A utility focused process for enhancing the use of horizon scanning in defence research

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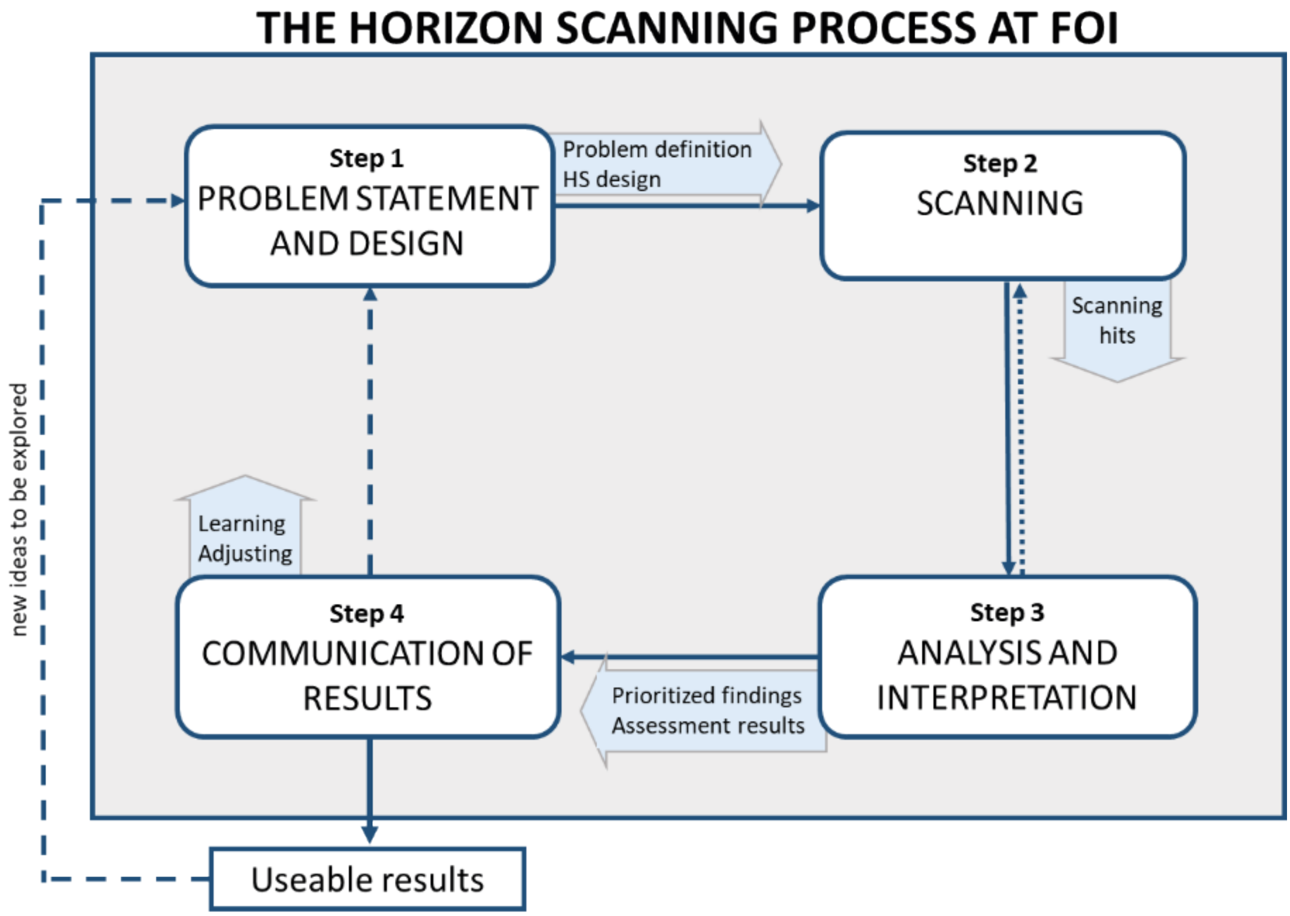

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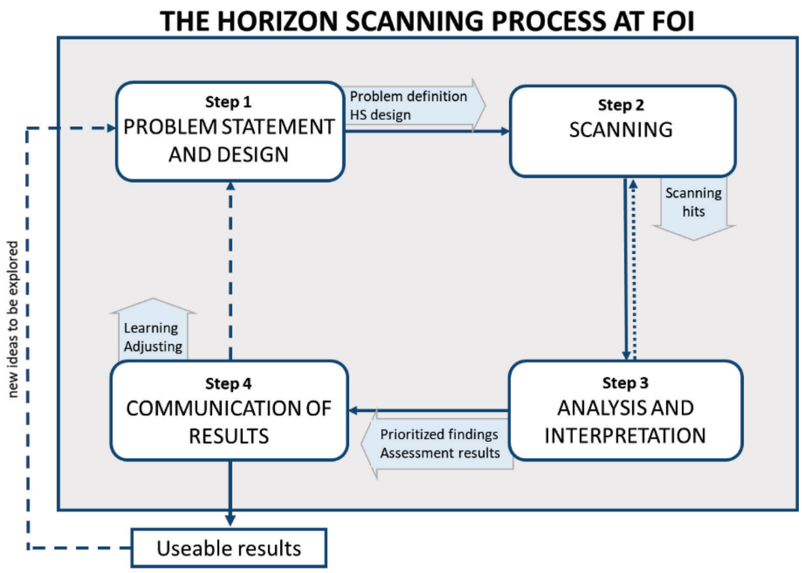

Titel	En användningsfokuserad avskanningsprocess till nytta för försvarsforskning
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Sammanfattning

Avskanning (eng. horizon scanning) är en metod för att på ett tidigt stadium identifiera signaler och förändringar som kan vara relevanta för en organisations utveckling mot framtiden. Vid avskanning studeras områden utanför eller i framkanten av en organisations verksamhet. Avskanningen kan antingen vara ämnesspecifik eller undersökande inom ett bredare fält. Målet är att hitta ny information eller sådant som tidigare inte uppmärksammats.

I rapporten beskrivs en process för avskanning. Den tar sin utgångspunkt i vetenskaplig litteratur, egna lärdomar och målet att processen ska stödja ett myndighetsgemensamt arbete med avskanning och teknisk prognos. Avskanningsprocessen har fyra steg: 1) problemformulering och design, 2) skanning och insamling av data, 3) analys och värdering, och 4) kommunikation av resultat. Processens fokus på användbara resultat kommer att underlätta arbetet och motverka vissa av de utmaningar med avskanning som den vetenskapliga litteraturen beskriver.

Processen baseras på ett antal användbarhetsfokuserade principer som guidar genomförandet av avskanningen. Tolkning av resultat tillsammans med de tilltänkta användarna uppmuntras. Den föreslagna avskanningsprocessen kan användas för olika typer av aktiviteter och utförandet kan anpassas till de specifika behov och förutsättningar som varje enskild avskanning har.

Nyckelord: horizon scanning, framsyn, avskanning, process, användbarhet, teknisk framsyn, försvar och säkerhet, naturvetenskap och teknik, värdering

Summary

Horizon scanning is a method to detect signals and early signs indicating future changes relevant to an organization. Horizon scanning studies information outside and beyond current business. The purpose is either to provide information on specific issues or to explore topics in a wider context. It makes visible unfamiliar and new information.

A utility focused process for horizon scanning is proposed. It is based on peer-reviewed publications on horizon scanning theory, use and processes, as well as own experiences and the requirement to support multi-agency work. The process consists of four steps: 1) Problem statement and design, 2) Scanning, 3) Analysis and interpretation, and 4) Communication of results. The process with its utility focused principles aim to meet some of the challenges with horizon scanning frequently reported in the literature and also to enhance obtaining relevant and useful output.

The utility focused principles guide the performance of the horizon scanning activity and improve the utility of the result. Engagement of stakeholders are beneficial to the outcome of the process. The process can be used in various types of horizon scanning activities and it therefore supports adaption to specific needs and conditions of an activity.

Keywords: horizon scanning, foresight, process, utility, technology foresight, defence, science and technology, assessment

Contents

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1 Introduction

We propose a utility focused process to enhance the use of scanning results. The process will be used by Swedish defence organisations, both within an organisation and in collaborations between organisations. A key requirement in the development of the process is that it should encourage the scanning team to consider the needs and purposes of the different organisations, which are to use the results of a scanning activity. As shown in the literature, not all results of horizon scanning are easy to use and therefore risk not being used at all. To meet these and other challenges a utility focus for the horizon scanning process is introduced. The proposed process is flexible and can be adapted to various horizon scanning purposes.

This report first describes theory on horizon scanning and then proposes a horizon scanning process intended for use in a multi-agency collaboration. This report aims to communicate the process to researchers interested in horizon scanning method development and others in need of an introduction to the process. This work was funded by the Swedish Armed Forces R&D Programme for horizon scanning and technology watch (AT.9221603).

1.1 Foresight and horizon scanning

Horizon scanning aims to detect signals and early signs of important developments and changes relevant to a stakeholder or organization. The time perspective and scope is usually beyond and outside that of everyday business. Horizon scanning is a methodology that provides results for foresight. Horizon scanning and foresight are research areas with diverse nomenclature. To clarify what horizon scanning does and does not entail, some common terms are defined below.

Foresight is a scientifically based methodology that provides and makes use of information of potential future developments (so-called futures). The United Nations Development Programme, UNDP, (2018) has suggested that foresight is prospective, policy-related and participative. Foresight does not aim to predict, but provides a structured, systematic and inclusive way of work aimed at empowering stakeholders in present day decisions of importance for the future. It supports organizations' understanding of what may lie ahead, what to prepare for or to take action. (Nehme et al. 2012, Cuhls 2019)

Technology foresight provides information and tools for organizations with aim to focus on science, technology and innovation. (Miles et al. 2017). Technology scanning also concerns finding and evaluating information outside the everyday business. The aim is to find (potentially disruptive) technologies and relevant technological trends from outside the organization's core technological competences (Schuh et al. 2015, p. 532).

