

Improving supplier selection process in a Finnish nuclear new build project.

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<p>In the case organization, current supplier selection and approval process has initially been developed to serve nuclear power plant's design and construction phases. During those phases the plant supplier covers most of the technical and commercial risks. This thesis focuses on the upcoming nuclear power plant's commissioning and operating phases, with target to improve the supplier approval process and methods used for selection of direct contract partners. For direct contracting, enhanced focus has to be put on the thorough risk assessment of supplier candidates.</p> <p>In this research work I applied qualitative research methodologies and followed the case study approach. At first, I analysed the case organization's current supplier approval process properly to formulate the starting point for development work. Then by literature review I obtained information about the best practices for selection of suppliers. By interviewing case organization's experts, I gained in-depth knowledge about what was working well and what could be improved in the current process. These interviews turned out to be very valuable for the development work, as I received versatile insights from the experts working in several departments. Each of them having unique perspective and knowledge on the supplier selection and approval practices.</p> <p>As an outcome of my research work, I provided new process model for the selection and approval of suppliers. This included creation of three new templates to support this new process. I developed Supplier questionnaire -template to standardize the information collection from supplier candidates. Also, the grading of suppliers was totally renewed because former way of grading was not supporting the supplier assessment from the beginning of the process. Moreover, the former grading method was considered to be confusing by users. As a third template, I generated new Supplier approval -template which compiles the supplier assessment information for easy decision making.</p> <p>To validate the outcomes of this research, I organized a focus group. This focus group consisted of the interviewed experts and case organization's thesis supervisor. Via open group discussion I was able to collect feedback from the experts, and finetune the proposed new process model and templates, before handover to the case organization for implementation.</p>	
Keywords Supplier selection, supplier approval, supplier questionnaire, risk assessment, grading	

Contents

Abbreviations.....	iii
1 Introduction	1
2 Objectives and scope	2
3 Case organization and operating environment	4
3.1 Regulatory framework.....	4
3.2 Hanhikivi 1 -project phases	5
4 Methods	7
4.1 Case study.....	8
4.2 Document analysis.....	8
4.3 Observations.....	9
4.4 Semi-structured interviews	10
4.5 Benchmarking	11
4.6 Process mapping	12
4.7 Focus group.....	12
5 Current supplier approval procedures	14
6 Literature review on Supplier selection and approval	18
6.1 Supplier selection.....	18
6.2 Supplier selection criteria	20
6.3 Supplier questionnaire	22
6.4 Risk assessment.....	23
6.5 Graded approach	24
6.6 Quality assurance	25
6.7 Approved suppliers list.....	26
6.8 Conceptual framework	26
7 Theme interviews	28
7.1 Need for process update.....	28
7.2 Findings regarding current process.....	28
7.3 Risk analysis.....	30
7.4 Supplier questionnaire	31
7.5 Proposals to new process	31
7.6 Other improvement proposals	33
8 Developing the supplier selection and approval procedures.....	34
8.1 Process model	34
8.2 Supplier questionnaire	35
8.3 Supplier grading.....	36
8.4 Risk assessment in supplier selection.....	36

8.5 Supplier approval template.....	38
9 Evaluation by focus group	39
10 Conclusions	41
References	43
Attachments.....	1
Appendix 1. Interview guide for case organization’s experts	1
Appendix 2. Interview guide for benchmarking	3
Appendix 3. Interview results mind mapping	5
Appendix 4. Process Model.....	6
Appendix 5. Supplier questionnaire	7
Appendix 6. Supplier grading matrix.....	12
Appendix 7. Supplier approval template	14
Appendix 8. Thesis research work presentation to focus group.....	15

Abbreviations

ASL	Approved suppliers list
CAP	Corrective action plan
CRP	Contract responsible person
EPC	Contract for engineering, procurement and construction
FH1	Fennovoima's Hanhikivi 1 project
FMS	Fennovoima Management System
FV	Fennovoima Oy
IAEA	International Atomic Energy Agency
IMS	Integrated Management System
ISO	International Organization for Standardization
NDA	Non-disclosure agreement
NPP	Nuclear power plant
PRP	Purchase responsible person
RFI	Request for information
RFP	Request for proposal
RFQ	Request for quotation
SCM	Supply Chain Management -unit
STUK	Finnish Radiation and Nuclear Safety Authority
YVL	Regulatory Guides on nuclear safety and security

1 Introduction

In this research work, purpose is to develop case organization's current process and practices for selection and approval of suppliers. Case organization is a Finnish nuclear energy company. Selection of suppliers plays crucial role in overall success of the company's performance. High-quality supply chain performance is one of the company targets, and careful supplier selection supports achieving this target. The process for assessment and approval of suppliers has to be planned well, considering several risk aspects to ensure successful supplier performance. Expected outcomes of this research work, are improved process model and new templates for the selection, assessment and approval of direct contract partners.

Need for this research work is due to two major upcoming changes which are natural in large projects. The first change relates to the Fennovoima's Hanhikivi 1 (FH1) project's progress. Current supplier approval process is focusing on the design and construction of the nuclear power plant, and management of the EPC (contract for engineering, procurement and construction) supplier's supply chain. This new process will focus on commissioning and operating phases, with concentration on direct suppliers. Aim is at having more thorough risk assessment embedded to the supplier selection and approval process. Enhanced risk assessment is required when the plant supplier is no longer covering technical and commercial risks. Second major change relates to the phase when company starts preparing for the operation of the power plant. Organizational change is anticipated with integration of Supply Chain Management (SCM) -unit into Procurement functions (Figure 1). Currently, supplier approval process is owned by the SCM-unit, while supplier selection, for instance long listing of supplier candidates, is part of procurement process.

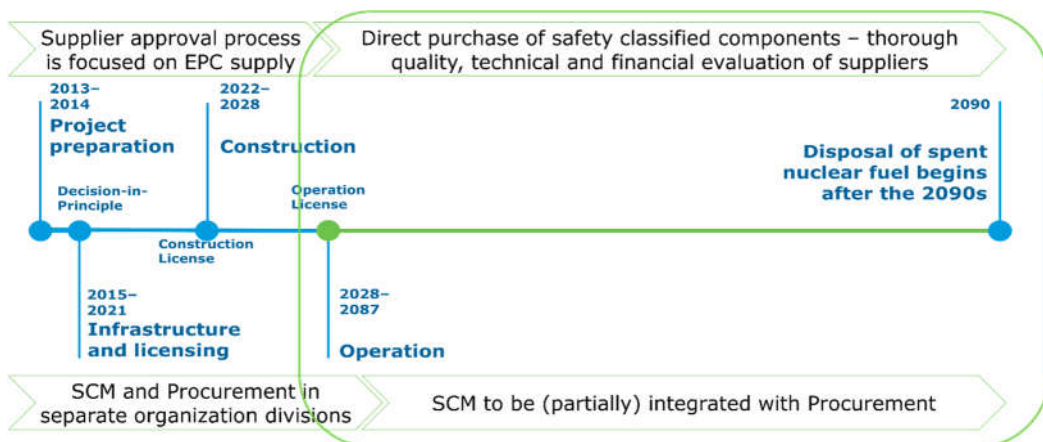


Figure 1. Thesis focus on the direct suppliers during commissioning and operation

2 Objectives and scope

Current supplier assessment process is based on the EPC contract signed with the plant supplier. According to this EPC contract, Fennovoima shall assess and approve all safety related and major sub-suppliers. However, plant supplier covers most of the commercial and technical risks related to its supply chain. By this research work, I aim at providing new supplier assessment methods for the case organization, with focus on the assessment of direct contract partners. Renewal of the process is needed to ensure well-functioning supply chain for high-quality commissioning works and safe operation of the nuclear power plant. It is essential to establish holistic measures to prevent having counterfeit or fraudulent items in the power plant. In this research work, focus is on finding effective and most suitable methods and process model for the case organization to conduct its supplier selection and approval. At first, I will analyse the case organization's current methods and practices for the selection, assessment and approval of suppliers. Then via literature review, expert interviews and process mapping, I will identify weak areas and ways to develop those practices. Focus is at finding ways to improve case organization's management system related to the selection and approval of suppliers.

In this research, primary objective is to find out what kind of methods and what kind of process would be most optimal for the case organization to conduct its supplier selection and approval. Supporting sub-questions guiding the research work focus on

- how case organization is currently assessing its suppliers,
- what are the possible weaknesses in the current process,
- what kind of selection and approval criteria for suppliers is recommended by literature and
- what kind of selection process could cover risks associated with supplier approval.

To find answers to these research questions, I will review the case organization's current supplier selection procedures and pursue to identify improvement areas. From literature review I will analyse what criteria should be set for selection of suppliers and how the approval of sub-suppliers is recommended to be performed by the authors. Then via several expert interviews I will collect insights related to the current process and practices. Based on all this information, gaps between the best practices and current management system can be identified. As an expected outcome, this research will provide harmonized supplier selection criteria and transparent supplier approval process. Research outcomes are evaluated by focus group which consists of several case organization's experts.

To ensure successful management and control over the supplier base and its deliveries, it is necessary to establish holistic processes and working methods for the management of the entire supply chain during the whole life span of the project and operation of the nuclear power plant. This supply chain management starts from the thorough assessment of the supplier candidates. Purpose of careful supplier assessment is to find qualified suppliers who are capable to fulfil strict quality requirements set for the suppliers' and for their deliverables. Supplier assessment is also one method to prevent having counterfeit items entering the nuclear power plant. During the licensing and construction phase case organization evaluates two types of supplier candidates. On one hand, candidate may belong to the EPC supply chain, being plant supplier's sub-supplier. On the other hand, supplier candidate may be evaluated as becoming a direct contract partner. At the current licensing phase of the project, most sub-suppliers belong to the EPC supply chain, meaning that the financial and technical risks are carried by the plant supplier. This research concentrates on upcoming project phases, when the portion of direct purchases will increase, e.g. supply of spare parts directly from the original equipment manufacturers or supply of maintenance service during annual outages. Already during the commissioning phase, case organization's supplier approval process shall include thorough risk evaluation. In this research, focus is on the direct suppliers with full scale risk evaluation as part of the supplier assessment process.

Considering the long lifespan of the FH1 project, implementation of the new supplier approval process will not be performed during this research work. This thesis will not cover any quality control methods such as inspections and test plans, nor investigation of supplier audit procedures. Moreover, I will not analyse or identify any potential software or Information Management solutions for data handling to manage supply chains. This research focuses on supplier selection and approval process, starting from the identification of a need for purchase, until having a supplier on the approved suppliers list (ASL). Also considering some quality assurance aspects, such as auditing as supporting tool for supplier assessment. Research excludes commercial bid evaluation.

3 Case organization and operating environment

Before analysing best practices and improvements to supplier selection and approval process, it is important to get an understanding of the case organization and its operating environment. Case organization, Fennovoima Oy, will construct Hanhikivi 1 nuclear power plant at Pyhäjoki, Finland. In 2013 Fennovoima signed an EPC contract with Russian State Corporation Rosatom’s subsidiary Rusatom Overseas (Fennovoima 2020). In 2015 this contract was transferred to Rosatom’s Finnish subsidiary RAOS Project Oy. The plant supplier, RAOS Project Oy, shall provide and manage the engineering, procurement and construction of the nuclear power plant. RAOS Project Oy will be responsible for all operations relating to the design, licensing, construction, and commissioning of the power plant, as well as the associated project management. (Fennovoima 2020.) Main FH1 project participants are presented in Figure 2.

