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A Proposal for Making an Information Model for an Acquisition Organization

Simen Lunke
Land Systems Division
Norwegian Defence Materiel Agency
Oslo, Norway
slunke@gmail.com

Satyanarayana Kokkula
Systems Engineering
University of South-Eastern Norway
Kongsberg, Norway
Satyanarayana.Kokkula@usn.no

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Abstract. Norwegian Defence Materiel Agency (NDMA) acquires military systems for use in the Norwegian Armed Forces (NAF). Acquisitions are organized as projects, and at any given time, more than 200 projects of varying complexity are running. Projects last for several years, and a lot of information is created and shared between NDMA, NAF, and the suppliers during the project phases. In this research we propose an information model by collecting information elements from existing processes and presenting them in a coherent model. The information model is described in three different ways using systemigram, logical model, and physical model. We validated the proposed model in an internal training session for NDMA employees, where we found that the systemigram was a suitable tool for training new project members. The main benefit of the information model is to shorten the project time, as demonstrated by an estimated time saving up to 19% using the Constructive Systems Engineering Cost Model. Further validation of the proposed information model on a complete project is required.

Keywords. Acquisition, information model, MBSE, digitalization.

Introduction

In the years to come the Norwegian Defence Materiel Agency (NDMA) has to increase the amount of acquisitions, and therefore has to streamline the resources used in projects (MoD, 2024). One way of doing more with less resources can be digitalization, and to do this it is necessary to understand the system that needs digitizing. This research will contribute to this understanding by describing the information model for an acquisition project in NDMA.

NDMA is an agency under the Norwegian Ministry of Defence (MoD), with the main task of acquiring military equipment for the Norwegian Armed Forces (NAF) (MoD, 2019). NDMA is organized into four divisions: Air Systems, Naval Systems, Land Systems, and Communication Information Systems, as well as five other units. It has a total of 1533 employees (Forsvarsmateriell, 2023).

As shown in Figure 1, several organizations are involved in acquiring military systems. The MoD and Norwegian Defence Staff manage the process on the government side. NDMA fulfills the needs of the NAF with systems acquired from one or more suppliers.

This research is limited to the NDMA Land Systems Division. Other divisions might have similar challenges that can benefit from the model proposed in this study. However, the model must be analyzed and possibly adapted to fit due to differences in the type of systems acquired and the broader context.

The system of interest in this research is the acquisition framework itself. The acquisition system can be defined as the processes and procedures that NDMA uses in an acquisition project. Input to the system is the needs of the NAF and the order from the Norwegian Defence Staff to acquire a system.

The system's output is the materiel system to the NAF and all information and material necessary for maintaining and sustaining the system in its lifetime (see Figure 1).

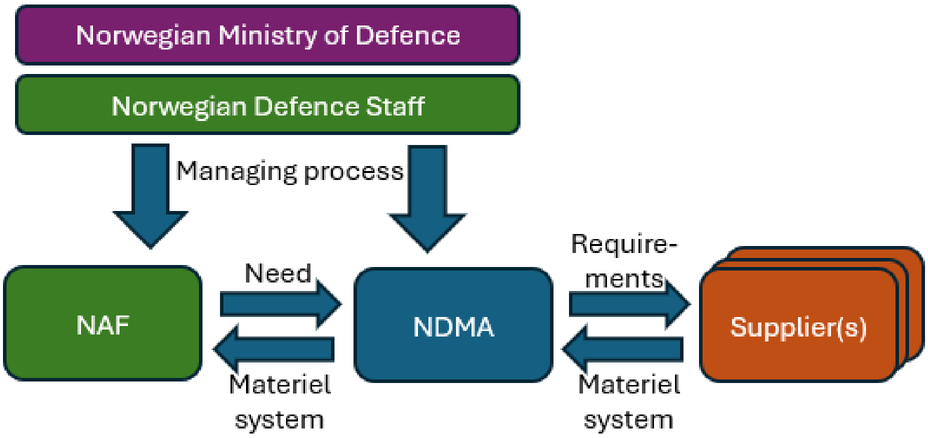

Figure 1. Actors in the acquisition process.