Environmental scanning and horizon scanning are sometimes used synonymously and horizon scanning is sometimes viewed as a subset of environmental scanning. (Miles and Saritas 2012) Horizon and environmental scanning are both used to detect (signals of) developments and changes, but there are differences; environmental scanning focuses on the present and current research areas of the organization, while horizon scanning has a more long-term orientation and broader scope, beyond and outside current research. (Choo 1999, Miles and Saritas 2012) Horizon scanning deals with detecting the new and unfamiliar, such as weak signals and signs indicating that change may occur. The purpose of scanning activities varies, but results serve to direct strategic analysis and provide support to decision-making. In some cases, the purpose is to provide information on specific issues, while in others it is to explore in a wider context. The main contribution of horizon scanning is assessed information provided as input to foresight or other strategic work. (Cuhls 2019)

Trend analysis, technology forecasting and prognosis mainly use statistical data to forecast the (one) future. There is a specificity concerning scope, issue and time horizon. (Bishop et al. 2007, Kindvall et al. 2017, and OECD 2020)

Technology watch is a trend analysis or prognosis of technology. Often, it uses statistically based methodology focusing on specific technologies or applications that in many cases is known to be relevant to the own organization (Holland Smith and Strong 2008). In defence, specific science and technology areas and materiel developments are followed, and technology watch usually focuses on a specific and known area or concept, which also allows for a more in-depth analysis.

A key difference between foresight and horizon scanning concerns process orientation and stakeholder engagement. Foresight is often performed within processes supporting decision-making and emphasizes (shared) knowledge and actionable results. Horizon scanning may be included in foresight and decision-making processes.

Horizon scanning of an organization's research areas may be confused with technology watch. However, the perspective to scan, not to search, beyond what is already in focus and known may guide the work. The scope of horizon scanning is different to and exceeds that of technology watch. The focus of horizon scanning is to find information on breakthroughs and innovation outside of the organization's current research areas, which generally does not include prognosis. Horizon scanning finds new, previously unknown information and thus serves as an early warning system and analysis tool of scientific innovation.

Horizon scanning may provide information that is highly uncertain or hard to accept. One example of uncertainty is the time required for an unknown immature technology or application to transition to a well-used product. Experiences within the defence domain show that the estimation of when deployment of a technology may occur is often too optimistic. It often takes more time than expected for ideas to mature and be developed to products or services. There is a risk of proposing findings that never will be realized, but the risk of not finding relevant changes may be worse. Some products with great impact on society are likely not detected by the defence community before they have been realized. Horizon scanning is a means to better navigate the future(s).

1.2 The needed horizon scanning process

FOI has previously published horizon scanning studies and reports on horizon scanning methods and processes, often in international or cross-agency collaboration (see e.g. Kindvall et al. 2017, Peters et al. 2019, Schubert 2017, and Wiklundh et al. 2016). There are on-going collaborations with NATO and EDA research groups on foresight, horizon scanning and technology watch. In addition, FOI has a particularly close collaboration with the The Netherlands' organization for applied scientific research (TNO), Defence Research and Development Canada (DRDC), and the UK Defence Science and Technology Laboratory (DSTL) on these topics. A summary of experiences and lessons learned from previous work is found in Lindberg et al. (2020), Appendix 2.

Based on recommendations, findings in the peer-reviewed literature and insights from previous work, a set of demands for the proposed horizon scanning process have been identified:

- **Used in multi-agency context**. The process must enable multi-organizational participation as well as easy handover of results between organizations.
- **Used for varying purposes**. The process must allow both broad, exploratory horizon scanning and in-depth, issue-specific horizon scanning. The horizon scanning process must be flexible to suit different stakeholders' purposes and objectives. The available resources for a horizon scanning activity will vary and are likely to be subject to time constraints.

- **Allow for stakeholder participation**. The participation of and dialogue with stakeholders must be conducted throughout the process. Sense-making together with key stakeholders is essential.
- **Based on a clear methodology**. The process must be easy to use, transparent, and the results need to be traceable, both in general and for scientific scrutiny. The process should allow use of qualitative and quantitative, manual and automated methods. In addition, the process must allow for studies of subjects of different maturity levels.
- **Based on a clear organizational structure**. A horizon scanning activity is regarded as an own entity. A horizon scanning is an independent activity also when it is an action within a project or research program. A dedicated scanning team leads the horizon scanning activity.

1.3 Outline

In the present report, a process for horizon scanning that meets the requirements presented in Section 1.2 is proposed. The process emphasizes sense-making, stakeholder participation and utility focus. The main contribution is the integration of a utilization focused perspective in the horizon scanning process. This will maximize the process usability and the results being used as the basis for further work in strategic planning and policy processes.

The structure of the report is as follows: Chapter 2 presents related work on horizon scanning, challenges with horizon scanning, and aspects on sense-making and utility focused evaluation. Chapter 3 presents the theoretical baseline for the work detailed in this report. A framework to enhance the quality and utility of the results is set forth. The proposition of the combined horizon scanning process and the framework for utility, namely the utility focused horizon scanning process, is described in detail in Chapter 4. Chapter 5 focuses on discussion and conclusions. The concluding appendix presents the first version of the principles for a utility focus.

2 Related work

This chapter presents related work that served as inspiration and guidance when developing the proposed utility focused horizon scanning process. Overall descriptions of horizon scanning, challenges with horizon scanning, and some aspects on sense-making and utility focused evaluation are given.

2.1 Horizon scanning

2.1.1 Definition and objective

There are many definitions and descriptions of horizon scanning. One often-cited definition of horizon scanning is:

> "Horizon scanning is the *systematic* examination of potential (future) problems, threats, opportunities and likely future developments, including those at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues, as well as persistent problems, trends and weak signals." (van Rij 2010b, p. 8)

Horizon scanning is typically conducted in areas outside the own organization's current research programs. (Hines et al. 2018) The horizon scanning time frame usually lies beyond planned activities. It adopts a longer-term orientation to probe novel and emerging issues within a future context. (Amanatidou et al. 2012, European Commission 2019)

Horizon scanning aims to create knowledge and deliver results for research, technology development, and public debate. (Amanatidou et al. 2012, van Rij 2010b) The objectives of horizon scanning vary and include (adapted from Cuhls 2019):

- Monitoring and reviewing developments of importance for the future,
- Deriving new search fields, finding new contexts for current research or research to integrate or follow,
- Building networks within or outside of organizations for shared early warning and knowledge, and
- Providing information to foresight and policy processes.

The value is to challenge presumptions and extend thinking to include and explore novel, short-term and long-term developments of relevance for decisions on future oriented issues. (Rowe et al. 2017)

The goal for horizon scanning is to detect signals and early signs of important developments and changes relevant to stakeholders. A signal may concern any change or novel information, from technology to policy, from basic research to applied research. Horizon scanning involves identifying, exploring and making sense of how these signals or trends may evolve and interconnect. Horizon scanning aims to detect changes at different time horizons. (Government Office for Science 2017, Cuhls 2019) The process should support finding novelty.

Organizations use horizon scanning to be alerted, navigate and broaden perspectives and to systematically analyse developments. Horizon scanning can include analysis, interpretation and prioritization of information, depending on the stakeholder's objectives. (Wintle et al. 2020, Cuhls 2019)

A horizon scanning activity is a structured **process** including for example:

- Exploration, assessment, application (Rowe et al. 2017),
- Dredging, selection, analysis and application (Miles and Saritas 2012),
- Scope, gather inputs, sort/cluster, analyse/prioritize, use (Wintle et al. 2020),
- Find, collect, analyse, frame (work for insights), apply (Hines et al. 2018), and
- Scoping, scanning, interpreting, probing/acting, and feedback/adjusting (Bengtson 2013, presenting the work of Day and Schoemaker 2006).

2.1.2 Organization of horizon scanning

The organizational setup of a horizon scanning process is highly dependent on the own organization, its context and preconditions. (Bengtson 2013) The literature demonstrates heterogeneity in the continuity of horizon scanning, spanning from ad-hoc and occasional activities with a focus on technology, to providing information on a regular basis, e.g., intelligence processes.

Continuous horizon scanning provides information on a regular basis and may over time need systems for handling and storing large amounts of data. Its focus is often on providing correct information about developments and validating or falsifying anticipations on the future(s). Independent and on-demand activities provide information on specific questions and are more likely to involve engaged stakeholders. (Bengtson 2013, and Cuhls et al. 2015)

Organizations may use in-house and dedicated teams for horizon scanning, exchangeable part-time scanning teams, outsource to consultants, or take part in large horizon scanning networks. The analysis of information may be independent of or performed together with stakeholders in decision-making processes. (Bengtson 2013, Choo 1999, Cuhls et al. 2015, Cuhls 2019)

In line with failure factors identified by Lesca and Caron-Fasan (2008), Bengtson (2013) stated that aligning the approach to suit the organizational context is a common attribute for organizations with effective scanning systems.

Schuh et al. (2015) pointed out that informal modes of coordination are applicable to horizon scanning within an organization’s own research and competencies. However, it needs to be systemized for areas outside of own business and competencies.

2.1.3 Roles in horizon scanning activities

Horizon scanning needs interplay between individuals with different roles and the context in which the activity is performed. Learning from and taking into account the organization’s and the individuals’ previous experiences, readiness, capacities and commitment forms a base for how to run a successful activity that interacts constructively with the participants. (Patton 2012)

Based on theory from Cranfield University and Waverley Consultants (2018), a conclusion is that the scanning team is ideally composed of the roles project manager, scanning process facilitators, and scanning methods facilitators. Sometimes, analysts and subject matter experts are part of the team.

