed in course of future work need to be mutually exclusive and collectively exhaustive.

The paper has outlined the basic meaning and relationship of effectiveness, efficiency and validity for Foresight, especially for evaluating Foresight. Furthermore it was shown that the three dimensions effectiveness, efficiency and validity are interconnected to varying extend. However currently the question how strong these dimensions are interconnected remains unanswered. Future research work thus should aim to

- explore the nature and intensity of the interconnectedness of effectiveness, efficiency and validity, e.g. the path dependency of the three dimensions;
- further develop or reassemble where appropriate criteria and indicators to fit in the FET;
- test the framework for applicability;
- prepare an interface to the overall STI policy mix and evaluations of other STI policy measures.

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