Problem: Acquisition within NDMA is usually organized into projects, and NDMA performs many projects simultaneously. Depending on the role of the individual, each employee is involved in one or several projects. Projects generate a lot of information, which is stored in several locations. Problems the project members can encounter are:

- challenging to find current/updated information
- long time needed for onboarding new project members
- challenging to keep track of information and changes to information

Solution: A possible solution to the problem starts with structuring the information in the same way in projects. This structure can be used to create a software tool or internal procedures to overcome the problems. Structuring information and knowledge in a standard way across projects positively impacts the time and quality of a project (Forcadell & Guadamillas, 2002). The research aims to create an information model for use in projects at NDMA and further validate if the model is possible to use in projects of different sizes, lengths, types, and complexity, see Figure 2.

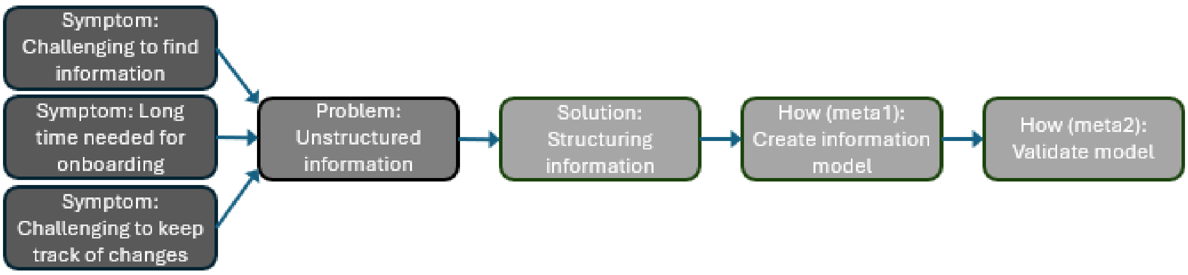

Figure 2. Symptoms, problem, and solution.

The research questions (RQ) derived from the problem statement are:

- RQ1 What information is common for most acquisition projects, and how do project teams store and share information today?
- RQ2.1 How can building an information model help NDMA to streamline projects?
- RQ2.2 What are the success factors for selecting a common information model?
- RQ2.3 Can a variety of projects use a common information model?
- RQ3 What is the best practice in similar organizations for building an information model?

This paper first describes the research methods used in the research. Second, it provides a brief introduction to the supporting literature. After this the proposed information model is described, first from a higher level and then in more detail in some areas. The research results are discussed before a conclusion on the information model's applicability in NDMA. Finally, some areas for future research are proposed.

Research Method

This study will use a multi-step research, as shown in Figure 3. First, a review of state-of-the-art literature in the field is conducted. The review will search for information in the Systems Engineering Body of Knowledge (SEBoK), literature from other sources, and papers and articles from companies and agencies involved in the field.

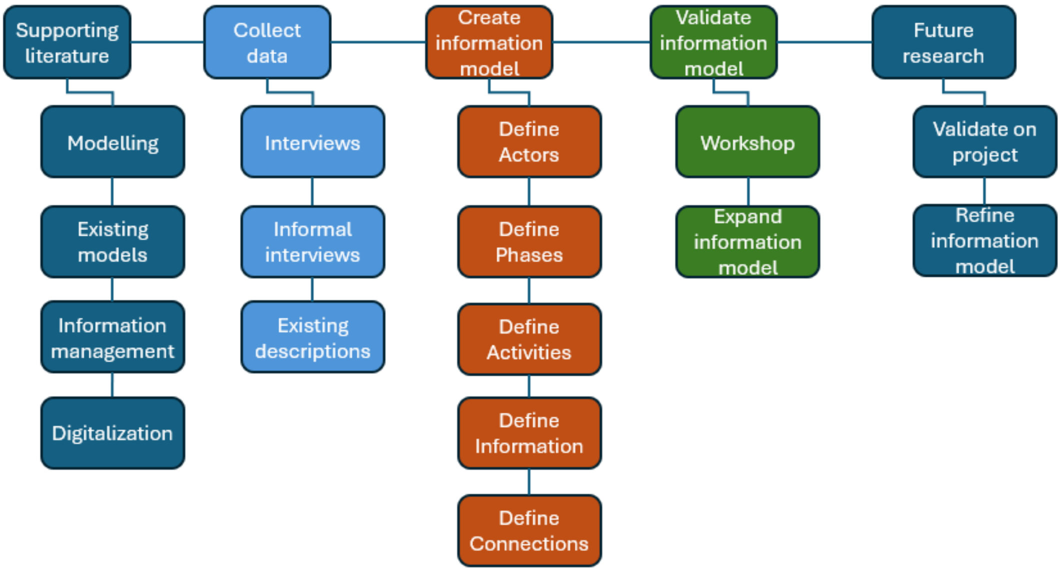

Figure 3. Research design.