Horizon scanning generally engages participants. Participants should, as in a utilization-focused evaluation process, be interested, skilled and credible, positive to interaction and have an open mind. (Patton 2002)

Coates and Coates (2016) defined a stakeholder as somebody affecting or being affected by a technology system. Furthermore, stakeholders approach issues based on what could be called personality (or bias). They can be a) technically and scientifically focused, b) focused on the organization, risk and security concerns, or c) have completely individualistic perspectives.

Patton (2013) used primary intended users to denote those who have a direct, identifiable stake in the process or the results. They may be affected (in their daily work) by the outcome, intend to use the process or the results thereof, or they could make decisions affecting the activity.

In horizon scanning there is a need for expert participation. The need for expertise gradually shifts throughout the process, from technical expertise to expertise on usage and stakeholders' questions. There are several concerns regarding bias when selecting experts. According to Garnett et al. (2016), considerations when deciding on type of expertise depend on the experts' depth and overview of an issue or a domain, their contribution to a heterogeneous group, and their commitment.

The selection of expertise should not be limited to technical competence. Cognitive diversity, meaning people with different modes of processing information and different perspectives, is an aspect to take into account when selecting participants. Heterogeneity is another means to mitigate bias, including background, organization, age and value system. (Garnett et al. 2016)

2.1.4 The horizon scanning approach

The scope or frame of the scanning may be limited to a specific research topic or may include a broad science and technology scanning investigating the macro-environment for (any type of) important signals. The boundaries of the scan, the frame, should be "neither too broad nor too narrow" (Hines et al. 2018). It should be set in relation to the stakeholders' objective, use of results and the scope.

Bengtson (2013) proposed that the diversity of approaches for horizon scanning suggests "scanning systems should be designed to fit the context and information needs of decision makers in a particular organization". However, determining the scope is perhaps not as straightforward as it may seem. Bengtson (2013) suggested that a broad search is necessary in order not to miss any important signals. If the search is too broad, there is a great risk of losing sight of the problem statement and be overwhelmed by the diversity of information. If the focus of the search is too narrow, there is a risk to miss new signals or to search only within known fields. In general, the greater the uncertainty of the studied topic, the broader is the scope it requires.

A key decision for the horizon scanning design is whether to take an exploratory or issue-specific approach. The approach has an impact on the type of results obtained. Horizon scanning can be performed as a broad and shallow search in a wide range of sources. It is then undirected, an (inductive) exploratory scan, to identify novel issues, perspectives and insights about potential developments in the near or distant future. It can also be a more specific, conditioned view, an in-depth and issue-specific scanning on topics already identified. The issue-specific (deductive) scanning aims to collate more information and falsify or strengthen evidence on identified signals and issues. (Choo 1999, Könnölä et al. 2012) The approach has a substantial effect on the choice of sources, methods and results.

The choice between exploratory and issue-specific scanning concerns how wide and deep the scanning should be. Schultz (2006), drawing on Choo (1999), described four approaches to scanning. Touring is a broad and undirected approach. In tracking, a conditioned viewing focuses on change items with known potential relevance. Satisficing means to informally dig deeper into a specific issue and, finally, retrieving is a formal and in-depth search.

Mapping the domain before starting a horizon scanning activity supports identifying already known information. (Hines et al. 2018) The domain map shows the existing knowledge and is a tool to challenge data found later in the scanning. It is also a tool to visualize and decide what information is new to the scanning team, experts or stakeholders. It broadens perspectives before progressing into the exploratory or issue-specific scanning. It categorizes the data into background (known) data and results from the scanning (new). It may also serve as a communication tool to navigate present and future knowledge. Visual and transparent methods and tools, such as domain maps or futures wheels, support communication of horizon scanning results.

Bishop (2009) proposed that scanning teams should be sensitive to changes in awareness of emerging issues. For instance, when an emerging issue shifts from only being known by few and disregarded by many, to becoming public knowledge.

2.1.5 Data sources and collection methods

The choice of data sources and data collection methods depends on the aim of the horizon scanning. According to Choo (1999) there are three alternatives: a) to find information of accuracy and focus in well-structured databases, b) to draw on communication between one or several individuals (domain or technical experts), or c) to find data in the informal grey literature on the internet. Grey literature includes various information sources produced outside traditional (scientific) publishing and distribution channels, and is usually not included in indexing databases.

Types of data sources include peer-reviewed literature that is likely to provide scientifically valid evidence of ongoing research at universities and research and development organizations. In order to find innovative information, sources should not include results more than a few years old. Results could also be found in new types of sources. (Hines et al. 2018) Podcast mining is one example of a new type of web-based source and method for horizon scanning. Welz et al. (2021) distinguished between individual thinkers unbound to organization and those affiliated to a larger umbrella organization, such as a university, institute or media institute, and finally, those affiliated with large public broadcasters such as the BBC.

Social media feeds and public media can be sources for common perceptions on emerging issues and ideas. Patents reveal innovative ideas that may lead to breakthroughs in the future. Some sources provide technical details, whereas others provide information on applications and implementation. (Bishop 2009, Cozzens et al. 2010, Cuhls et al. 2015, Hiltunen 2008, and Mikova and Sokolova 2019) Further, Mikova and Sokolova (2019) proposed using levels of technology maturity as a parameter for selecting sources. In other words, if the interest is novel findings in basic research the typical source is science citation indexes, whereas novel social applications could be found in the public press or on the internet.

Hiltunen (2008) proposed the information life cycle of emerging issues. The life cycle is made up by phases with increasingly higher media coverage and public awareness, starting in idea creation, followed by elite awareness. The life cycle peaks at halfway, when there is government awareness, and starts to decline when it is brought into routine and finally record-keeping. Different sources apply to each phase. Scientific journals and patent applications belong to the initial phase. It can also be noted that organizations of relevance to defence often publish results that can be categorized as grey literature.

Bishop (2009) proposed the same sources, but used the axes Novelty/Quantity and Significance/Selectivity to map the sources. Hiltunen (2008) found that scientists/researchers, futurists, colleagues, academic and scientific journals, and reports from research institutes are good sources for finding weak signals. This may be a changing scene, and here podcasts is an example.

Determining search queries and keywords in automated searches is a delicate task. Often, queries or words are specific, directing scanning to searches on current knowledge and perceptions. The choice of keywords has a direct effect on the inclusion or omission of results (Welz et al. 2021).

Scanning methods include automated text mining on various sources, text analytics by sentiment analysis and machine learning, manual searches by in-house or external experts, Delphi for identification and prioritization, expert opinion, individual and group filtration using classification criteria, peer-review, and meetings with cross-disciplinary horizon scanning groups. (Wintle et al. 2020, Hines et al. 2019) Comparing results from separate horizon scanning activities may reveal previously overlooked issues (van Rij 2010a).

To manage and analyse the overwhelming amount of available information, there is a need for some kind of structured methodology and suitable tool(s). Concepts for data architectures have been proposed (Schuh et al. 2015). Organization aids further work, e.g., web-based tools for selecting and tagging collected data outperform traditional spreadsheets (Hines et al. 2018). Tags may include descriptors such as source, scanner, date, ranking method, and other metadata, such as author affiliation. Metadata associated with the raw data should also be stored. With the rapid evolution of software and automation, it is nowadays easy to create a structure between metadata, the raw information and selected scanning hits. This will aid analysis and help in tracking and tracing data flows and decisions on scanning hits.

Automated tools are continuously developed and enhanced. The AiCE (Autonomous information comprehension engine) is one tool for automated horizon scanning in terms of handling, analysing and presenting large amounts of data. This tool aims to reduce the need for manual text analysis and the information burden on the analysts and scanning team, thus providing them with better support and more time for analysis and assessment of impact (Bongiorno et al. 2020). Another tool is the Horizon scanning tool (HSTOOL) developed by FOI, which is used for discovering trends in scientific literature. Literature is automatically clustered and ranked based on topic and scientific impact (Karasalo and Schubert, 2019a, 2019b).

2.1.6 Selecting scanning hits

The data from the scanning or searches need to be organized and prioritized to support the users in their work to find new information. The subset of data of interest is called scanning hits. Scanning hits provide indications of development or transitions that can affect one or several domain(s). Scanning hits can include basic scientific laboratory results, new scientific theories, product prototypes, elements in the macro-environment, ongoing experiments and applications of research and development, etc. (Rowe et al. 2017).

Criteria are generally used to select and filtrate data. Examples of criteria are estimated potential impact, relevance, novelty, level of innovation, evidence (falsifying or validating hypothesis), plausibility, levels of stakeholder and media interest, policy priority, stage of development, ethical and social issues, and time frame (Hines et al. 2019). The STEEP[1] taxonomy is also suggested for organization and prioritization of data (Schultz 2006, Bengtson 2013).

Methods to select scanning hits can be divided into automated, semi-automated or manual. The general difference is in which ways the experts are involved. Scanning hits can be selected by choosing the most interesting data or by discarding data of less interest (Wintle et al. 2020). Other approaches can be to select hits based on metadata or automatically clustered data. Methodological information should be added when selecting hits, such as the person selecting the hits, method/ranking method used for selection, why a hit is deemed important, and criteria used for assessments.

Scanning hits can be assessed separately as well as in relation to other scanning hits. A scanning hit in the form of a single weak signal can be a sign of future change with potential important consequences. Several (weak) signals can also be aggregated, interact and may together indicate a future change of importance. (NATO 2020a, NATO 2020b, van Rij 2010a) Some results provide newness in both technology and concepts and such novelty is often found by combining alternatives (NATO 2020b). This report recommends studies of combinations when assessing scanning hits.

[1] social, technological, economic, environmental, political

Hits that show disruption are rare. Disruptive hits should indicate that the baseline itself, that is, the world as we know it today, is about to change. Bishop (2009) used the fall of the Soviet Union as an example of a "discontinuous" event that changed the baseline globally.