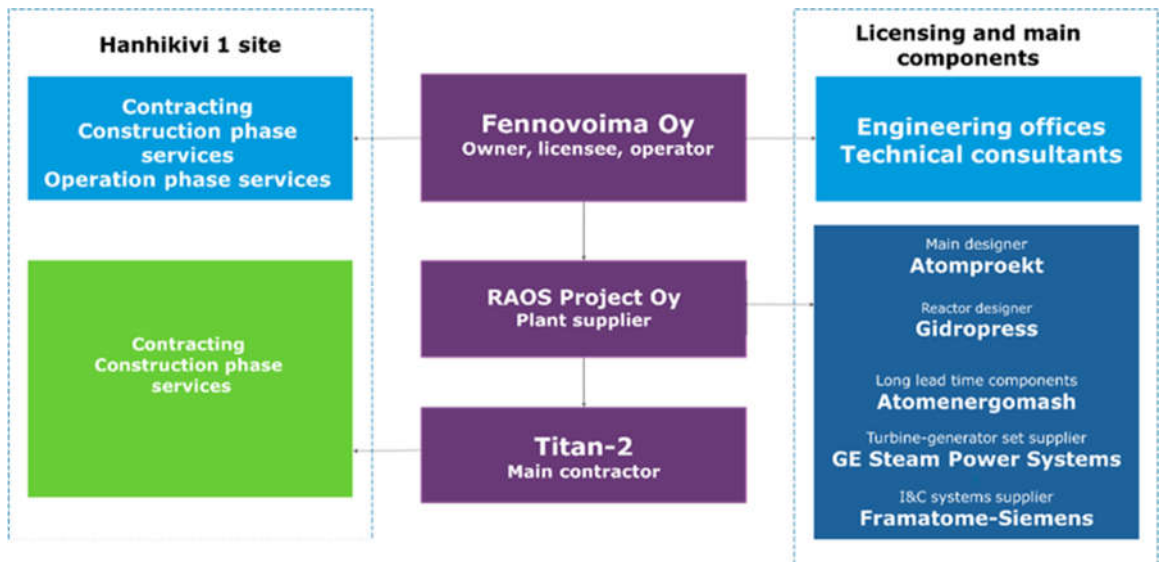


Figure 2. Main FH1 Project participants (Fennovoima 2020.)

3.1 Regulatory framework

Construction and operation of a nuclear power plant is highly regulated by the International Atomic Energy Agency (IAEA). In Finland, the Radiation and Nuclear Safety Authority (STUK) is responsible for the supervision of safe use of nuclear energy (Nuclear Energy Act 1987). Fennovoima as the future holder of the nuclear facility’s construction license shall ensure during construction that the nuclear facility is constructed and implemented in conformity with the safety requirements and using approved plans and procedures. (YVL A.5 2019.) The safe use of nuclear energy can only be assured by the high-quality performance of selected suppliers and by consideration of safety aspects

during the design, manufacturing, construction and commissioning works. Thus, careful assessment of suppliers is crucial phase in ensuring the safe construction and operation of the nuclear power plant.

In late 2018 Fennovoima launched a development program to ensure the progress of the Hanhikivi 1 power plant project in accordance with the new timetable estimate. The development program's main goals are to ensure the safe plant and high-level safety planning, construction readiness by Fennovoima and main suppliers, and integrity of the technical design, high-quality implementation and supply chain performance, operational readiness and a strong safety culture. (Fennovoima 2019.)

These set goals cannot be achieved without well-functioning supply chain and high-quality implementation of the approved procedures by the selected suppliers. Thorough supplier assessment is essential to ensure the safety of the constructions works and safe operation of the future nuclear power plant. Supply chain readiness is one of the key factors in ensuring high-quality construction of the plant. The competence, resources and quality management of all suppliers involved in the construction and manufacturing of plant systems, structures and components are evaluated considering the safety impact of the scope of works. All suppliers must have a good understanding of the nuclear power plant's safety requirements and the Finnish quality requirements and construction procedures. (Fennovoima 2020.)

It is also essential to keep in mind that without well performing supply chain Fennovoima will not be able to obtain all the necessary nuclear licenses and conventional permits for the operation of the nuclear power plant. There are several factors related to the supplier approval. At minimum, fulfilment of statutory requirements shall be ensured, such as, Contractor's Liability Act 1233/2006 when the work is performed in Fennovoima's premises. For the most safety critical components' deliveries the list of evaluation items is exhaustive, including verification of management system certifications validity, audits, quality assurance document reviews, technical capability, resources and financial checks. According to the Regulatory Guides on nuclear safety and security YVL A.3 (2019), documented information shall be kept of suppliers approved on the basis of assessment. Moreover, YVL A.3 requires that the actions to assess, control and guide suppliers important for nuclear or radiation safety shall be planned.

3.2 Hanhikivi 1 -project phases

FH1 -project consists of several phases, each having specific characteristics as presented in the Figure 3. At the moment, project is in the infrastructure and licensing phase.

Meaning that Fennovoima has submitted the construction license application to the Ministry of Economic Affairs and Employment. A prerequisite of the construction license is a favourable safety assessment from the Radiation and Nuclear Safety Authority (STUK). To receive a favourable safety assessment, Fennovoima must show that the FH1 project meets the preconditions for the license provided for by law, meaning that the plant will be constructed in such a way that safe operation can be ensured. (Fennovoima 2020.) Thus, Fennovoima together with the plant supplier and sub-suppliers is working on the plant's design documentation and development of the management system documentation. During this phase, conventional construction works can be performed at the FH1 Site. Once government has granted the construction license to Fennovoima, the construction of the nuclear power plant can be started. Construction phase includes equipment manufacturing, installation works, and commissioning of the plant. Operation of the nuclear power plant may start once the operation license has been applied and granted.



Figure 3. Hanhikivi 1 main milestones and life span (Fennovoima 2020).

4 Methods

In my research, I choose a philosophy of pragmatism (Figure 4). Pragmatists recognise that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture (Saunders & Lewis & Thornhill 2015, 144). Thus, I will utilize several methods in order to gain versatile information and different kind of perspectives to support my research work. This research study is conducted by using qualitative methods and by applying deductive approach to theory development. A researcher following a deductive approach starts by specifying the theory guiding the study – in the process, quoting the major points stressed in the theory, and exemplifying how the key aspects of the theory relate to the research problem (Upadhyay 2015, 9). This means, that I will establish conceptual framework to guide the development of the case organization’s current practices for supplier selection. Target is to reveal methods for effective and comprehensive supplier assessment, which can lead to high-quality supply chain performance. In my thesis I use a case study approach and undertake a cross-sectional research. Where a problem at a particular time is to be dealt with, a cross-sectional research is undertaken to answer a question or solve the problem (Sahay 2016, 5).

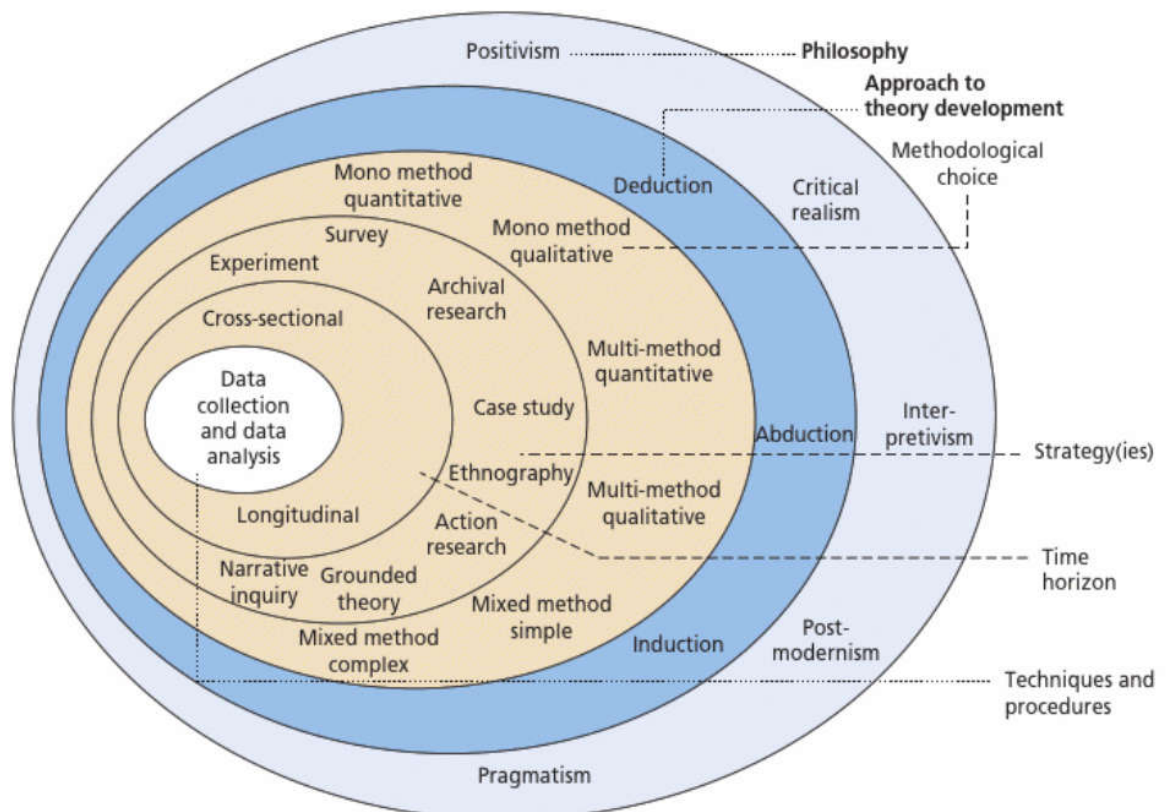


Figure 4. The research onion (Saunders et al. 2015, 124)

4.1 Case study

Case study strategy can be applied to development work where the task is to produce suggestions and new knowledge to support the development work. By applying case study approach, it is possible to produce knowledge about a phenomenon taking place at present in its real situation and in operating environment. (Ojasalo, Moilanen & Ritalahti. The third draft, 29-30.)

Case studies are most appropriate when the purpose is to understand an organization's situation well and the task is to solve a problem that the organization has perceived or produce suggestions for development by doing research. In pure case studies, the purpose is not to advance change or develop anything concrete, but to create ideas for research or suggestions for solving perceived problems. Case studies are in-depth investigations of a target in its own environment. (Ojasalo et.al. The third draft, 21-22.)

Figure 5 illustrates the case study process.

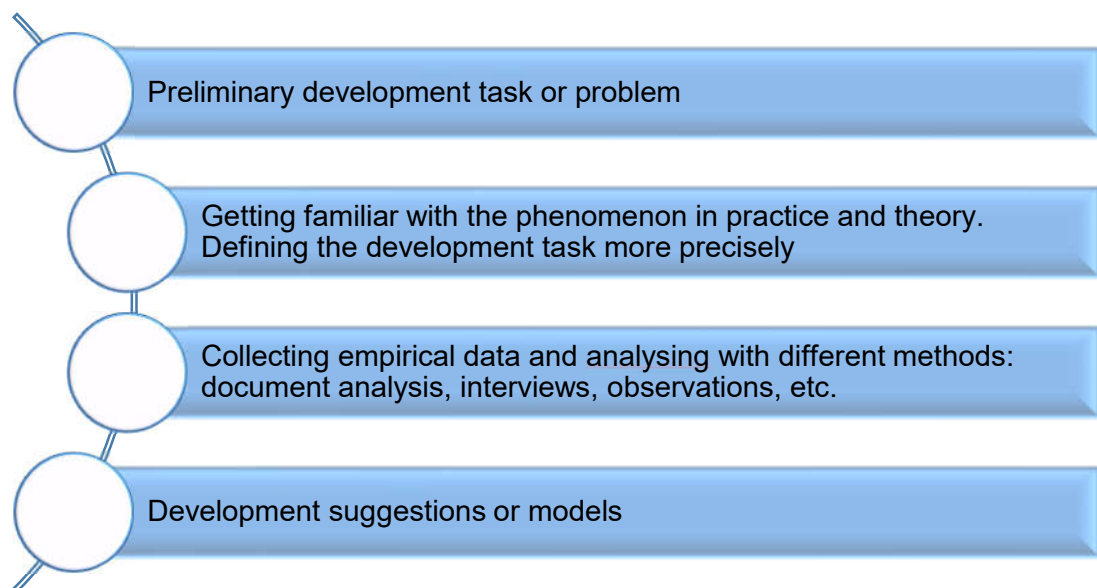


Figure 5. Case study process (adapted from Ojasalo et. al. The third draft, 31)

4.2 Document analysis

Multiple document sources, such as case organization's management system documentation, IAEA and STUK guides, research studies on the procurement and supplier assessment are reviewed and analysed to build on the theory base from which I can deduct new insights and thereby to work on the new model for the supplier assessment and selection. Critical literature review provides the context and theoretical

framework for the research (Saunders et al. 2015, 70). Document analysis and literature review process are not a linear, but rather cyclical process requiring several iterations as shown in Figure 6.

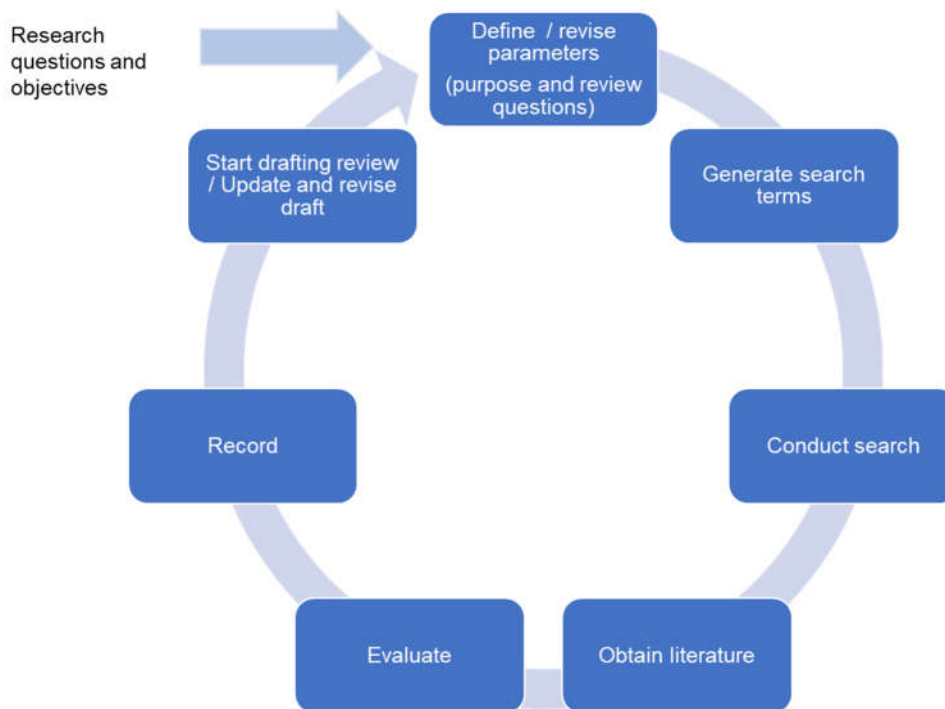


Figure 6. The literature review process (adapted from Saunders et al. 2015, 73)

4.3 Observations

Saunders et al. (2015, 360) recommend that if one works full or part-time as well as being a student, there may be an opportunity to use one of the participant observation roles in the employing organisation as the means to collect data to answer research question and address research objectives.

Participant observation suits to qualitative research as data acquisition method, but as being member of the work community being observed and having first-hand experience from the process being observed, I have to be careful not to create any bias conclusions. Choice of participant observation is influenced by factors including the nature of the research question and objectives, ability to simultaneously undertake the job and manage the demands of participant observation, being able to maintain objectivity and ensuring that closeness to informants does not lead to conflict (Saunders et al. 2015, 380).

4.4 Semi-structured interviews

As part of this research, I will interview procurement, quality assurance, financial and supply chain management experts working in the case organization by utilizing a semi-structured theme interview method. In appendix 1 is stated an interview guide including main themes. Purpose of the interviews is to gain further insight of current process, what problems the interviewees have identified and how current users consider the process could be improved. I intent to utilize vast knowledge and experiences these experts have gained during their working life. Semi-structured interview also provides the opportunity to probe answers, where interviewer wants interviewees to explain, or build on, their responses (Saunders et al. 2015, 394). By the one-to-one experts interviews I gather in-depth knowledge about the current supplier assessment process in practice from multiple viewpoints, what is working well and where is room for improvement. One benefit of semi-structured interview is that interviewees may also lead the discussion into areas that had not previously been considered but which are significant for problem understanding, and which help to address research question and objectives, or indeed help to formulate such a question (Saunders et al. 2015, 394).

The lack of standardisation in semi-structured interview can lead to concerns about reliability/dependability. In relation to qualitative research, this is concerned with whether alternative researchers would reveal similar information. Moreover, an issue is often raised about the generalisability/transferability of findings from qualitative research interviews. (Saunders et al. 2015, 397.) However, this research does not aim at bringing out any general assumptions or new theories. Purpose is to find out most suitable supplier selection methods for the case organization only, not for the whole industry. The validity/credibility of the data produced by semi-structured interviews is generally seen to be less of an issue (Saunders et al. 2015, 397).

Subjective approach sees interview data as being socially constructed; co-produced on the one hand by the views and interpretations of the participant and on the other hand by the interviewer, who asks questions, responds to the participant's views and interprets the resulting data during data analysis (Saunders et al. 2015, 390). As I am interviewing experts about a process affecting their daily work, I have to consider a possibility of bias in their responses. Some responses can be favourable for them, but not necessarily for the outcome of the whole supplier selection process. Thus, some criticality have to be applied in implementing the interview results to my research study. To overcome this reliability / dependability data quality issue there is a need to use a rigorous design and ensure that

explanation of how the data were obtained and analysed provide sufficient detail to show that findings are dependable (Saunders et al. 2015, 399).

Experts to be interviewed are selected carefully to cover all aspects of the selection and approval process. Procurement expert is interviewed to gain understanding of the current process, receive information about problem areas and to receive improvement ideas. Supply Chain Management experts are interviewed to utilize their past experiences and knowledge gained while working for operating nuclear utility and in nuclear industry. Purpose is also to reveal weak points in the current process. By interviewing Financial expert, I want to get better insight of financial risk management aspects and how to integrate those into the supplier selection process. In addition, Quality Assurance expert is interviewed to review current process from quality management perspective and gain better understanding on allocation of the management system requirements to different types of suppliers.

Due to the current pandemic situation all interviews are conducted remotely by applying Skype application. By transcribing all interviews, I can further analyse the recorded qualitative data.

4.5 Benchmarking

The purpose of benchmarking case organization's supplier approval process with other company operating in a safety critical business area, is to compare the processes and gather further information about experiences on the supplier selection practices. Most probably some steps along the process are done differently and some learning curve has already taken place in the selected company. Aim is to collect the best practices and lessons learned. Appendix 2 presents the theme interview guide for benchmarking.

The basic idea in benchmarking is learning from others and questioning own operations. When best practices are searched for in other organizations, it is necessary to apply them creatively, which means producing something new. The purpose is to help to identify weaknesses in operations and set goals and generate ideas for developing them. (Ojasalo et al. The third draft, 25.)

Requests for interview was submitted to two companies working in a highly safety regulated industry. However, under the current Covid-19 circumstances the benchmarking was not possible to be performed as planned.

4.6 Process mapping

Flowcharts and diagrams can be utilized to clarify the steps in supplier selection and approval process. Visualization is an efficient way to explain the working processes and roles of different parties involved in achieving the desired output. By mapping the process, it is easier to detect if some unnecessary activities are performed along the process or if the sequence of task allocation could be improved.

Savory & Olson (2001, 3) highlight that the identification of how a process or current system operates is the essential element in identifying improvement opportunities. That is why the current as-is state is defined at first, prior to proposing any development items. However, it is good to keep in mind that mapping a process does not explain the whole process, but merely visualizes the main activities. By mapping the process, I hope to gain better understanding about the sequence of activities and roles of different parties. Visualizing also makes it easier for me to explain, during the theme interviews, how the supplier selection is currently performed.

By modelling the work, it is possible to gain one or more benefits:

- Help to explain how work is done.
- Broaden the perspective regarding work.
- Provide a common conceptual frame of reference about work.
- Express rules, guidelines, or principles related to work more simply.
- Clarify relationships, identify key elements, and consciously eliminate confusion factors concerning work. (Damelio 2011,34.)

As part of this research work, I map a new process model by mirroring the current process to the best practices from literature, my own observations from working with the supplier selection and approval process and by taking into account the results of experts' interviews.

4.7 Focus group

Focus groups and group interviews are methods often used synonymously to mean an organized discussion with a selected group of individuals to gain collective views about a research topic. The distinguisher of focus groups is that they are interactive, the group opinion is at least as important as the individual opinion, and the group itself may take on a life of its own not anticipated or initiated by the researcher. (Arthur & Waring & Coe & Hedges 2012, 186.) Focus groups can be used to encourage interactions between participants as an effective means to articulate pre-held views about a particular issue or topic (Saunders et al. 2015, 420). I want to apply focus group to validate my research

outcomes and finetune the proposed new procedures. By group discussion I aim at limiting the possibility of having any individual bias affecting the results of my research work. As a moderator of the focus group, I will lead the session and actively encourage discussion among participants by posing open-ended questions. Check and Schutt (2012, 211) list key points for running a focus group:

- A great moderator is a neutral and genuinely respects the participants and is a great listener who can draw people out.
- Main questions ask what you really want to know, can be answered by participants, are clear and understandable to the participants, and provide useful answers.
- Participants are homogeneous by relevant category for comparisons, with no power differentials within the group.
- Audio recording.
- Analysis. Compare answers of different participants to different questions.
- Reporting. You are speaking for the participants. Lead with the big insights and answer the questions that were asked of the study. Interesting quotations get attention!
- When in doubt, ask from the participants.

5 Current supplier approval procedures

In order to be able to properly analyse and evaluate best practices and improvements to case organization's supplier selection and assessment procedures, it is essential to describe the current supplier approval process with consideration of potential weak areas.

In the case organization, supplier approval process is owned by the Supply Chain Management -unit in the Project Management -division. Commercial aspects of purchasing are owned by the Procurement-unit in the Support Functions -division as per Figure 7. It is to be noted that Supply Chain Development -unit includes Supply Chain Management and Supply Quality Assurance -functions.

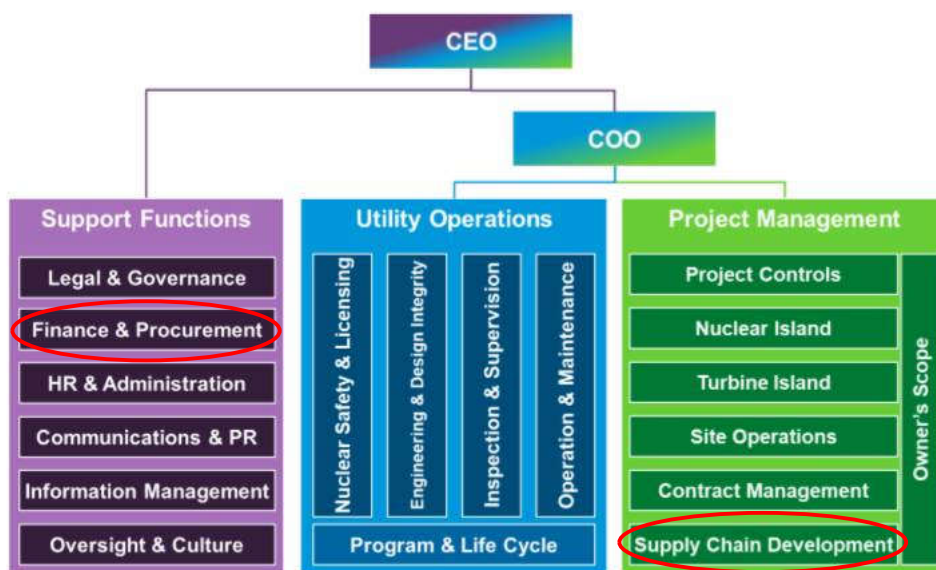


Figure 7. Case organization's organizational structure (FMS 2021, 8.)

Establishing procedures for the supplier and sub-supplier assessment is responsibility of the Supply Chain Management (SCM). Whereas tendering and contracting processes are Procurement-unit's responsibility. This separation is due to the FH1-project's current phase with focus on the EPC supplier's plant delivery. Procurement is handling direct purchasing, whereas Supply Chain Management's main focus is on the EPC supply chain. For the assessment and approval of direct suppliers these processes are connected with each other. Procurement is obliged to contact SCM whenever there is a need to evaluate a supplier candidate (Figure 8). It is not allowed to sign a contract prior having that vendor assessed and approved by the SCM-unit. (FMS 2019, 5).