2.1.7 Analysis and prioritization

The list of scanning hits may be long or short, simple or complex, and the type and order of work assessing the hits may vary. Usually, one individual scanning hit rarely provides enough information pointing towards to a future change. Rather it is more likely that the scanning hits together contribute to the result as indications of a potential change. (Bishop 2009 and Hines et al. 2018) Estimation, assessment and prioritization contribute to reaching this understanding on how scanning hits combine, or mesh, to provide change.

Qualitative methods dominate assessments, and expert participation and consultation are common. The mind-set of those participating in the assessments is crucial, a challenge in horizon scanning discussed in Section 2.2.

The literature points to the necessity of transforming data into information and in some cases even knowledge. This is important in order to make the results understandable for the end-users. In exploratory or broad scanning, (qualitative) interpretation of the findings is particularly important. Issue-specific activities often build evidence and better knowledge of the scanned issue. (Bengtson 2013)

Preferably, the method for selection should be fast and easy to use. To aid the identification of scanning hits, a three-level judgement model is suggested (Hines et al. 2018). The first level in this model is applicable to the selection of scanning hits. The suggestion is to use three criteria to rank scanning hits: confirm, resolve and novelty, with novelty having the highest value. These are similar to the three types of scanning hits proposed by Bishop (2009, p.10): (1) "confirming: a change that indicates that the baseline forecast or hypothesis is more likely, (2) creating: a change that indicates that a new alternative future is more plausible, and (3) disconfirming: a change that makes an alternative future less plausible". Most of the scanning hits are confirming developments that are in line with emerging trends and already expected futures. The types of scanning hits that are of the highest value are the hits that are novel and alter plausible alternatives or challenge mind-sets about the topic.

In analysis and prioritization, impact, relevance, effect, desirability, urgency, etc. are in focus. There is a multitude of criteria and methods to estimate, assess, interpret and prioritize scanning hits and findings. (Amanatidou et al. 2012, Bishop 2009, van Rij 2010a, Hines et al. 2018, and Hines et al. 2019) Which criteria to use and how depends on the aim of the analysis and the chosen method. Common criteria in the literature include impact, novelty, credibility, feasibility, and timelines.

One proposed method to measure, or capture, the subjective interpretations of the horizon scanning material is Osgood's semantic differential scale. It is a rating scale designed to measure the connotative meaning of objects, events and concepts. The connotations are used to measure the semantics or meaning of words, particularly adjectives, and their referent concepts. The scale may be used in conjugation with other assessment methods, such as categorizing future events as continuing trends, new emerging trends, weak signals, wild cards or hype phenomena, followed by quantitative assessment using different criteria. The method results in easily grasped figures. (Hideg et al. 2020)

There is a risk of missing developments that are completely new, those that require long preparation times or those of great relevance but with a slow or uncertain rate of development. One way to detect these developments is to use a criterion called regret. Regret is used to value the importance of something that may, but is uncertain to, occur. The criterion regret may function as an alternative measure to assess urgency (time of impact). When assessing regrets the participants (use emotion to) value the level of their own regret, for instance, if something occurred and no action was taken. This may be effective for issues where current action may be required to mitigate risk although the issue in itself may not seem urgent. (NATO STO 2021)

In some horizon scanning activities, it will be necessary to prioritize between findings. The third level of Bishop's (2009) model includes weighting/scoring of the findings. Although there are descriptions of scoring in the literature suggesting it as being unnecessary for some horizon scanning activities, it may well be necessary to identify the most important results. To assess innovation methodologies presenting results on a two-axis figure, such as value and risk, may be used (Peters et al. 2019). Multi-Criteria-Decision-Analysis is a method to use in such assessment (Ruggeri et al. 2020).

2.1.8 Results of a horizon scanning

The goal of horizon scanning is to provide relevant information that is so new it has not yet been widely reported, is on the margin of current thinking, and that challenges past assumptions. Stakeholder participation in the synthesis, or assessment and the sense-making of information, enhance the implementation of results. (van Rij 2010b) Oral presentations can also enhance the understanding of results and complement information in written reports.

The results from a horizon scanning may vary but ought to show the need for information and indicate development or transition in one or several domains. In practice, results include basic scientific laboratory results, new scientific theories, product prototypes, ongoing experiments and applications of research and development, as well as descriptions of why they are relevant to the organization and the issue.

The exploratory and issue-specific approach of horizon scanning yield different results. The results from an exploratory scanning may be a long list of signals providing hints, i.e., precursors, for emerging issues (Amanatidou et al. 2012). Exploratory scanning provides results that may be a starting point for an issue-specific horizon scanning. A broad approach is to gain an overview of emerging issues and signals in the macro-environment. (Schultz 2006)

The objectivity, quality and reliability of exploratory scanning, which often rely more on qualitative expert based methods, may be questioned. The results are highly dependent on the scanning team and experts' skills. Automatic searches, second opinion sources or information from independent scanning communities can be used to increase objectivity. (Amanatidou et al. 2012, Bishop 2009, and Cuhls et al. 2015)

In contrast to exploratory scanning, issue-specific horizon scanning draws on (one or a few) hypotheses of some proposed emerging issue or known information gap. The signals detected when scanning are used to better understand, modify, strengthen or contradict these hypotheses. Issue-specific horizon scanning is an in-depth scanning providing evidence and in-depth information within well defined domains on narrower topics. (Amanatidou et al. 2012)

2.2 Challenges in horizon scanning

There is extensive literature on scanning approaches, methods and tools. Less is published on successful practical methods and best practices of horizon scanning, although examples exist. However, the literature provides challenges and suggestions on how to improve horizon scanning.

The diversity of organizational setups, alternative methodologies and choices for running a horizon scanning were presented in previous sections. According to van Rij (2010a), and related to the diversity in methodology and aim, issues with horizon scanning activities and methods are:

- How deep or broad to scan,
- How to and who should select and prioritize hits/issues,

- The criteria to be used (and who should develop values and criteria),
- The degree of evidence (how scientifically proven a hit or signal has to be),
- Handling the complexity and unknowns,
- Efficiency of the process and stakeholder involvement.

Several of the challenges presented in literature are internal to the horizon scanning process and organization. That is, the challenges are on issues within the process itself such as the choice of methods, participation of experts, the constitution of the scanning team, and management.

There are also issues that could be referred to as external challenges. These concern how the results and the process of horizon scanning are used in, for example, policy processes. These challenges include results not contributing to organizational knowledge, results that are difficult to incorporate into policy and decision-making, and results where the evidence for the findings may be considered too weak to be of use. (Garnett et al. 2016) It is noted that horizon scanning initiated without attention to the delivery of the results may quickly be forgotten. (Cuhls et al. 2015) Challenges also include that communication of results need to be adapted to different types of actors (government, private sector or academia), taking into account the long-term view (timing of result delivery), and making use of results due to learnt patterns of thinking. (Nehme et al. 2012)

Cuhls (2019) presented learning points that support a successful set-up of horizon scanning activities. Based on recommendations by Cuhls et al. (2015) and own previous work, it was found that a clear organizational structure is one means to achieve utilized results. There is a need for coordination and brokerage with users, regardless of stakeholders' commitment to the process activities. Communication and collective information or knowledge are also essential means for a successful horizon scanning.

Coote (2012) expressed the challenge of perceiving what is actually new, and the mind-set of those working with and receiving the results from the scanning. This is relevant both for the work within the process and in the communication with stakeholders. Horizon scanning may provide unexpected results, and it is generally problematic for such information or ideas to be accepted. The individual level of knowledge, presumptions, and a desire to stay in the comfortable knowledge zone rather than navigating the complexity of the unknown, affect scanning activities. (Hines et al. 2018) Results that are novel to both technology and concepts are the ones that are the least likely to be accepted. These results provides uncertainties for an organization that have to be mitigated.

Lesca and Caron-Fasan (2008) presented factors that put strategic scanning activities at risk of failure and being abandoned. Risk factors include: inappropriate involvement of management or poor management, unclear aims and objectives for the horizon scan, misalignment of the activity with the organization's strategy, insufficient budget, too technical focus of an activity, unqualified people, previous experiences (failures) not taken into account, and complexity.

Furthermore, Lesca and Caron-Fasan found that activities were abandoned when the activity was not supported by management or met their expectations, the activities' objective was to implement an almost exclusive computerized system, there was an urgent need for results and stakeholders were not engaged or interested. Failure of scanning activities can often be attributed to unclear objectives and to participants not being committed to the work (Lesca and Caron-Fasan 2008). The scanning team not only needs to ensure that the results are of use, but the process should also be useful for those who participate in it. (Cuhls et al. 2015, Patton 2012)

If it is not clear how the results should be used, e.g., as input for further activities by the stakeholders, there is a considerable risk that the results are not used, or even misused. Some reasons are information overflow, a weak link between horizon scanning activities and policy, insufficient details being provided, results not being sufficiently based on evidence, and difficulties translating the results into concrete actions (Cuhls et al. 2015).

Other challenges include finding relevant information and dealing with noise, handling uncertainty and unpredictability, and avoiding bias and information overload (Rowe et al. 2017).

Ignorance and bias occur when humans identify and analyse information. There are several types of bias and simply put, they depend on how individuals and groups process and value new information in relation to current knowledge and historical experiences. Bias may occur, for instance, in relation to age, culture, language and profession. (e.g., Jackson, Practical foresight guide (2020)). The works by Hideg et al. (2020) and Provencher et al. (2002) describe how to select experts with heterogeneous background, in order to avoid bias. Although often discussed in relation to human perception and individual bias, the same reasoning also applies to statistical methods.