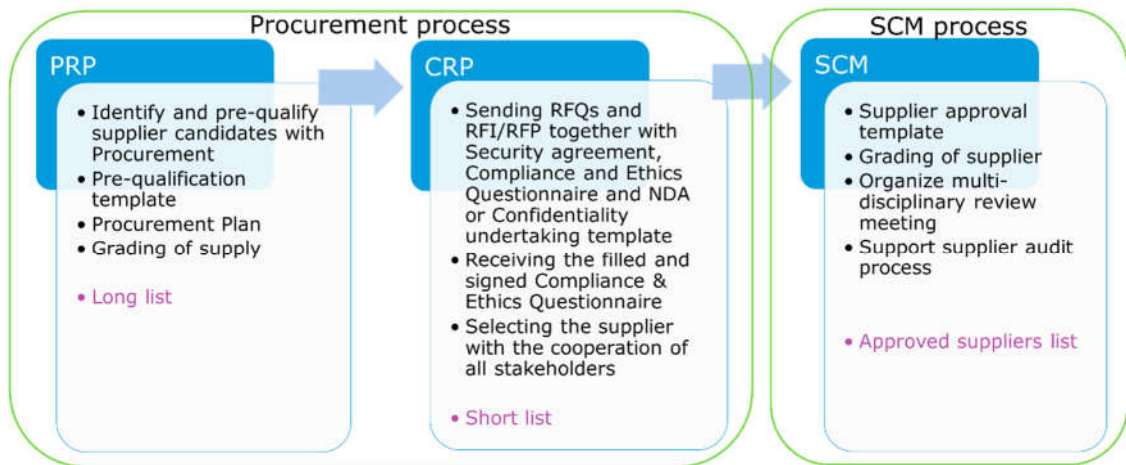


Figure 8. Connection of Procurement and SCM processes (adapted from FMS Process Charter – Procurement 2019)

Approval of a supplier requires co-operation between several disciplines. Engineering brings in the product knowledge with subject matter expertise, Nuclear Safety considers the overall safety of the delivered product and integration to the plant, Supply Quality Assurance evaluates the maturity of suppliers' management system and conducts supplier audits when seen necessary. Supply Chain Management coordinates and manages this supplier approval process (Figure 9).

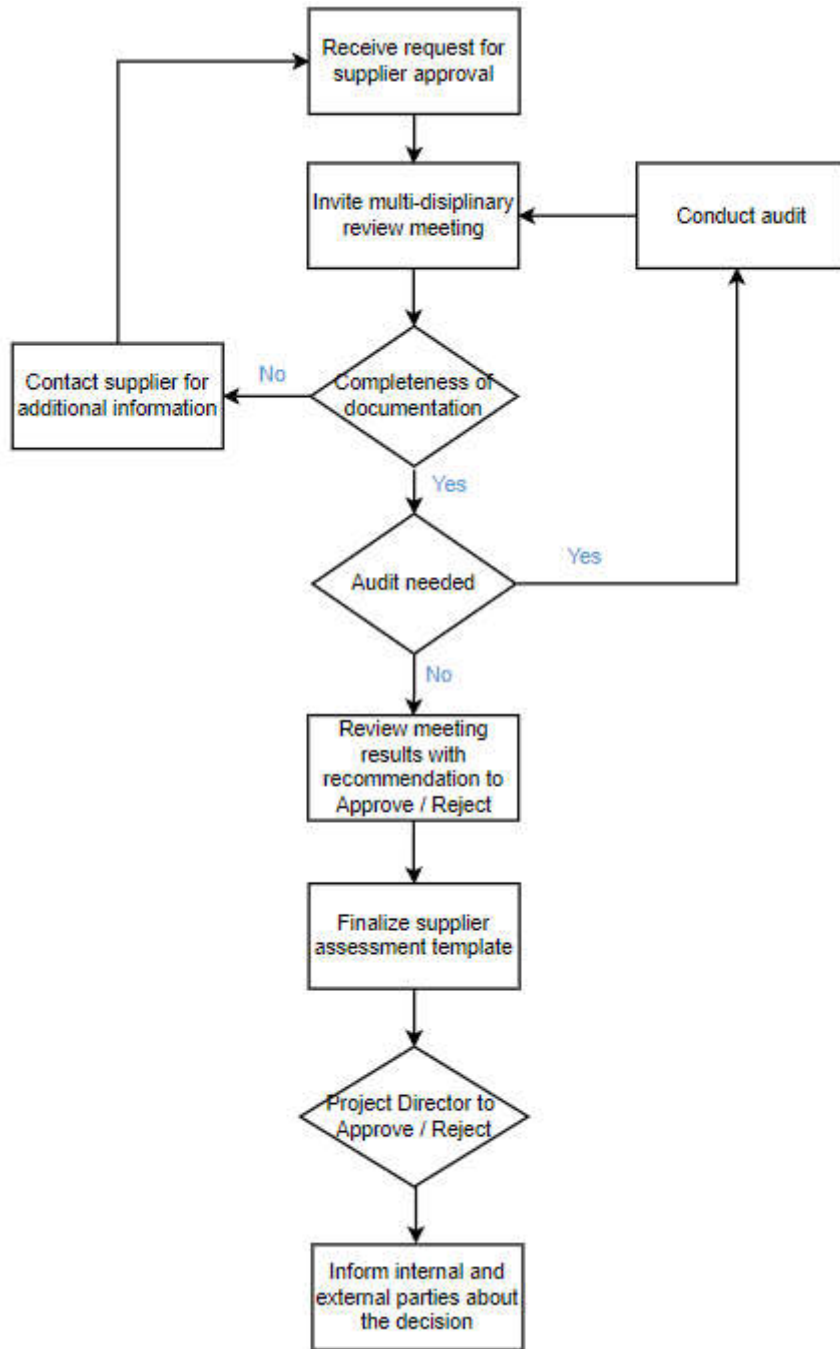


Figure 9. Main phases of the supplier approval process (adapted from FMS - Supplier and Sub-supplier Approval Instruction 2019)

Based on my own experiences while working in the Supply Chain Management, the indicated completeness of documentation (Figure 9) is seen as a grey area, as the required documentation is not explicitly described in current procedures. I consider that by having a standard supplier questionnaire, as part of the supplier assessment document package, can make the process more transparent and can make the supplier relationship

management easier as all involved parties know from the start what is to be requested from the potential suppliers.

The evaluation of audit need as part of the assessment process is based on a graded approach. This means allocation of resources to most safety critical supplies and loosening the control where the risk impact of the supply is lower. As per YVL B.2 (2019) all systems, structures and components of the nuclear power plant shall be classified based on their safety significance. According to current FMS Supplier and sub-supplier approval instruction (2019, 21) grading of products and services should support the allocation of requirements to specific supplies and suppliers. However, the current product grading process has turned out to be too time consuming and complex for practical implementation. Thus, the planned product grading is not supporting the grading of suppliers as described in the SCM's supplier approval instruction (Figure 10).


Product Grade / Safety class	A		B		C		D	
1	A1	ISO 9001 or equivalent	B1	ISO 9001 or equivalent	C1	ISO 9001 or equivalent	Not Applicable 	
	Audit needed		Audit needed		Audit needed			
	Quality Plan including A.3 requirements for MS		Quality Plan including A.3 requirements for MS		Quality Plan including A.3 requirements for MS			
2	A2	ISO 9001 or equivalent	B2	ISO 9001 or equivalent	C2	ISO 9001 or equivalent	D2	ISO 9001 or equivalent*
	Audit needed		Audit needed					
	Quality Plan including A.3 requirements for MS		Quality Plan including A.3 requirements for MS		Quality Plan including A.3 requirements for MS*		Quality Plan including A.3 requirements for MS*	
3 or EYT / STUK	A3	ISO 9001 or equivalent	B3	ISO 9001 or equivalent	C3	ISO 9001 or equivalent	D3	ISO 9001 or equivalent*
	Audit needed							
	Quality Plan as per YVL A.3 annex		Quality Plan as per YVL A.3 annex		Quality Plan as per YVL A.3 annex*		Quality Plan as per YVL A.3 annex *	
EYT	AE	ISO 9001 or equivalent	BE	ISO 9001 or equivalent	CE		DE	Only legal obligations e.g. Contractor's Liability Act
	Audit needed							
	Quality Plan*		Quality Plan*		Quality Plan*			

Figure 10. Grading of suppliers for certain scope of works (FMS - Supplier and Sub-supplier Approval Instruction 2019)

In addition, current procedures do not determine how to perform financial nor technical evaluations. Financial reports are collected, and previous experience is checked, but I consider that there should be some acceptance levels or ratios set for the financial assessment. Also risk evaluation should consider supplier's experience in Finnish nuclear energy sector and prior deliveries according to European standards.

6 Literature review on Supplier selection and approval

Based on a thorough literature review, the following concepts and theories define the main themes used in my research study and provide solid ground for development of the supplier selection and approval process for the case organization.

6.1 Supplier selection

The successful execution of purchasing relies heavily on the capability of the selected suppliers. Selected suppliers must have the technical, commercial and personnel capability to perform the necessary works, as well as having implemented a quality management system that supports the activities affecting product and service quality. Suppliers normally need to be evaluated to gain assurance in their capability of meeting contract requirements before awarding the contract. Supplier assessment and selection does not guarantee that the selected supplier will meet schedule and other requirements, but there is a degree of confidence obtained, that they will be successful. (IAEA 2021.)

YVL A.3 (2019) requires having appropriate procedures for supplier assessment and selection. It also states that records shall be kept of the supplier assessments and supplier's ability to deliver the product or service and the related documentation in compliance with the requirements shall be evaluated prior ordering. Moreover, the approval of suppliers of products or services important to safety shall be for a fixed duration only. The periods of supplier approval validity shall be defined in the purchasing procedures.

The process of effective supplier assessment is vital to the procurement process and a fundamental pre-requisite of a total quality output from the organisation (Carter 1995). If the selected supplier fails to meet the deadline or delivers faulty items, it creates a high risk for the operative stability of the case organization and ultimately dangers company's ability to keep promise to its customers. Therefore, an efficient supplier assessment process needs to be in place and is of paramount importance for successful supply chain management. It begins with having a need for a new supplier, determination of selection criteria and pre-qualification by submittal of request for information. Followed by the final supplier approval (or rejection as the case may be). (Sonmez 2006, 4.)

For effective and efficient supply management it is recommended to maintain long term partnership with carefully selected reliable suppliers. Therefore, choosing the right suppliers involves much more than just scanning a series of price lists. The final choice will depend on a wide range of factors which include both quantitative and qualitative

aspects. Extensive multi-criteria decision-making approaches are proposed for supplier selection. (William & Xiaowei & Prasanta 2010.) Sourcing and qualification for new suppliers in an open market for complex equipment can take up to 6–12 months, or even longer, to complete (IAEA 2016, 48). Suppliers that pass the assessment process are generally added to the approved suppliers list (ASL).

Literature provides several process models for the assessment and selection of suppliers. According to Iloranta & Pajunen-Muhonen (2015, 235) this process shall entail five phases:

- Market research
 - Recognition of most suitable candidates
 - Compile basic information about suppliers
- Ensuring supplier's interest
 - Evaluation of possibilities for mutual co-operation
 - Review of suppliers' supply and offerings
- Request for proposal (RFP)
 - Evaluation of suppliers' capability, capacity and suitability of performance
- Request for quotation (RFQ)
 - Actual basis for tender comparison, competitiveness
 - To find most optimal solution for the need
- Negotiation
 - To find the best option
 - Strengths, weaknesses, opportunities and threats
 - Finalization of the resolution.

On a high level this summarizes the key elements, but I find it unnecessary to contact supplier candidates four times along the process: to ask possible interest for tendering, then submitting requests for proposal after which the quotation is requested and finally the negotiations. Prior requesting actual proposal, I would recommend submittal of request for information (RFI) to gather information about the suitability and general capacity of the candidate. RFP generally includes some information about case organization, so considering information security aspects, any specification should not be submitted prior evaluation of fulfilment of pre-requisites for compliant performance. Moreover, RFI can be submitted without having the non-disclosure agreement (NDA) being signed yet. Response to the RFI also indicates supplier candidate's interest for mutual co-operation, so in my opinion there is no need to request these separate.

According to IAEA (2016, 48) steps involved in the sourcing and qualification of new suppliers typically include a request for information, supplier preselection based on RFI feedback and supplier interest, a prequalification process whereby selected vendors go through an audit process as seen necessary, and then a qualification step prior to contract

award when the qualification is confirmed satisfactory and the supplier is added to the purchaser's approved suppliers list (Figure 11).

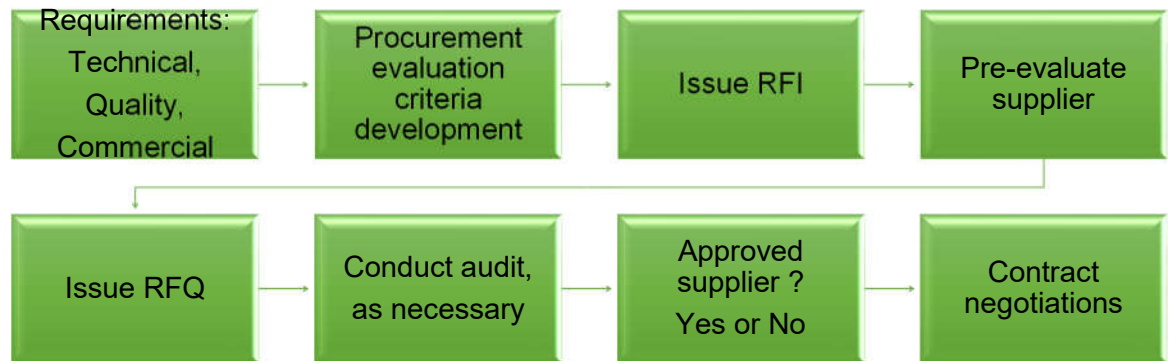


Figure 11. Typical steps in the nuclear procurement process (adapted from IAEA 2021)

By combining aspects from the two above-described process models, an optimal supplier approval process for the case organization can be established.

6.2 Supplier selection criteria

YVL A.3 (2019) states that the requirements for the selection of suppliers and the selection procedures shall be defined. These shall include the requirements pertaining to the supplier's management system and its quality management (YVL A.3 2019).

Supplier selection criteria is the set of criteria to be considered upon supplier selection. There are two major categories to consider in the supplier evaluation process: business criteria and technical operational criteria. Business criteria consists of elements that evaluate the health and performance of an organization and will help predict how well a particular supplier can meet its contractual obligations over time. (Sollish & Semanik 2011, 101-102.) Operations criteria include quality management processes and measurement systems, evaluating engineering expertise, and conducting site visit (Sollish & Semanik 2011, 123). Carter's 10 C's model for supplier assessment highlights the key elements to be evaluated (Figure 12).

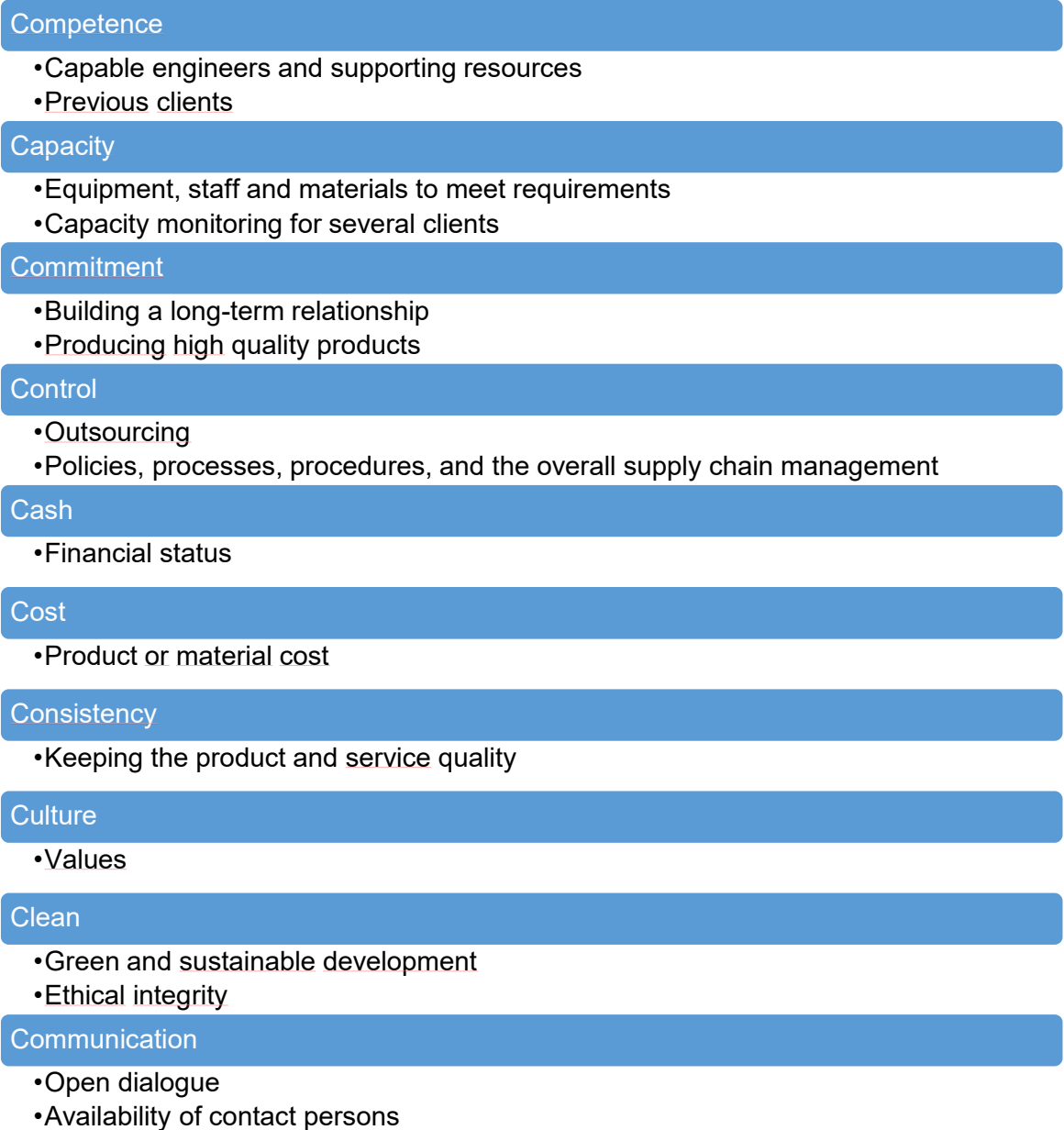


Figure 12. Carter's 10C's for supplier assessment (adapted from Carter 1995; Luo 2018)

It is to be noted from the above list that cost is not the most widely adopted criterion. The traditional single criterion approach based on lowest cost bidding is no longer supportive and robust enough in contemporary supply management (William et al. 2010). As the commercial tender bid evaluation is not considered in my research, I exclude the cost aspect as selection criteria. Total cost of ownership can be analysed if the supplier is able to meet the quality, safety and technical requirements for successful delivery. This approach is supported by Nieminen (2016) as she recommends to first collect information about supplier candidates by submittal of request for information and based on the received questionnaires, selection is then made to whom the request for quotation is sent.

Another approach to supplier assessment is called SOCCER model (Figure 13).

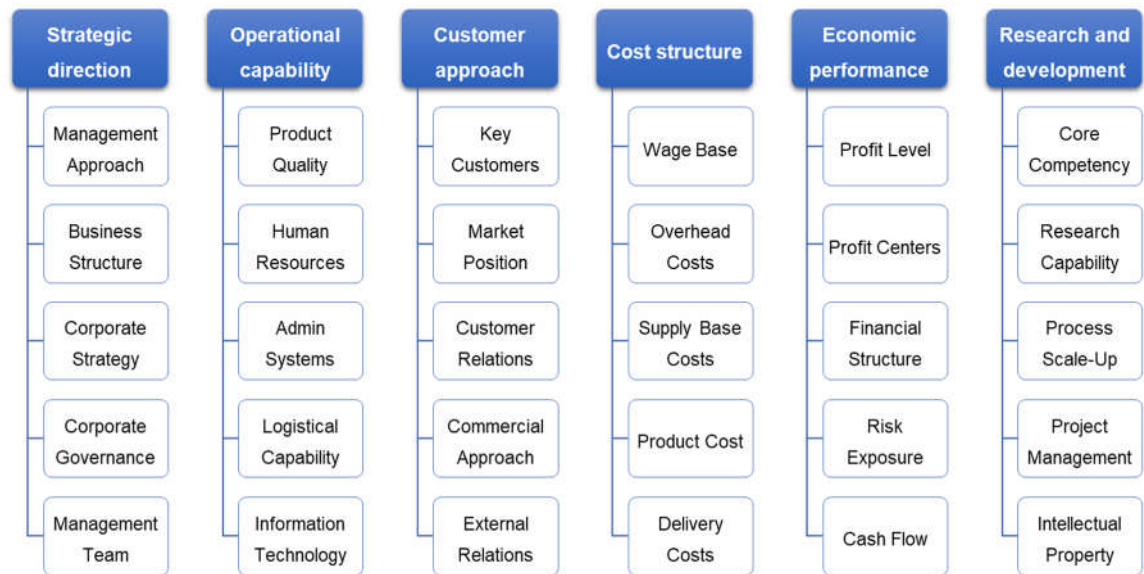


Figure 13. Supplier assessment according to SOCCER model (adapted from Rogers 2009, 97).

With comparison to the Carter's 10C's, SOCCER model provides more strategic view on the supplier assessment as it is not merely focusing on the supplier's capabilities but considers also long-term strategic direction. There are similarities in the presented approaches as well, like evaluation of operational capability and measurement of economic performance. With the combination of Carter's 10 C's and SOCCER model, most suitable and effective supplier selection criteria can be established for the case organization.

6.3 Supplier questionnaire

As part of the supplier selection and approval process, a questionnaire can be sent to potential suppliers to gather information about the candidates' experience, expertise, capability and financial resources to support the possibilities for successful supply.

Covered topics may include questions regarding the company's:

- Key personnel,
- Organisation structure,
- Management system procedures and certificates.
- Industrial safety record,
- Subcontracting strategies,
- Environmental and social performance,
- Ethical standards and values,
- Production facilities,
- Experience with a particular technology or standard,

- Production capability under different conditions
- Financial statements and records (IAEA 2016, 50-51).

According to Lysons & Farrington (2012, 267) following attributes should be evaluated upon every supplier assessment and supplier specific information is typically gained via questionnaire:

- finance
- insurance
- productive capacity and facilities/service support capacity
- quality
- health and safety
- environmental management
- existing contracts held and performance
- organizational structure and key personnel – resources
- sub-contracting – proposed actions
- procurement capability and supply chain management.

I consider above mentioned topics to be headers in the supplier questionnaire under which specific detailed questions are listed. However, the questionnaire shall be kept as short and clear as possible to encourage potential suppliers' willingness to participate to the tendering. The implemented questionnaire shall support the evaluation of supplier candidate in determining if set selection criteria is met or not. Thus, the questionnaire shall be aligned with the selection criteria.

6.4 Risk assessment

Risk is the degree of exposure the company has to supplier performance failures, such as quality defects, late deliveries, or service failures (Gordon 2008, 58). Risk assessment is to be performed with consideration of prior experience of the supplier candidate, financial operation status and level of quality management system.

In relation to the supplier assessment, three risk categories shall be considered. Technical risks regarding the expertise of the management, suitability of the production facilities, the skills, tools and testing equipment of the supplier candidate for the manufacture of the required goods and services. Quality risk refers to the quality management of the candidate and the required quality control methods of the supply in question. Financial risk relates to the degree in which the company is considered to function steadily and effectively for the duration of the contract. Following aspects are to be assessed: financial condition, investment elasticity and a solid financial condition to avoid company going bankruptcy prior fulfilment of its contractual obligations. (van Weele 2010, 37.) Financial

key ratios as per Table 1 can be utilized. For example, calculating the return on capital employed, solvency ratio or current ratio.

Table 1. Key ratios indicative reference values (adapted from Alma Talent 2021)

Key ratio	Excellent	Good	Satisfactory	Tolerable	weak
Return on Capital Employed	> 15%	10-15%	6-10%	3–6 %	< 3%
Return on Equity	> 20%	15-20%	10-15%	5–10 %	< 5%
Solvency ratio	> 50%	35-50%	25-35%	15–25 %	< 15%
Net gearing	< 10%	10-60%	60-120%	120–200 %	>200%
Current ratio	> 2,5	2-2,5	1,5-2	1–1,5	< 1
Quick ratio	> 1,5	1-1,5	0,5-1	0,3–0,5	< 0,3

6.5 Graded approach

Graded approach is defined in the IAEA Safety Glossary (2021) as follows:

For a system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control.

In practice, with regard to the supplier selection process, this means segmentation of suppliers for allocation of resources and requirements based on the safety significance and risk level associated with the supply. YVL A.3 (2019) states that the management system shall be developed and applied with consideration to the safety significance of the operation and that the principles of observing risk-based decision-making and safety significance shall be described. In the nuclear power plant, all systems, structures and components are grouped to safety classes 1, 2 and 3 and Class EYT (non-nuclear safety) on the basis of their importance for safety (YVL B.2 2019). This shall be the starting point for the determination of the management system requirements and verification methods during supplier selection and approval.

This risk-based approach coordinates the set of quality requirements, acceptance criteria and methods, and the extent and strictness of verification activities during the procurement process (IAEA 2016). It is to be noted, that safety class alone is not sufficient for determining the degree of selection criteria and assessment methods. Processes for the supply of non-safety related products can depend for instance on the economic or production impacts of the equipment or complexity of the item to be procured. Processes for significant non-safety related products can end up being similar to those of safety related equipment. (IAEA 2016.)