2.3 Knowledge and sense-making

In horizon scanning, new information is at the centre of work. The participants are familiarized with the information by sense-making. Findings relevant to stakeholders' purpose(s) and questions are found and communicated. This in essence means creating new knowledge by making sense of the information found in the scanning. It also means to challenge individual perceptions, mental maps and assumptions made about the future. (Garnett et al. 2016) Furthermore, deciding why information matters requires an understanding of the context. Transformation of information into knowledge is done in dialogue with others, in a process where the individual perception is challenged and most likely changed in relation to the views of others. (Könnölä et al. 2012) In horizon scanning the useful ideas and results of the future may well be the ones that appear ridiculous (Dator 2018). It is therefore highly advantageous if the stakeholders are present when making sense of the horizon scanning results, since this sense-making process is a means to reach the goal of usefulness.

Eerola and Miles (2011, p. 265), who discussed future-oriented technology analysis, stated the need to consider the context and the individual as a part of the horizon scanning system.

On a similar note, Könnölä et al. (2012) expanded on newness and sense-making "…before something, an idea or object, can be sensed, it has to be constructed". Könnölä et al. 2012 added (p. 223) "… this construction is essentially a collective activity of knowledge creation". They then reasoned on synthesis and collective sense-making, in which groups have to make individual perceptions, and interpretations meet and evolve together with other individuals. In collective sense-making, individual knowledge is challenged and most likely changed. Many, but not all, horizon scanning assessment methods are collective.

Cuhls et al. (2015) reasoned that sense-making is a "socialization of the findings" and that people are needed to transfer and adapt the information to induce learning. It is necessary for sense-making and to familiarize the stakeholders with the results, or engage them more closely in the work, to enhance their use of the results. Failing with sense-making could mean that published information is unused or questioned.

The transfer of the key observations and conclusions from the scanning to the user needs to be clear and structured. (Cuhls et al. 2015) It also needs to be timely. Sense-making and information management must therefore be tailored to support the transition from information to knowledge within the user community. Outputs and outcomes, useable results and used results have to be considered when defining the objectives. (Cuhls et al. 2015, Patton 2012)

2.4 Utilization-focused evaluation

Utilization-focused evaluation focuses on the notion *intended use by the intended users* (Patton 2012, p.4). Patton (2008, p.24) described utilization-focused evaluation as being located between two extremes, where one extreme is an "oversimplified image of analysing evaluation findings then mechanically making instantaneous decisions based on those findings" and the other extreme is "ignoring evaluation findings altogether, or worse, misusing them". This means that an effective, useful, and meaningful evaluation is an activity performed throughout the horizon scanning, actively taking into account how each evaluation step will affect the final use of the results. By following such a procedure, the likelihood of primary intended users and other stakeholders making rash and unfounded interpretations of findings, or simply ignoring the findings altogether due to e.g., doubts regarding their importance, is minimized.

Hence, the activities, methods, and tools used in an evaluation may be chosen in a way that suits the research question/topic – or even on the prerequisites of the participants – as long as each step along the way is aiming towards the evaluation activities' intended use. The evaluation is an interactive process between the intended users and the evaluators. Moreover:

> "A utilization-focused evaluation can include any evaluative purpose (formative, summative, developmental), any kind of data (quantitative, qualitative, mixed), any kind of design (e.g., naturalistic, experimental), and any kind of focus (processes, outcomes, impacts, costs, and cost-benefit, among many possibilities*). Utilization-focused evaluation is a process for making decisions about these issues in collaboration with an identified group of primary users focusing on their intended uses of evaluation.*"
> (Patton 2002, p.1)

Foresight and horizon scanning demonstrate similar approaches (see e.g. Cuhls 2019 and Schuh et al. 2015). The European Commission (2019) has pointed to seven logical phases to use in an iterative foresight approach; feasibility, parameters, scoping, organization, methodology, management, and evaluation. These phases display great similarities with Patton's utilization-focused evaluation.

Applying the utilization-focused evaluation philosophy to horizon scanning is challenging, but it also enables relevance and flexibility. The likelihood of generating meaningful and useful results regardless of stakeholder, purpose, goal and objective increases. Well used, the philosophy provides an efficient process with regard to limited resources, since each step is carefully set to fulfil a certain goal.

On the other hand, if an evaluation or horizon scanning process is not utilization-focused, the risk of side-tracking or just generating meaningless results is disregarded. If so, the horizon scanning is likely to lose both its internal and external validity. The used resources would have been better invested somewhere else.

3 A utility focused process

In this chapter, the fundamentals for the proposed horizon scanning process are presented. The proposed process is outlined and the principles for a utility focused approach are presented. Furthermore, an organization for performing horizon scanning activities is suggested.

3.1 Reference base for the process

The proposed process is strongly influenced by some of the references presented in Chapter 2. The concept of purpose with and how to perform horizon scanning is based on the work by Cuhls (Cuhls et. al 2015, Cuhls 2019), Bengtson (2013), Hines et al. (2018) and van Rij (2010a, 2010b). The recommendations by Cuhls (2019) and Wintle et al. (2020) on how to perform successful horizon scanning were integrated in the proposed process. The idea that stakeholders need to commit to the process is in line with the work by Lesca and Caron-Fasan (2008). The utilization-focused evaluation by Patton (2002, 2012, and 2013) has been adopted by us, since we consider it to be a straightforward approach to combine sense-making and stakeholder commitment.

In Section 2.1.1, common divisions of a horizon scanning activity as suggested in the literature were presented. In addition to the steps "scanning" and "analysis", we suggest adding steps that ideally engages the stakeholders, such as problem statement and design of the horizon scanning activity in the early phase of the activity, and sense-making and interpretation of the results later on. This is done in order to better provide results that suit the intended use for the primary intended users.

Thus, we propose a horizon scanning process consisting of the following four steps:

1. Problem statement and design
2. Scanning
3. Analysis and interpretation
4. Communication of results.

Based on the utilization-focused evaluation of Patton (2002, 2012, and 2013) and reported successful processes, recommendations and failure factors (see e.g. Cuhls et al. 2015, Lesca and Caron-Fasan 2008), as well as the authors' own experience, we develop a set of principles for utility focused horizon[2] scanning process. The principles are presented in Section 3.2 and a detailed checklist can be found in the appendix (Chapter 7).

3.2 Principles for a utility focused horizon scanning process

The horizon scanning process and its activities need to be managed "with careful consideration of how everything that is done, *from beginning to end*, will affect use" (Patton 2012, p.4). The horizon scanning process needs to support the users in interpreting and evaluating results according to their intended use. A set of principles for managing a utility focused horizon scanning is therefore suggested. The principles are based on a checklist for utilization-focused evaluation by Patton (2002, 2012, and 2013). Terms that are considered applicable to horizon scanning are reused, less relevant information was deleted, and details specific to evaluation were added.

[2] Note the modification of name compared to Patton. We prefer to call the principles "utility focused".

Figure 1 shows how these principles apply to the steps in the proposed horizon scanning process. The principles apply to one or several steps in the horizon scanning process. Some of these principles may seem trivial, but coordinating a horizon scanning activity is a complex task and important details are easily forgotten or overlooked.

On an overarching level, the principles for the horizon scanning process are:

A. **Situational analysis.** The use of the horizon scanning is context dependent and is likely to be enhanced by adapting the horizon scanning process to crucial situational factors.
B. **Identify primary purpose.** The goal for the utility focused horizon scanning is the intended use by the primary intended users. It must clearly identify the objectives and purpose of the scanning in order to enhance the use.
C. **Focus and detail the objective.** It should identify and address all high priority objectives and questions.
D. **Horizon scanning design.** The process is adapted to the current situation in order to lead to useful findings and results. It must carefully select activities, methods and criteria to achieve the intended goals.
E. **Data collection.** It should manage the collected data with utility in mind.
F. **Data analysis.** It must organize the analysis to facilitate the final use by the primary intended users.
G. **Facilitate use and sense-making.** Use needs to be facilitated, ideally with the appropriate stakeholders present.
H. **Evaluation and feedback.** A utility focused horizon scanning process should be evaluated by whether the primary intended users used the results of the horizon scanning as intended.

Further details can be found in the Appendix and in Lindberg et al. (2020).

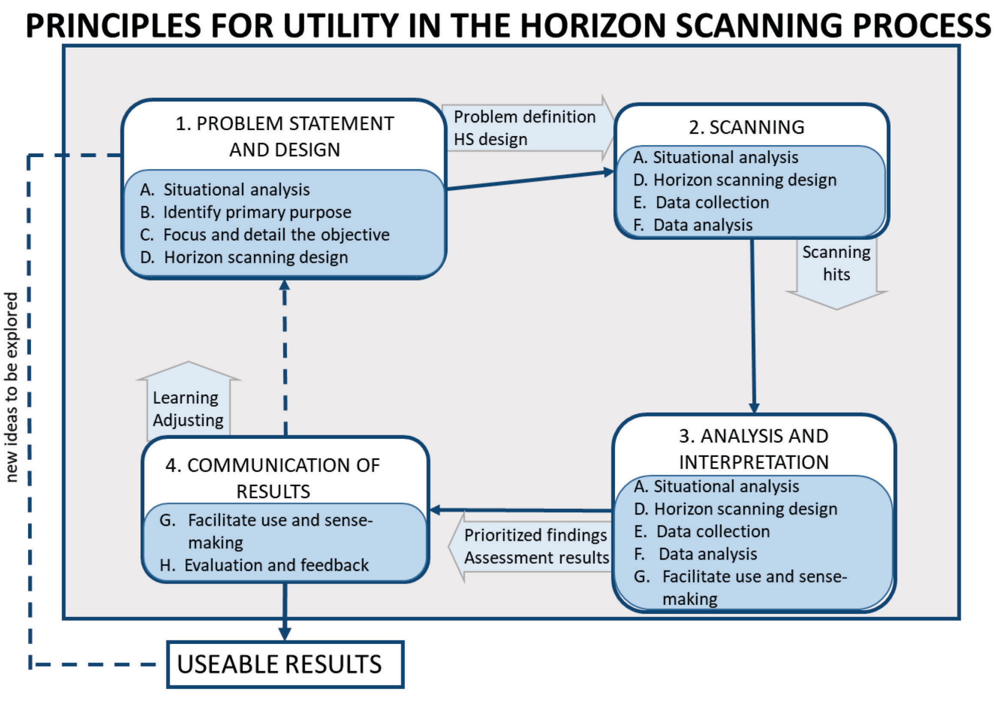

Figure 1. Utility focused principles that guide the horizon scanning process in each step are shown in dark blue boxes. Arrows show output from each step.