As per YVL A.3 (2019) the licensee shall define in supplier assessment and approval procedures when the supplier assessment is to be based also on proof obtained by auditing. Guidelines for the management system requirements and audit needs shall be defined based on the safety classification of the works and derived risk assessment, i.e., by applying graded approach.

6.6 Quality assurance

According to the IAEA Safety Glossary (2021), quality assurance is the function of a management system that provides confidence that specified requirements will be fulfilled. Quality assurance can be considered as defect prevention (Lysons & Farrington 2012, 280). Quality assurance can also be associated as risk mitigation action which may include supplier's management system review or audit at supplier premises. Supplier audits can be used as a supplementary tool to obtain further information about the capabilities of the supplier and implementation of described management system documentation. Audits are commonly executed at supplier facilities to ensure that their management system is effectively written and implemented and in compliance with all aspects of the supply requirements. By auditing, it is possible to get assurance that safety related goods and services are procured from suppliers who have been carefully evaluated and determined to be capable of providing the items and services successfully. The extent of audit activities can be graded based on the safety significance or importance of the items being supplied. (IAEA 2021.)

YVL A.3 (2019) specifies that suppliers of safety-significant products and related services shall have in place a management system that is appropriate certified (for example, ISO 9001 or ISO 19443) or independently evaluated by an expert third party. Moreover, it defines that related to deliveries of products or services in safety class 1 and 2, the management system of the supplier shall comply with the management system requirements set forth in the YVL A.3 and be compatible with the other standards used in

the operation. Supplier's management system can be supplemented by the quality plan to fulfil customer specific requirements.

In 2018 a new ISO 19443 quality management systems standard was published for specific requirements for the application of ISO 9001:2015 by organizations in the supply chain of the nuclear energy sector supplying products and services important to nuclear safety (ITNS) (ISO 19443:2018). On June 2020 STUK gave a decision to clarify the application of aforementioned YVL A.3 on suppliers who are important in terms of safety and commented on, among other things, how new standard ISO 19443:2018 can be applied (STUK 2020). Until today, this STUK decision has not been implemented into the FMS documentation.

6.7 Approved suppliers list

Suppliers that have been assessed and deemed capable of successful performance in the provision of goods and services can be added to the approved suppliers list (ASL).

According to IAEA (2021) approved suppliers list typically includes:

- Supplier's name, address, facility location(s), email address and telephone number,
- Items or scope of supply the supplier is qualified to provide under the approved quality assurance programme scope,
- Certification and accreditation details, including approval methods used,
- Expiration date of approval and
- Approved quality assurance programmes.

Case organization's approved suppliers list has been found satisfactory in several internal and external audits. Thus, update of the ASL is not part of this research. It is just noted as a final step of the supplier selection and approval process.

6.8 Conceptual framework

The conceptual framework as per Figure 14 consists of three main phases. At first, the need for purchase is recognized and list of potential suppliers established by market screening. Secondly, the supplier capabilities against technical, financial and quality requirements are checked with supporting supplier questionnaire. Based on the risk evaluation, need for supplier audit is determined and possibilities for supplier approval assessed. This conceptual framework has been generated from the theoretical framework and document analysis to support this research study. This framework is used in the research for elaborating the new supplier assessment process for case organization.



Figure 14. The conceptual framework

7 Theme interviews

The conducted expert interviews provided very valuable information about the current supplier selection and approval process, and its weaknesses. After transcribing the semi-structured theme interviews, I analysed the qualitative data by drawing up a mind map as per appendix 3. This mind map resulted with six focus areas:

- Why process update is seen valuable,
- Aspects about the current process,
- Risk analysis,
- Supplier questionnaire,
- Proposals to new process, and
- Other ideas brought up during the interview discussions.

7.1 Need for process update

Interviews revealed several reasons why process update is seen valuable:

- Supplier selection is not one continuous process. Which causes that there is no transparency from start to finish.
- Grading is not clear, e.g. what grade B means in Procurement Plan. Also grading is performed twice which creates confusion.
- Requirements are not detailed enough, e.g. what is to be checked from the financial statement or prior experience.
- Current process is seen rather light, as there are no clear requirements.
- More focus on what is really required, baseline.
- Stronger risk analysis.
- Supplier selection is considered to be too dependent on the person, instead of process guidance.

As one of the interviewed experts clarified: “Current supplier approval -template includes ‘experience’ and ‘organization chart’ as check points, but it has not been pre-defined what is the requirement baseline. It is more like case-by-case review without any guidance.”

7.2 Findings regarding current process

During the interviews, it became obvious, that supplier selection was not seen as a one continuous process but consisted of two separate processes. These two processes had not been evaluated as a single continuum from identification of a need for purchase as an input, up to approval / rejection of a supplier candidate as an output (Figure 15). As described in chapter 5, Procurement part includes the identification of potential suppliers and short listing. SCM’s approval process includes only evaluation of the one finally selected supplier, the winner of the tendering. The fact, that supplier selection and approval consist two separate processes, causes gaps in the information flow.

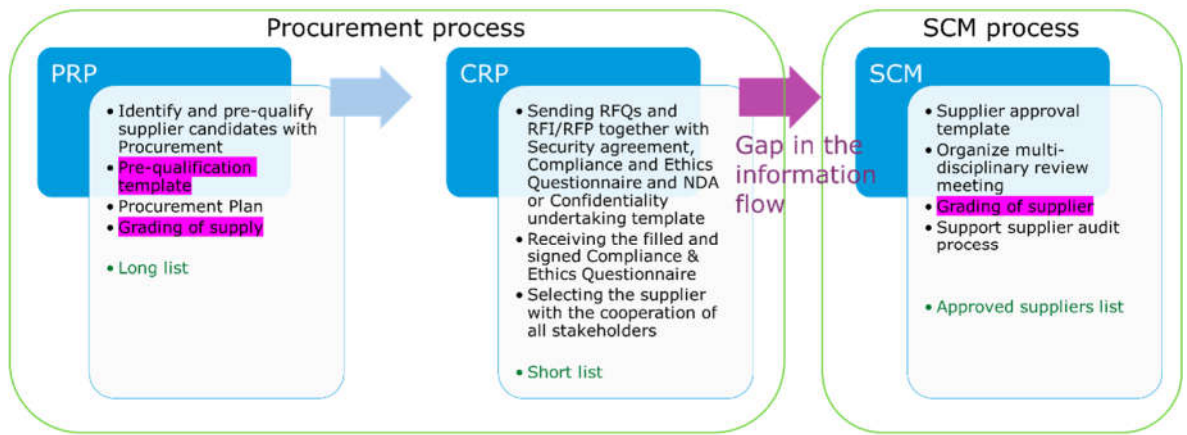


Figure 15. Findings about current supplier selection process

In this thesis, I evaluate supplier selection and approval as a single process, which can, however, have tasks assigned to several units. Current process has good elements, as presented in Figure 16, problem is that some of the related tasks are not properly described in any instruction. Grading at the Procurement Plan is seen very confusing, as there is no guidance related to the results. If grading resulted to B or C, that should lead to different kind of requirements towards the supplier selection. However, those requirements are not stated anywhere. Then there is second grading, in the SCM approval process (Figure 15). That grading sets, for instance, requirements to the suppliers' management system. However, based on the interviews, those supplier selection related requirements should be specified earlier in the process, preferably at the beginning. It was also noted during the interviews that the pre-qualification template is not in active use as it is not seen as bringing any added value to the supplier selection.

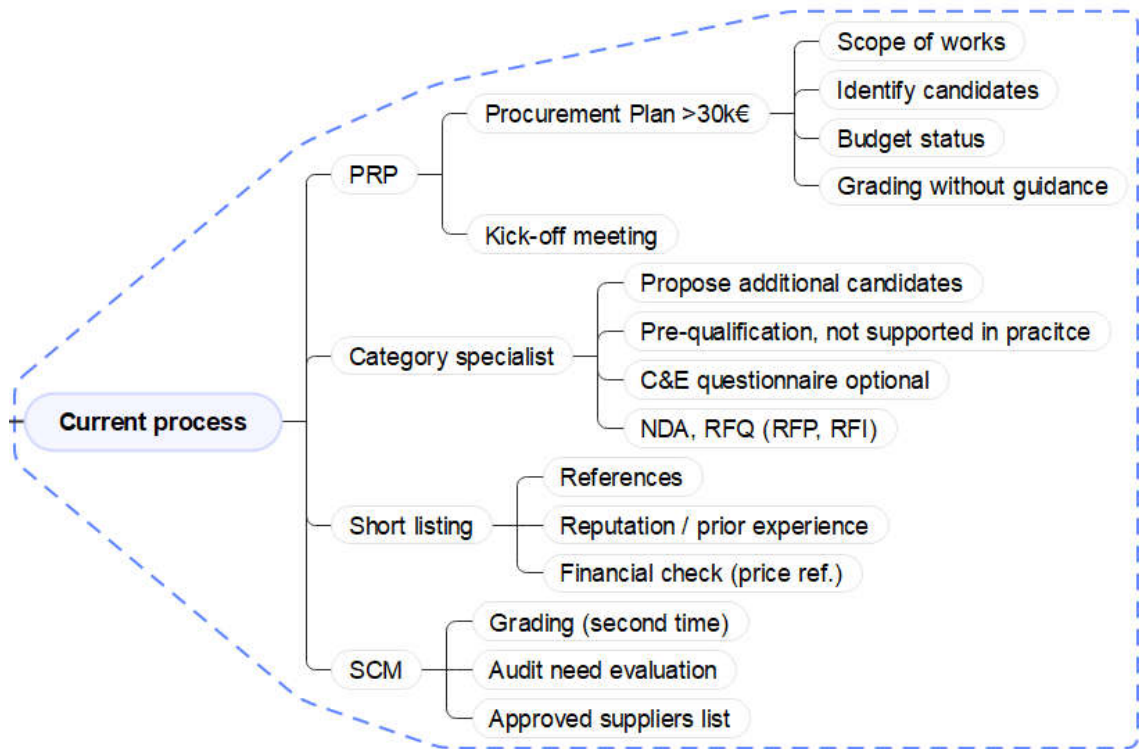


Figure 16. Interview results regarding aspects on the current process

7.3 Risk analysis

Another example, about good practice without proper guidance, was about the financial check. This financial check had turned out to be very valuable tool for short listing of potential suppliers, but it was not described in any FMS instruction. Financial check was seen as valuable part of the overall risk analysis as noted by one interviewed expert: “With proper financial check, we can secure our assets and reputation.”

In addition, technical risk assessment was not detailed either. Meaning that supplier candidates’ prior experience was one of the items to be checked upon supplier selection, but what to look exactly with regards to it was not instructed. Interviews resulted with several good aspects to look into, in terms of risk analysis, upon selection of the supplier as per Figure 17.

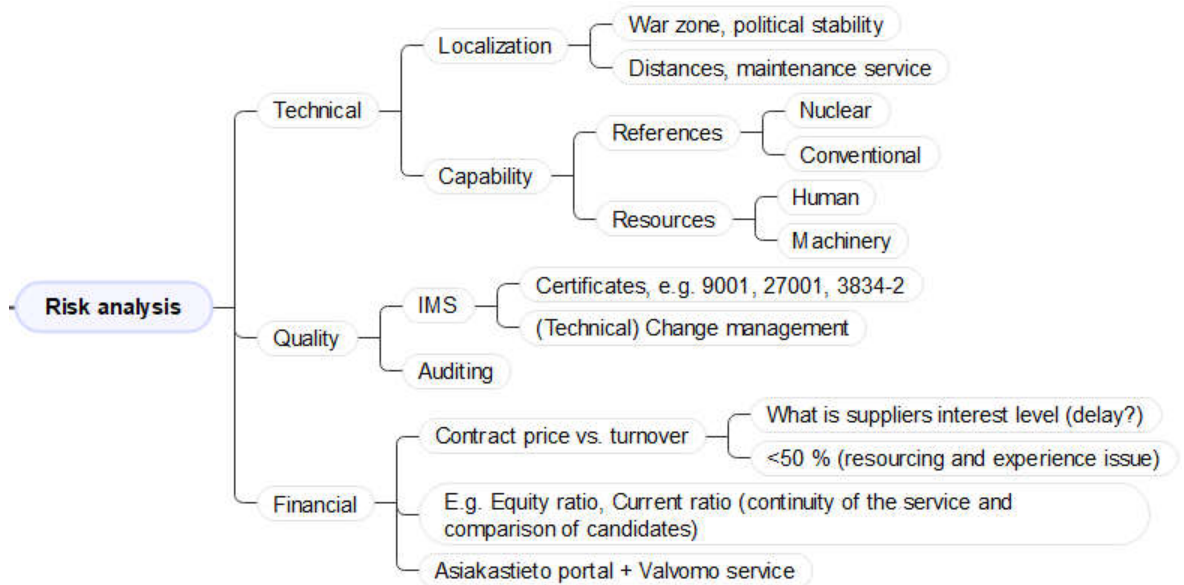


Figure 17. Aspects to risk analysis as part of supplier selection

7.4 Supplier questionnaire

As reported by the expert interviews, the pre-qualification questionnaire was not in active use, as it was not thorough nor precise enough to serve final supplier selection. Current pre-qualification questionnaire is very brief and vague. In addition, Compliance and ethics -questionnaire is sent separately. Considering the overall supplier relationship management, implementing only one supplier questionnaire to support the whole supplier selection and approval process, is recommended (Figure 18).

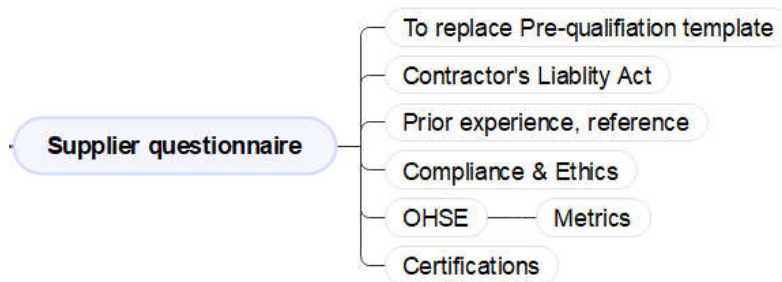


Figure 18. Items related to the Supplier questionnaire as interview result

7.5 Proposals to new process

Based on the interviews, development of the grading to be more specific on setting requirements towards the supplier on one hand and guiding the case organizations performance on the other hand, was seen valuable (Figure 19). In the nuclear energy

sector, the classification of systems, structures and components provides already some grading, but quality and technical risk evaluation should be incorporated. Current way to perform the grading and determining which requirements were applicable to which supplier, was causing confusion among persons participating to the supplier selection process.

One interviewed expert explained the grading process as follows:

For the initial grading we should understand what kind of contract we are working on and what kind of competence is needed to fulfil these requirements. Like are we about to order something unique, first of a kind, or are we buying bulk material. So, these are totally different things.

Interviewees also recommended to perform active sourcing to support the Procurement Plan phase in finding suitable candidates. At the time of my research work, case organization had not defined how the STUK's decision 31/0002/2020 (STUK 2020) should be implemented in management system. This decision relates to the application of YVL A.3 and how potential suppliers' certification as per ISO 19443:2018 standard should be considered in the supplier approval process. This is one of the topics to be included to the new grading matrix.

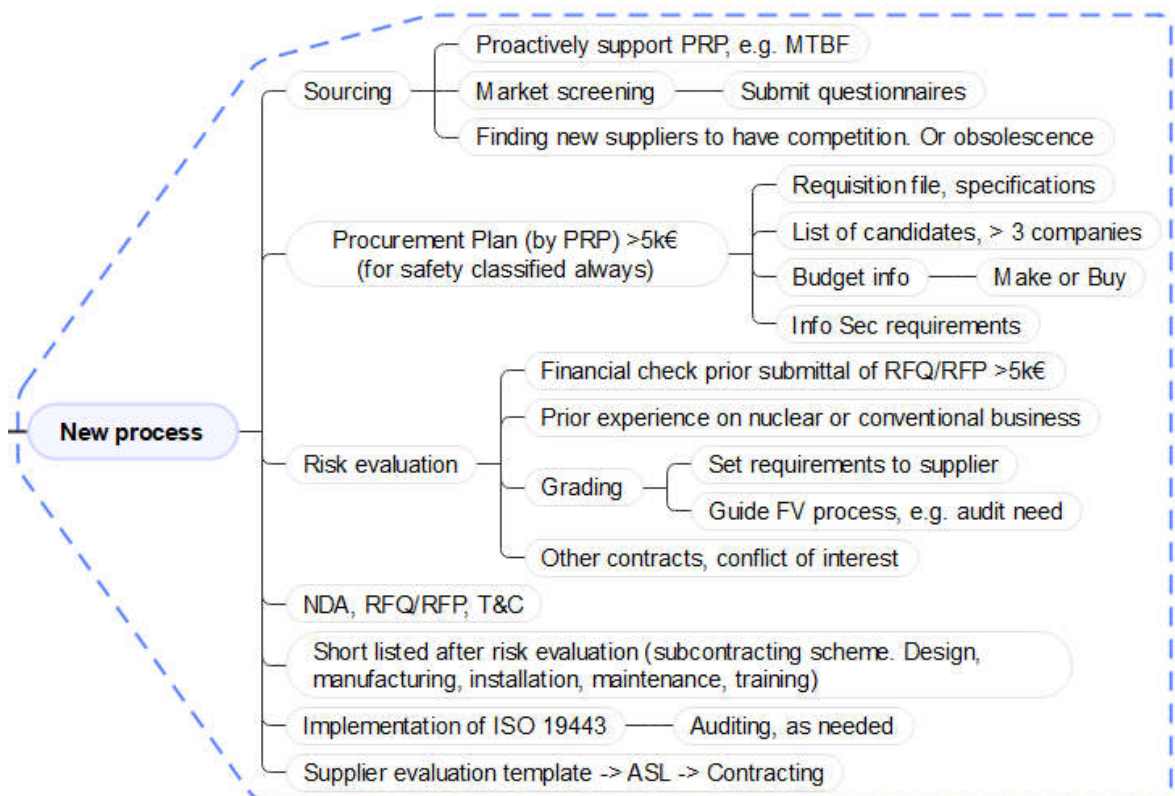


Figure 19. Recommendations to the new process from the interviewed experts

7.6 Other improvement proposals

During the expert interviews, also other valuable ideas were presented, such as:

- Scan and approve suppliers in advance for quick contracting and easy replacement.
- Establish frame agreements (in advance).
- Pre-qualification not needed as an additional step.
- Whole selection and approval process to be owned by Procurement.
- More focus on supplier management, annual evaluation of key parameters, view on total annual spend, instead of individual contracts.

These are important aspects from the interviewees and should be considered by the case organization during management system updates.

8 Developing the supplier selection and approval procedures

Based on the performed extensive literature review and considering the outcomes from the expert interviews, five development areas were identified:

- Process model
- Supplier questionnaire
- Supplier grading
- Overall risk assessment and
- Supplier approval template.

8.1 Process model

According to my experience of over ten years in nuclear procurement of which last six years in the case organization, I had observed that current process gave too much flexibility and variance in decision making depending on who was leading the supplier assessment. Also, as brought out during the expert interviews, current instructions did not specify what documentation should have been asked from the supplier in each case. By this research work, I aimed at making the process more instructive, thus also more transparent, and easier to apply.

To establish most optimal process model for the case organization, I analysed the process models proposed by Iloranta & Pajunen-Muhonen (2015, 235) and IAEA (2016, 48) presented in literature review chapter 6.1. From Iloranta & Pajunen-Muhonen (2015), I implemented the start of the process by market screening, supplemented by ensuring supplier's interest via submittal of Supplier questionnaire (Figure 20). From the typical steps presented by IAEA (2016, 48), I took the pre-evaluation of the supplier prior issuance of the RFQ. By this risk-based supplier assessment supported by supplier grading (appendix 6), it is possible to better target the request for quotation to most suitable supplier candidates. Thus, saving time from analysing too many offers. Ultimately, I adjusted the recommended process model based on the interview results (Figure 19). New process model is presented in appendix 4. It introduces sourcing as a totally new phase to the case organization's supplier selection and approval process. Moreover, financial role in supplier assessment has been clarified, and supplier questionnaire is introduced as a new tool for short listing the supplier candidates, prior submittal of RFP/RFQ. In addition, supplier grading has been taken as part of initial selection process, instead of having it in the final approval step as in the current process.

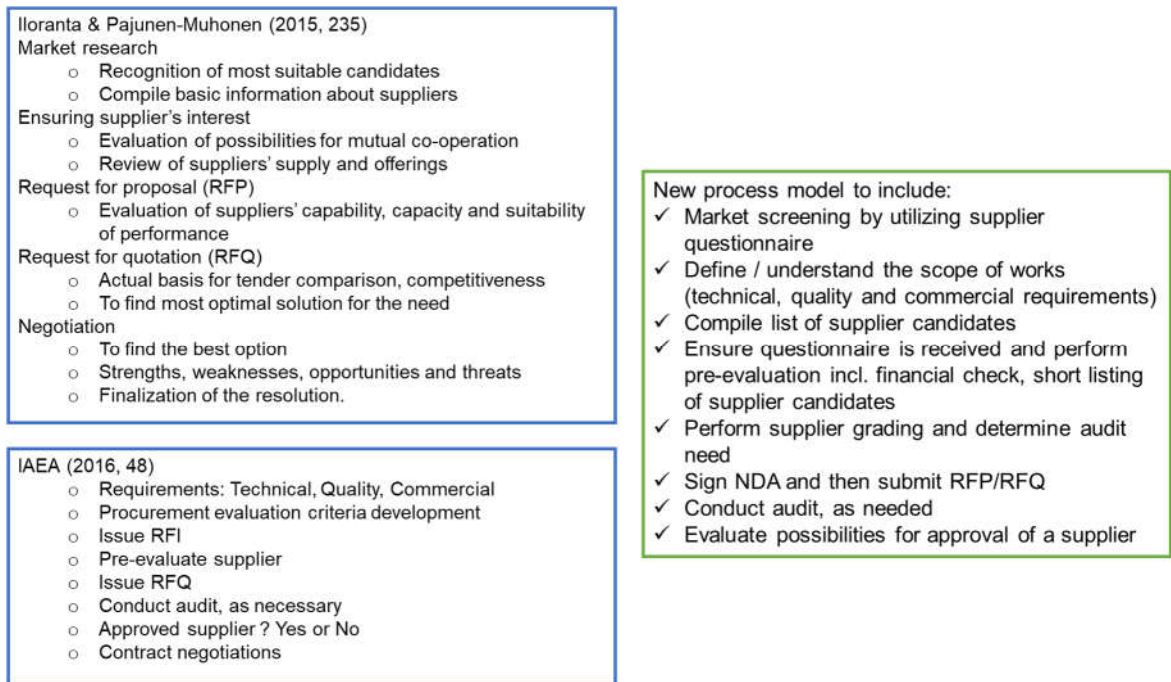


Figure 20. Combining elements from the literature review to establish new process model

8.2 Supplier questionnaire

The supplier questionnaire, presented in the appendix 5, is formulated considering aspects provided by the literature review in the chapter 6.3 and proposals from the interviewed experts as per chapter 7.4. As stated by Lysons & Farrington (2012, 267), supplier questionnaire gathers information related to finance, productive capacity and facilities/service support capacity, quality, health and safety, environmental management, existing contracts held and performance, organizational structure and resources, sub-contracting, procurement capability and supply chain management.

New supplier questionnaire includes also topics from the current Compliance & Ethics questionnaire. Supplier questionnaire is divided into six sections:

- General company information,
- Organizational structure and extent,
- Management system and certificates,
- Compliance and ethics,
- Technical capabilities and
- Financial information.

The supplier questionnaire is introduced as a new tool to be taken into use as part of supplier screening and short listing. Applying supplier questionnaire, already at the first phase of the supplier selection and approval process, supports the procurement plan with

determining the list of potential sub-suppliers. Supplier questionnaire provides also input for the supplier grading and financial check which are performed for short listing of supplier candidates. This is one of the key tools to manage risks related to the supplier selection.

8.3 Supplier grading

As concluded by the expert interviews, supplier grading should be performed at the beginning of the selection process to guide the setting of requirements towards supplier candidates and to steer internal activities. As clarified by one interviewed expert: "Grading is actually part of requirement specification. That is setting correct requirements by using grading as a tool to support this requirement allocation."

In addition, interviewed experts proposed to have more risk focus on the supplier selection. Thus, the grading is divided into three risk areas as recommended by van Weele (2010, 37): quality management, technical and financial. Appendix 6 presents the resulted grading matrix.