3.3 Organization and roles

As pointed out by Schuh et al. (2015) in Section 2.1.2, informal coordination may be sufficient for horizon scanning within an organization, but it needs to be more systematic for areas outside the organization's core competencies or if external experts are used. In this report it is argued that a systematic approach is of great value even within one´s own organization.

A number of roles are needed to execute a horizon scanning process. The two main categories are the *scanning team* and the *stakeholders*. The scanning team is composed of a *project manager*, *scanning process facilitators* and *scanning methods facilitators*. The stakeholders include *clients, primary intended users* and *subject matter experts* or *experts*. The description of roles is rather extensive. However, one individual may have more than one role and it is possible to perform a horizon scanning activity using this process with a team of just a few persons.

The scanning team is in charge of the activity throughout the entire process. The scanning team performs the horizon scanning design, supports the other participants, communicates with stakeholders, and executes the process. All scanning team members should also have at least a general knowledge of the domain (e.g. science and technology or defence) for the subject of the horizon scanning activity.

The project manager leads the scanning team and is responsible for the process. The project manager is also in charge of allocating resources and has the ultimate responsibility for the quality of the end result.

The scanning process facilitators are experts on how to design, perform and communicate a horizon scanning activity. They ensure that the approach, actions and methods match the goals defined for the activity.

The scanning method facilitators are experts on particular methods used in the process.

The clients are the stakeholders directing the activity and the end users of the results. The results are always delivered to the clients.

The primary intended user refers to the stakeholders who will actually use the results from the activity.

Stakeholders participating in the process by providing various types of expertise are called subject matter experts or experts. The domain expertise needed depends on the topic, but may include science and technology, defence and security, military capabilities, user aspects, or economy. Individual participants can represent several of these competencies, and may be found within or outside the own organization.

It is a requirement that the scanning team commits to the entire activity, from initiation to well after the delivery of the results. Moreover, the scanning team needs to support the users in interpreting and evaluating the process and results in line with their intended use. Thus, the stakeholders need to commit to the process as well. Another key issue in the process is a regular dialogue between the scanning team and the stakeholders. Based on experience, face-to-face meetings are important in Steps 1, 3 and 4. The need for expertise gradually shifts throughout the process. For example, the expertise needed to select scanning hits (Step 2) usually differs from the expertise required to assess the extracted signals and draw valid conclusions for the stakeholders (Step 3). Dedicated analysts and expertise on usage and stakeholders' questions are valuable in Step 3.

4 The proposed utility focused horizon scanning process

Figure 2 presents the process and the major actions for each step. The measures and actions taken in each step are the same for both exploratory and issue-specific scanning. However, the methods and tools can vary and need to be adapted to suit the specific task. Continuous documentation on method and findings is key for transparency, traceability and accountability. This report does not guide on specific choices for methods or tools but some are described in Chapter 2. Additional descriptions on methods are found in Kindvall et al. (2017).

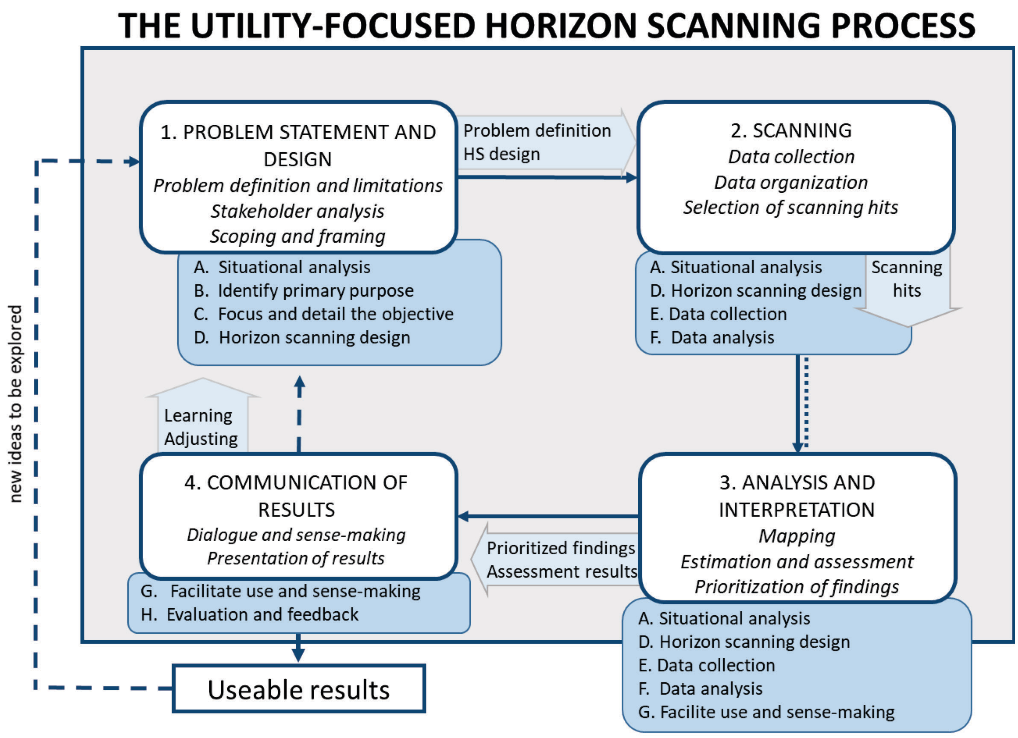

Figure 2. The horizon scanning process with actions (in *italic*) for each step in the process. Utility focused principles are shown in dark blue boxes. Arrows show output from each step.

4.1 Step1. Problem statement and design

Problem statement and design is the first step in every horizon scanning activity. Problem statement is a pre-scanning action of great significance for the result (Wintle et al. 2020), as it directs how, what and why to perform a scanning. The scanning team, the client and the primary intended users need to reach consensus on the purpose of the horizon scanning, their expectations on the outcome of the activity, and the intended use of the results. The design of the horizon scanning activity is outlined to match these intentions, including decisions on approach, topic(s) to scan, and methods and tools to use. As shown in Figure 2, three actions and four utility focused principles (A-D) are used.

Shortcomings in this step are sometimes noticeable at an early stage in the ensuing work or may not become visible until the end of the activity, if at all. One example is premature decisions about what methods and tools to use in the scanning. Step 2 is then initiated without enough consideration of why the scanning is carried out, how to select scanning hits to use in the assessment, or how the results are intended to be used. An equally important shortcoming is the lack of a clear problem definition and understanding of the needs of the primary intended users of the results. This risks providing information that does not correspond with the needs of the client and intended users. If so, invalid results from horizon scanning may be used to guide decision-making and the results risk not being used. Perform the process design with care to avoid such dilemmas.

Principles A-D (see Appendix) guide Step 1. To connect to utility focused evaluation, the scanning team should design and facilitate the process so that the output matches its intended use. Use of the results should be considered from the very beginning to the very end of the horizon scanning process. The transfer of information and implementation of the results need to be considered from the start, as the purpose and objectives have major implications for participants' and stakeholders' engagement. Stakeholders' need for results depends on situational and context dependent factors, internal and external to the own organization. In the utility focused evaluation process, situational analysis is an ongoing activity. (Patton 2012) Identify and manage the unspoken needs/agenda of the stakeholders in this step.

4.1.1 Problem definition and limitations

The problem definition serves the purpose to clarify the interests for the horizon scanning. It sets and documents many of the outputs from the problem statement step and is a result from Step 1. Limitations concern restrictions both regarding the horizon scanning itself (what questions to examine or not), and the context, such as the management plans. Document the limitations as transparently as possible.

4.1.2 Stakeholder analysis

As mentioned in Section 2.2, failed scanning activities are often attributed to unclear objectives and to participants not being committed to the work. The participants' roles need to be clarified. The scanning team not only needs to ensure that the results are of use, but also that all participants should have interest in the outcomes or contribute to the work. Principle A guides the stakeholder analysis (as well as common methods for stakeholder analysis).

The scanning team should also consider how participation in the horizon scanning process contributes to generating knowledge. Principle B supports the work to formulate clear objectives and, as a result, engage stakeholders. However, stakeholders with high stakes, influence or interest may not be able to participate in the process. Liaising with stakeholder communities may be an option if the stakeholders cannot participate, in order to obtain input from the directing parties and primary intended users. The authors' own experiences of horizon scanning have revealed the importance of involving clients and stakeholders with a direct interest in the results.

4.1.3 Scoping and framing

The boundaries of the scan, that is, the frame, should be set in relation to the stakeholders' objective and intended use of results. As presented in Section 2.1.4, there is a delicate balance between performing broad scanning, in order not to miss any important signals, and focused scanning, in order to reduce the risk of losing sight of the problem statement and being overwhelmed by the diversity of information. If the focus of the scanning is too narrow, there is a risk that new signals are missed or that the scanning is only performed within zones of comfort. In general, the greater the uncertainty in an organization or technical environment, the broader the scope is required.

Scoping and framing are used to navigate present and future knowledge. The use of domain maps (Section 2.1.4) is one way to transparently understand and challenge data found in the scanning that is new to oneself, other participants or others. Other visual and transparent methods are mind maps and futures wheels.

Principle C supports the scanning team in framing, ensuring that all high priority questions are included in the problem statement and that the intended uses of the answers are identified in the proposed design. In cases where high priority questions are disregarded, the scanning team should document the reasons for the decision. To support the decision of the width and depth of the scan, the four approaches to scanning described in Section 2.1.4, touring, tracking, satisficing and retrieving, may be used.

Once the formulation of the problem statement and the purpose and intended use of the results have been clearly defined, the scanning team should commence the specific horizon scanning design, including choice of methods and tools. Pointing out the need for a problem definition and the use of utility focused principles aims to avoid some of the challenges reported on in the literature. However, methods and tools may need to be refined throughout the process. Using Principle D, the scanning team constructs a rough design for the process, methods, data sources and criteria.

Table 1 illustrates some of the decisions on approaches and aims of a horizon scanning activity and guides the design decisions on methods and tools. It is a compilation of the presentation in Chapter 2. The alternatives (light blue) are in some cases independent of each other, whilst in other cases there is dependence. It is advantageous if the design, methods and criteria affecting the results are communicated to the stakeholders before work in Step 2 starts.

Table 1. Design decisions. Decisions (dark blue) with alternatives (light blue) when designing a horizon scanning activity.

Scanning and analysis				
Type of horizon scanning	Exploratory horizon scanning		Issue-specific horizon scanning	
Approach	Touring	Tracking	Satisficing	Retrieving
Scanning approach for data collection	Automated methods	Systematic (manual) examination		Expert dialogue
Method to find scanning hits	Select		Delete irrelevant information	
Level of evidence	Low	Medium		High
Analysis on	Individual hits	Relations between hits		Integration of hits
Ambition of analysis and interpretation	Prioritize hits	Estimation	Criteria analysis	Impact assessment
Method for analysis and interpretation	Workshop	Interviews/surveys/questionnaires		Quantitative

4.1.4 Output from Step 1

The problem statement and design step includes identifying and defining the problem that the scanning should address, a stakeholder analysis, scoping and framing the area to be scanned and identifying limitations to the work. The output from this step is a definition of the problem, directions, intended use of results and ways to communicate the results, as well as the setup for the horizon scanning process, suggested methods, tools and criteria.

4.2 Step 2. Scanning

In the scanning step, data is collected, organized and selected with the goal to find the scanning hits that will be further analysed. A vast amount of data is collected in this step, but only the scanning hits are carried forward to Step 3. In order to handle the large, sometimes overwhelming, amounts of data, Coote (2012) noted that scanning is not the same as reading; it is rather a skimming process (p.109). Thus, scanning focuses on a quick selection of hits.

It is preferable to set the systems to store, organize and categorize data before scanning, making collected and refined data accessible for further use. Visual representation may support this. Software support is essential, and it is advantageous if the storage system allows for tagging and sorting data. Principles A, D, E and F guide the design.

The sources scanned should not be too restricted in time horizon or technology readiness levels/maturity. The time required for technologies or scientific findings to mature to products and services that enter the market vary between research and application area.

4.2.1 Data collection

The choice of sources for data collection depends on the aim of the horizon scanning. There are three broad categories of data collection methods: automated methods, systematic (manual) examination, and expert dialogue (Table 1). Automated methods dominate in data collection, but systematic manual examination and expert dialogue are also useful in combination with automated approaches. In Section 2.1.5 there are further details on data collection and data sources.

4.2.2 Data organization

Collected data must be systematically structured and stored. It is necessary to apply transparency and traceability to be able to backtrack analysis and interpretations during and after the horizon scanning activity. Modes to store data include separate data files, databases and wikis. To obtain transparency and traceability the data needs to be stored and organized in a way that allows for systematic retrieval of the information at a later date. Thus, in order to collect information and manage the available information, a structured methodology and suitable tool(s) are needed. The system for storing and organizing data affects the selection of scanning hits.

4.2.3 Selection of scanning hits

Scanning hits provide an indication of development or transitions that can affect one or several domain(s). It is common practice to use some kind of predefined criteria for selecting and assessing scanning hits. The methods and criteria used are however specific to each horizon scanning activity. Some useful approaches described in the literature are presented in Sections 2.1.6-2.1.7.

4.2.4 Output from Step 2

The output from Step 2 is a list of scanning hits including metadata, documentation on selection methods, limitations and criteria. The documentation is needed for transparency and traceability of scanning hits and to enable revisiting the data and judgments. The work is iterative in nature and often includes several scannings. The recommendation is to iterate between Step 2 and Step 3.

4.3 Step 3. Analysis and Interpretation

Step 3 involves analysing and interpreting the scanning hits to produce findings. A finding denotes a result from analysing and interpreting one or several scanning hits and may concern emerging issues, signals, etc., as well as an interpretation in relation to the stakeholder's objectives. Actions include mapping new information and the use of criteria to estimate, assess and prioritize the scanning hits. The level of ambition may vary. A low ambition level could include ranking and quickly analysing individual scanning hits, while a high ambition level may include extensive assessment, sense-making and interpretation. Regardless of the ambition level of the analysis, the horizon scanning process relies on criteria and methods for processing the information in a structured and transparent way. Facilitation and sense-making are at the very centre of the collective work in Step 3 and utility focused Principles A, D, E-G supports the work.

The authors' experience is that there is a close connection between Step 1 and the criteria used in the analysis and interpretation in Step 3. Depending on the scanning hits, the criteria and methods in the horizon scanning design set in Step 1 may need to be adjusted in Step 3.

4.3.1 Mapping

In this step, the domain map (Section 2.1.4) supports separating background data from scanning results. The domain map, created in Step 1 based on current knowledge, supports clarification of the information's novelty when scanning hits and ideas are compared with the pre-existing knowledge laid out in the domain map. Adding information to the domain map also supports linking information and building new understanding. If comparing results from separate horizon scanning activities, previously overlooked issues may be revealed. The domain map may generate new insights.

4.3.2 Estimation and assessment

Analysis and interpretation of the scanning hits provide results (findings) for the client and primary intended users. It includes assessing the relevance of the information/findings in relation to the questions in the problem statement and design (output from Step 1). It also includes to interpret which findings were found to be relevant and why. Careful analysis is also a means to avoid presenting too many or irrelevant signals and results to the client and the primary intended users.

To estimate value and assess the information qualitative and/or quantitative methods are used. In exploratory or broad scanning, (qualitative) interpretation of the findings is particularly important. Issue-specific activities often build evidence and better knowledge of the scanned issue. (Bengtson 2013) The literature provides a vast amount of criteria for estimation and/or assessment; some are presented in Section 2.1.7.

In estimation, the believed value of individual or combined scanning hits in relation to criteria is proposed. This value should be regarded as an opinion, formed after some consideration, by experienced subject matter experts and stakeholders.

Assessment of scanning hits can be done separately or in relation to other scanning hits. As noted in the literature (Section 2.1.7), novel results are often found by combining scanning hits. This report recommends the analysis to include combinations of hits.

An assessment is to decide the importance of something. The assessment should consider and appropriately include the purpose and objective of stakeholders.

4.3.3 Prioritization of findings

Meeting the purpose and objectives of the horizon scanning activity is the highest priority. Referring back to criteria on timelines, such as urgency (time to impact) and on feasibility, findings that are likely to create disruption in the near future should be given more attention in communication. This includes findings where a change is likely to occur in the near future, even if little can be done to prepare for, change, or hinder the development or transition. Such results are urgent and need instant communication, although they may be of low priority for long-term forward-looking activities. Accordingly, if the change is expected to occur in the distant future and no urgent action is needed, the topic can be monitored at regular intervals.

Weighting or scoring findings by, for example, multi-criteria methods is one way to prioritize findings (Section 2.1.7). Weighting of findings has two goals; to clarify the results to the participants in the horizon scanning and to enable effective communication. In the work of weighting findings, participants explain and discuss the importance of the finding in relation to each other or pre-defined criteria. Prioritization therefore makes individual interpretations of findings explicit, which clarifies the results. Considering the challenges of communicating results and recommendations, only the most important results should be presented to the clients and the primary intended users.

4.3.4 Output from Step 3

The output from Step 3 includes the findings, an updated domain map, and answers to the questions formulated in Step 1. Before finalizing this step, it needs to be considered if the results in Step 3 are satisfying or if there is need for one more iteration.

4.4 Step 4: Communication of results

Communication of the results is the final step in the horizon scanning process. Results are both internal and external. External communication and reporting in line with the problem definition made in Step 1 is provided to the stakeholders. In this step, the scanning team communicates and discusses the results by meeting stakeholders. The reporting should fit the needs of the primary intended users.

4.4.1 Dialogue and sense-making

Ensuring that the scanning output will come to the intended use is a critical part of communicating the results, see Principle G and references in Sections 2.3-2.4. Sense-making and information management have to be tailor-made to support the transition of information into knowledge within the intended user community. Thus, they have to be involved in the process. The importance of translating results into a language stakeholders are accustomed to and deliver results to the right people at the right point in time is emphasized. Based on own experiences and the notions of information and knowledge by Snowden (2020), it can be noted that delivering results at the right point in time is a delicate issue. Efficient translation of results requires that the brokers of information are familiar with the stakeholders' knowledge, language and narrative.

In other words, the findings should be presented so that it is clear how they can be used and how they should be interpreted. See Section 2.3 and the pitfalls described by Cuhls et al. (2015).

4.4.2 Presentation of results

Results from horizon scanning are often controversial, uncertain or speculative, and may involve topics outside core competencies. Results that challenge current mind-sets regarding technology and the use thereof (concepts) are hard to communicate. Presentations and communication of results therefore need to take into account the receivers' interests. Understanding stakeholders' expertise, what they can make from information, comprehend and make sense of is critical for communication.

As illustrated in Section 2.2, one challenge with horizon scanning is that when the results are finalized, the stakeholders may have forgotten what questions they asked. Applying Principle G mitigates this risk.

The results must provide relevant information on the scanned topic and clearly refer to user needs. The recommendation is to present results both orally and in writing. Meetings allow for sense-making by dialogue and continued interpretations of the results.