As mentioned in the chapter 6.5, in the nuclear power plant, all systems, structures and components are grouped to safety classes 1, 2 and 3 and Class EYT (non-nuclear safety) on the basis of their importance for safety (YVL B.2 2019). This is now the starting point for the grading. New supplier grading also considers the two categories in the supplier selection noted by Sollish & Semanik (2011, 123): business criteria and operations criteria. Business criteria includes historical data, like financial analysis, customers and reputation. These will predict how well supplier candidate can meet the contractual obligations over time. Grading matrix's financial and technical risk-based assessment focuses on this business criteria. Operational criteria is covered by management system requirements with an option for supplier audit, factory visit. Considering that the grading is now to be performed at the very beginning of the process, it brings transparency to the whole supplier selection and approval process, and moreover it improves comparison of supplier candidates from risk perspective.

8.4 Risk assessment in supplier selection

I targeted to create transparent and easy-to-use tools to support the supplier selection and approval process. Thus, the inputs needed to perform preliminary financial evaluation are covered in the supplier questionnaire. This will save time from searching the relevant financial data, as it is requested directly from the supplier as part of initial screening. Following the literature review, especially Alma Talent's (2021) key ratios in Table 1 with

indicative reference values, and based on the expert interviews, four financial ratios (Table 2) are included to the financial risk assessment in appendix 6.

Table 2. Financial ratios for risk-based supplier assessment

Financial ratio	Purpose
Estimated contract value / revenue = <50 %.	This shall ensure that supplier has prior experience on similar magnitude deliveries and it has enough resources for successful delivery. This figure also reveals supplier candidate's interest towards tendering. If contract value is only marginal as compared to the revenue, there is a risk that bigger customers will get priority in case of overbooked production capacity.
Equity ratio	Calculated by dividing total shareholders' equity by total assets. Reference ratio of 40 % is considered to be good and below 20 % is poor. The higher the equity, the lower the probability of payment default.
Return on equity	Measures company's profitability by dividing net income by shareholder's equity. As per chapter 6.4, ratio over 15% is good and below 5% indicates weak profitability.
Current ratio	Selected to give an assumption of a company's ability to pay back its debts with its assets by dividing current assets by current liabilities. Whereas ratio over 2 is good and below 1 is poor.

These ratios are to be used as an alarm signals, and it is to be noted that these do not tell the whole truth about company's financial performance in the long run. Purpose is to avoid making long term commitments to companies which may face delivery issues or even bankruptcy in the near future. Financial department's expertise is to be utilized for more thorough financial evaluation. In addition, certain payment terms and warranties by mother company can provide financial security to contracting.

As defined by van Weele (2010, 37) technical risks refer to expertise of the management, suitability of the production facilities, the skills, tools and testing equipment of the supplier. These aspects are covered in the supplier questionnaire, which contains topics related to the company's organization and technical capabilities. Supplier questionnaire is utilized to tackle also quality risks. Quality management of the supplier candidate and quality control aspects are covered in the Management system and certifications -section of the questionnaire. Related to major or safety critical supplies, it is rather common to conduct an audit to supplier facilities. By auditing it is possible to verify the level of implementation of the documented practices.

8.5 Supplier approval template

In this new process model, supplier approval -template (appendix 7) is a summary table to combine all the information generated along the evaluation process. This template is used for the official review and approval of a supplier candidate, as that document is to be submitted for approval in the electronic document management system. Supplier approval template can also be used as a check list to ensure that all steps along the selection process have been taken. Template includes following sections:

1. General company information, e.g. name, address and contact person
2. Scope of works, including safety class and supplier grading
3. Compilation of documents generated during the process
 - Contractor's Liability Act
 - Procurement Plan
 - Supplier Questionnaire
 - Supplier grading matrix
 - Financial check, if >5k€
 - Audit report / Corrective action plan (CAP)
4. Evaluation of a need for authority (STUK) approval
5. Review meeting memo, including date, participants, comments
6. Decision and valid until date.

Template is intended to present the review meeting recommendations and process steps taken in a clear manner, so that the final approval or rejection of supplier candidate is then easy to make.

9 Evaluation by focus group

After finalizing the proposals for new supplier selection and approval procedures, including new process model, supplier questionnaire, new method for supplier grading and new supplier approval template, I organized a focus group to discuss and comment these outcomes. The interviewed experts and case organization's thesis supervisor formed the so-called focus group. At first, I stated the initial problem, objectives and methodology of this research work. Continued by presenting the interview results and research outcomes, including new templates. Appendix 8 includes this thesis presentation given to focus group. Purpose of this group discussion was to get feedback for the development proposals and have confirmation about the suitability of the outcomes.

During the focus group discussions, very valuable comments and advises were given by the experts. Such as uniqueness of the technology as a risk aspect. Meaning that are we binding our options to single supplier for several years by placing an order to certain company. For example, considering later availability of spare parts and maintenance work. As one Supply Chain Management expert clarified:

Typical to nuclear industry is that when you are doing this requirement specification and design for some system and there is some equipment, for instance valve. It is very hard job to replace that equipment by some other equipment. Because you have to do this change work for that. It means that you have to apply STUK approvals for those. You have to do new justification. When you have selected the supplier, it will be the supplier, not forever, but I would say that the change process is so difficult and time consuming that it is easier to stay on that equipment and manufacturer.

This uniqueness of the product and assessment of suppliers' capabilities for continuity of the service are taken into account in the Supplier grading -template. This statement basically emphasizes the need for thorough risk-based assessment of supplier candidates. Also, it was noted during the discussions that Valvomo-service provided by Suomen Asiakastieto Oy is available only for Finnish companies. Thus, case organization does not have similar visibility to the financial statuses of foreign companies. Moreover, Financial expert clarified that the financial ratios do not give full picture about the company's financial status. Thus, it was recommended to invite specialist from the Finance-unit to the review meeting to provide further analysis on financial statements.

Other valuable comment was given by Quality Assurance specialist, related to the STUK decision 31/0002/2020 (STUK 2020) for applying YVL A.3 and ISO 19443 standard. Point was that, at the moment, YVL A.3 compliance is required only from EPC Supplier and

Main Contractor. Most probably, during the operation phase, deliveries with such complex supply chains will not be ordered. Thus, focus group recommended to update the proposed grading matrix by requiring Project specific management system to comply with ISO 19443 or YVL A.3 annex for safety class 1 supplies. Initially proposed full YVL A.3 compliance was not considered necessary and should be required only in very special, complex, cases.

Focus group participants appreciated the clarity of the new process model and how supplier grading was now supporting the selection process and comparison of the candidates. It was little bit questioned by one expert if the Supplier Questionnaire is too heavy, but it was noted that this type of questionnaires and even longer templates are common practice in the nuclear industry. During the concluding words of the focus group meeting, one case organization's manager gave credit to the research outcomes, "Of course, when the amount of information is increasing, it may automatically little increase the work of handling, but it's worth for that cause there is so much improvement what comes to the overall process and others."

10 Conclusions

In this research, objective was to find out what kind of methods and what kind of process would be most optimal for the case organization to conduct its supplier selection and approval. To provide answer to this research question, I started my research work with the sub-question of how case organization is currently assessing its suppliers. This sub-question was answered by analysing the current process and methods implemented in the case organization, for instance reviewing related management system documentation. Having worked about six years in the company, helped me in this phase of the research as I had observed and worked with this supplier selection and approval process. Having gained understanding on the current supplier selection methods, I wanted to discover what are the possible weaknesses in the current process. Before approaching case organization's expert to have their view on current process and development needs, I needed to get further insight about good practices from the literature review. This data collection and recommendations from the authors supported me in preparation for the interviews. Interviewing case organization's experts turned out to be extremely valuable in understanding the starting point for development work and in formulating optimized methods and process for selection and approval of suppliers. Via the theme interviews with quality assurance, financial, procurement and supply chain management experts, I managed to identify weak areas in the current process and received ideas for further improvement.

By thorough literature review, I was able to answer the third sub-question of what kind of selection and approval criteria for suppliers is recommended by literature. Process mapping, literature reviews and expert interviews all provided insight into what kind of selection process could cover risks associated with supplier approval. By combining the best practices and tips from the literature review with the interview results, and by applying process mapping, I created new process model for the selection and approval of suppliers. This new process is supported by three new templates. These templates are Supplier Questionnaire, Supplier grading matrix and Supplier Approval -template. Evaluation of the research outcomes was done by the focus group. During this group discussion some valuable comments were given by the case organization's experts for finetuning the process model and templates. These final updates ensured that the proposed process and templates are optimal for the case organization to conduct its supplier selection and approval.

Planned benchmarking could have brought good tips and recommendations on how to implement best industry practices. However, considering that the interviewed case

organizations' experts have previously worked e.g. in an operating nuclear facility and in a manufacturing organization which supplies components to several nuclear power plants, and they reflected these experiences in their responses, I could say that even this benchmarking was covered to some extent. The selected research methods supported the performance of this research work and resulted to improved supplier selection and approval process for the case organization.

By this research work, I wanted to bring clear results to the identified weak areas (Table 3). Based on this feedback, "I would like to thank you for this work. This is remarkable improvement I would say. I was frankly speaking surprised how much the improvement there has been happening during this development work. So big thanks for this." received from the case organization's thesis supervisor at the end of the focus group meeting, I consider that this target was achieved.

Table 3. Research outcomes for the identified problems (Appendix 8)

Identified problems	Research outcomes
Supplier selection contains two processes.	✓ Supplier selection as one continuous process.
No transparency from end to start.	✓ Supplier assessment template summarizes the process
Grading is not clear, not supporting procurement.	✓ Grading revisited to guide from the beginning
Requirements are not clear, e.g. what is to be checked from the financial statement or experience.	✓ Financial evaluation and technical risk assessment specified
Stronger risk analysis needed.	✓ Risk aspects emphasized, ✓ Supplier questionnaire implemented.
Current process is seen rather light, baseline needed.	✓ Supplier questionnaire supported by grading matrix provide baseline
More focus on what is really required	✓ Technical, quality and financial risk aspects implemented to the process
Supplier selection is considered to be too dependent on the person, instead of process guidance	✓ New templates make the process more harmonized and independent from the person

As noted in the chapter 2, implementation of the new supplier approval process was not included to this research work. To ensure successful implementation of these new practices, this process and templates could be piloted with couple actual cases. Final implementation of the new process and templates shall be done as standard management system update. Brief training is also recommended to ensure that all involved experts understand and apply the new methods in a harmonized manner. As for any process, having key performance indicators (KPI) for this new supplier selection and approval process, should be considered for continuous development of the case organization's management system. KPIs could follow for instance handling duration of the supplier approval process or amount and type of non-conformities by the approved suppliers, Further research could be performed to analyse suitable methods for management of the supplier base and controlling of suppliers' performance.

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Attachments

Appendix 1. Interview guide for case organization's experts

Main themes	Support Questions
Introduction	Introduce myself, expectations for the interview and timeframe. Ask permission to record the interview.
Supplier assessment	<p>What is your role in the supplier assessment and selection process?</p> <p>Based on your experiences what is working / not working in the current process?</p> <p>Which units should contribute to the supplier assessment?</p> <p>What do you consider to be essential regulations guiding the assessment process?</p> <p>Utilization of grading matrix</p> <p>Risk assessments (quality, technical, financial)</p> <p>Is there some aspects missing in the current process?</p>
Supplier interface	<p>Supplier questionnaires</p> <p>Supplier audits</p>
Measuring the process	<p>How would you measure the success of the supplier assessment process?</p> <p>KPIs</p>
Wrap-up	Summarize key take-aways

	<p>Is there still something else to consider?</p> <p>Agree on next steps</p> <p>Thank you!</p>
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Appendix 2. Interview guide for benchmarking

Main themes	Support Questions
Introduction	<p>Introduce myself, expectations for the interview and timeframe. Ask permission to record the interview.</p> <p>What are your main responsibilities?</p> <p>Describe in brief the characteristics of company and its supply chain?</p>
Supplier assessment	<p>How the responsibilities in supplier selection process are distributed?</p> <p>Describe the main aspects in supplier approval and selection in your company?</p> <p>In general, what practices are essential for successful supplier assessment?</p> <p>Any experience of something that has turned out as failure in supplier assessment?</p>
Supplier grading	<p>Utilization of a grading matrix</p> <p>Risk assessments (quality, technical, financial)</p>
Main regulations	<p>Regulatory background</p> <p>Main laws and regulations affecting to the assessment process</p>
Supplier interface	<p>Supplier questionnaires?</p> <p>Supplier audits?</p>
Measuring the process	<p>Have you established any key performance indicators to measure the process?</p> <p>What kind of KPIs?</p>

Wrap-up	Summarize key take-aways Is there still something else to consider? Agree on next steps Thank you!
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