4.4.3 Output from Step 4

Communication of the results is the final step in the horizon scanning process. Usually, results are delivered to the stakeholders in the format of a report and an oral presentation that include the findings, answers to client questions as well as a description of the methodology and the process used. Internal reporting includes documenting and storing the collected and processed data, documenting the use of methods, and writing reports.

Finally, work on evaluation of the horizon scanning design, how results were used by the intended users and lessons learnt are also reported. It is proposed to make use of and learn from the horizon scanning process, both intra-process learning and inter-process learning. Principle H supports the work. Intra-process learning includes learning, feedback and adjustment of the process, the organization, and the methods used within the scanning organization. Inter-process learning includes transferring results to stakeholders and making the results of use in their processes. Evaluation of the utility and effect of results in these processes provides input for improving the horizon scanning process as well as proposing additional horizon scanning topics. This evaluation can only be conducted sometime after horizon scanning results have been delivered and communicated with the primary intended user and client. This is a reason to report on lessons learnt separately. These findings are not yet available at the time of communicating the results from the horizon scanning.

5 Discussion and conclusions

5.1 Discussion

This report presents a process for horizon scanning and principles for increasing utility and use of results. It also presents the underlying theory and discusses the context and issues that should be addressed when working on the complex issue of exploring the future. The speed and diversity of technological changes combined with the uncertainties of the future are key factors in horizon scanning. This context of plentiful information, uncertainty and complexity is challenging for the human mind. Facilitation by a dedicated scanning team supports use and application of available data, including the new and controversial one. Analysis of complex issues and generation of new ideas requires interaction with human minds. Therefore, this report discuss engagement and commitment by the participants, sense-making, organizational dependencies and common pitfalls.

The proposed process supports systematic studies of science and technological development of importance to Swedish defence. The process is not bound to long or short time frames or specific technology readiness levels, but rather aims at finding relevant information on the unknowns not covered by current research and development programs. Furthermore, the process is developed to support multi-agency collaboration, involving stakeholders, primary intended users and various subject matter experts.

The utility focused principles intends to improve the design of horizon scanning activities, improve usefulness, and use of the results. They aim to overcome some of the challenges frequently connected with horizon scanning, such as:

- Not defining or forgetting the objective of the scan, i.e., the client's and primary intended user's needs.
- Searching the known and current research without collecting data and analysing the unknown.
- Being confused by the data and navigating back into the familiar comfort zone.
- Forgetting that something new actually can be a combination of scanning hits or findings.
- Results being left untouched rather than being used.

In this report, a utility focused horizon scanning process is considered as a fundamental shift of focus: from the results and the outcomes, such as information in a report, to why and how that information will matter in further work.

The proposed process can be criticized for being too ambitious. It is not a simple protocol, neither is it an instruction manual. Instead, it is a theoretical framework that can be used as guidance. In general, the ambition, purposes, constraints and need for details vary between horizon scanning activities. Therefore, the scanning team ensures that the specific approach, actions, methods and tools of the horizon scanning process are adapted. There is a risk that actions, organization and the process will be over-implemented and thus reduce time for creative discussions and reflections. The utility focused principles aim to avoid pitfalls. An important insight is that care and effort during the initial design and management of the horizon scanning activity are keys to reach the goal to provide useable results. Therefore, Steps 1 and 4, and to some extent Step 3, which are sometimes excluded from processes for horizon scanning, are included in the proposed process.

Another criticism may be that the process allows for wider scopes than pure science and technology issues, and risks being too unspecific. The process is based on literature on horizon scanning, rather than technology scanning. It allows to produce rather crude technical results as well as results to be included in decision- and policymaking processes as this is one stakeholder objective. As pointed out by Cuhls (2019), the perceived opinion of what type of results is possible to use in strategic processes vary in the literature. Some authors propose pure technical descriptions, whereas others favour sense-making and insightful explanations. In this report, it is argued that these opinions may depend on: a) a deliberate choice to focus on the scanning team's core capability, i.e., the ability to provide information on data and scanning hits, b) the (lack of) insight into policy processes to which the horizon scanning team delivers the results and finally, c) to ignore the considerations of output and outcome. The utility focused process aims to support the use of results also in policy. In cases where the results are limited to proposing information on scanning hits and collected data it must be made clear to the stakeholders.

One limitation of the developed process is that it is mainly based on peer-reviewed literature. Challenges, good examples and lessons learned found in the literature are used. However, guides on how to apply horizon scanning in government organizations are usually found in grey literature. Some grey literature and books are included, but were not systematically investigated in our work.

The process clearly encourages stakeholder participation. There is a risk that some stakeholders will take over the activity in a way that unintendedly changes the problem statement. The scanning team must balance stakeholder participation with a structured and transparent process. Participation is confined to certain actions or types of work, in which dialogue and expert opinion is needed.

As mentioned above, the proposed process is a theoretical framework that can be used as guidance. From now on, the proposed process will be tested in real horizon scanning activities, both internally at FOI and in multi-agency collaborations. It will be further developed based on the feedback and learning (last part of Step 4). In addition, the analysis of good examples of applying horizon scanning within organizations will continue. In future work user-friendly guides specific for internal and external use and/or purpose will be developed.

Finally, quantitative and automated methods play significant roles in horizon scanning, and their importance will probably increase with developments of artificial intelligence algorithms. This development will be monitored.

5.2 Conclusions

This report proposes a utility focused horizon scanning process for use in multi-agency collaborations. Based on peer-reviewed literature, it describes how to initiate, set up, collect, analyse, interpret, document, report, and communicate information and results when using this process. The process is flexible and can be designed to suit different purposes and ambitions of the collaborating agencies. The principles for a utility focused process and the actions in each step provide a systematic, flexible, traceable and transparent way to work. Collective sense-making of findings is viewed as a key for success.

The process is general and rather ambitious. It adheres to the directions and requirements given when starting the horizon scanning activity. As the purpose and objectives of individual horizon scanning activities vary, the process must be adapted to the ambition and actions of each individual activity. The process can be used both for identifying scanning hits based on collected data and for providing interpreted findings for strategic foresight and policy processes. It is our hope that by applying the utility focused principles, some of the risks and challenges with horizon scanning frequently reported in literature are addressed and mitigated.

Throughout the process, commitment from scanning team members is required and commitment from stakeholders and other participants is identified as an important means to achieve the objectives. Finally, horizon scanning means taking risks, as searching for the new and unknown means leaving the familiar comfort zone.

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7 Appendix: Principles for a utility focused horizon scanning process

The table below presents a first version of a detailed checklist of utility focused principles. The background of the list is described in Section 3.2.

Table 2. Detailed checklist of principles for a utility focused horizon scanning process

A. Situational analysis

The use of the horizon scanning is context dependent and is likely to be enhanced by adapting the horizon scanning process to crucial situational factors.

- Understand the strategic or political context for the activity.
- Identify and engage the primary stakeholders, including the primary intended users.
- Consider the readiness for and previous experiences of horizon scanning (positive as well as negative) within the scanning team as well as the stakeholders.
- Clarify timelines and available resources (e.g., staff and financing).
- Continuously assess the commitment of the organization.
- Update the situational analysis throughout the process and communicate it to the stakeholders. Be particularly aware of decisions and deadlines that affect the use.

B. Identify primary purpose

The goal for the utility focused horizon scanning is the intended use by the primary intended users. It must clearly identify the purpose of the scanning in order to enhance the use.

- Clarify the purpose and identify the objective(s) of the horizon scanning and the use of the results.
- If the horizon scanning is not a (completely) stand-alone activity, consider how the horizon scanning contributes to the objectives of the main project of which it is a part.
- Consider how the process and results contribute to generating knowledge.

C. Focus and detail the objective

It should identify and address all high priority objectives and questions.

- Given the objectives, identify all high priority questions.
- Ensure that all high priority questions (or issues or topics) are addressed.
- Clarify and document why other (high priority) questions are not addressed.
- Communicate the derived focus of the horizon scanning to the stakeholders.

D. Horizon scanning design

The process is adapted to the current situation in order to lead to useful findings and results. It must carefully select activities, methods and criteria to achieve the intended goals.

- Make use of prior experiences of horizon scanning.
- Focus the process and adapt the horizon scanning design as the process unfolds.
- Assure that the design provides traceability, transparency and accountability.
- Test setups and assure that the results obtained can be used as intended.
- Assure that the proposed methods are feasible, cost-effective and ethical.
- Assure that results obtained by the methods selected are reasonable, credible, valid, and understandable to the primary intended users.
- Include evaluation and lessons-learnt for each step.

E. Data collection

It should manage the collected data with utility in mind.

- Consider utility when organizing the data collection (both the final use of the primary intended users and the internal use during the process).
- Engage experts relevant for the data collection.
- Inform the primary intended users of important interim findings.

F. Data analysis

It must organize the analysis to facilitate the final use by the primary intended users.

- Examine the findings and their implications from various perspectives.
- Organize and present data so that they are understandable and relevant to the participants and/or primary intended users.
- Actively involve and support users in interpreting findings and generating recommendations.

G. Facilitate use and sense-making

Use needs to be facilitated, ideally with the appropriate stakeholders present.

- Ensure that the appropriate stakeholders and experts are represented in the work and clarify the consequences if they are absent.
- Work together with the primary intended users to exploit the findings and learnings from the process.
- Decide on dissemination and exploitation mechanisms to support the intended use.
- Identify potential risks for misunderstanding or unintended confusion.
- If possible, stay involved beyond formal reporting, and engages in follow-up facilitation.

H. Evaluation and feedback

A utility focused horizon scanning process should be evaluated by whether the primary intended users used the results of the horizon scanning as intended.

- Evaluate the intended use by the primary intended users, by trying to determine the extent of the end use of the results.
- Assess the extent to which additional uses or users were served beyond those initially targeted.
- Learn from any identified misunderstanding or unintended confusion during the horizon scanning.
- Evaluate the process design and performance in relation to the results.

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