In the first step, we use knowledge from existing literature as a foundation to gather the data needed to create a proposed information model for NDMA. The primary data collection involves conducting interviews with seven employees at NDMA. The participants are selected based on their varied experience in projects and from several parts of the organization. This will help illuminate the problem from several points of view, as well as collect any best practices from parts of the organization that can be combined in a proposed information model for NDMA.

In the second step, we use both formal and informal interviews to gather data. The number of interviews is a balance between the amount of information needed to create the information model and the time available to do research. Using few interviews and gaining insight from fewer projects would give a narrow base for the model. Questionnaires could be used to gather information from more employees but would increase the uncertainty of the respondents understanding the problem. The formal interview balances the need for describing the problem and having comparable answers from respondents.

The informal interviews are informal talks with stakeholders with experience with respect to the problem. They aim to fill small gaps in the collected data or gain insight into the topic from other perspectives. Documentation from NDMA's Quality system will also be refined and used in the proposed information model.

Then the proposed information model will be created in a step-by-step process with layers of information. This process will be iterated whenever necessary.

In the final step, the information model is validated in a workshop, where the interview participants review it and assess whether it would be useful in their project. A better approach to validation would be to use the model in a complete project. However, this is not possible due to the long timeframe of a project and the shorter time available for this research.

Supporting Literature

Modelling. The terms abstraction and conceptual model are described in SEBoK (SEBoK, 2023b). A model can be abstracted to a higher level to hide unimportant details from the viewer. These can be details that are not important for the understanding of the model and the message that the author is trying to give. It describes the possibility of creating a view of the model to show the relevant information for a specific stakeholder. A conceptual model shows the elements in a system and the relationship between them.

The Norwegian Digitalisation Agency has created guidelines for creating information models (Digitaliseringsdirektoratet, 2021). The guidelines describe how to create an information model that can be submitted to a common catalog for sharing information between agencies in the Norwegian government. A description of an information model following their guidelines also includes all the data fields and parameters, which could also be called a data model.

The proposed model in this paper will first be described at a high level to give an overview and then a detailed view of specific areas. This will make the description of the information model easier to follow. The information model will not include specifications of data types and will therefore not be a data model. A data model is needed when creating software and digitalizing but is outside the scope of this research.

Existing information models. Object Management Group (OMG) has created a description of a Unified Profile for DoDAF and MODAF (UPDM) (OMG, 2013), which includes all necessary elements for US Department of Defense and UK Ministry of Defence. The document is primarily a technical description of the data model.

The Model Base Acquisition User Group has created a reference model for use in acquisition processes (Hart & Hause, 2023) in the United States (US). The model focuses on structuring information in model-based systems engineering (MBSE). The user group emphasizes the need for standards to exchange models between the acquirer and supplier.

Christer Fröling (2022) describes a generic information model for an acquisition organization. He describes how documents are updated during the process, since the process is very iterative. The documents are divided into several types: administrative documents, requirement documents, and commercial documents. He describes the need for a project to define an information structure to avoid misunderstandings and errors.

When creating an information model for a specific company or organization, it is essential to tailor the model to the organization, "*not too little, not too much*" (Wheatcraft, 2023a). This paper suggests a model based on the research in the referenced literature tailored to the needs of NDMA.

Information management. Information management (IM) is a sub-activity under Systems Engineering (SE) management in SEBok (SEBoK, 2023a). IM is described as collecting, managing, and distributing information to recipients. Information can be relevant for an entire organization or only one specific system. Some good practices are listed, including creating a data model to support efficient information management.

Digitalization. Dinesh Verma (2023) describes that an information support system must be designed with a human-centered approach. He describes the need to understand the environment before designing the system and consider the user needs and acceptability of a support system.

The Norwegian Digitalisation Agency has some design principles (Digitaliseringsdirektoratet, 2022) for creating a successful data model, including focusing on the user needs, using existing terminology, making it accessible in standard formats, and making it modular.

The Current Situation at NDMA

MoD requires NDMA to follow the PRINSIX project framework in acquisition projects (MoD, 2019). The framework controls all phases, from the idea phase to the transition phase, where a system is handed over to the NAF and put into operational use (Gravås, 2021). Figure 4 shows all the phases with English translations.

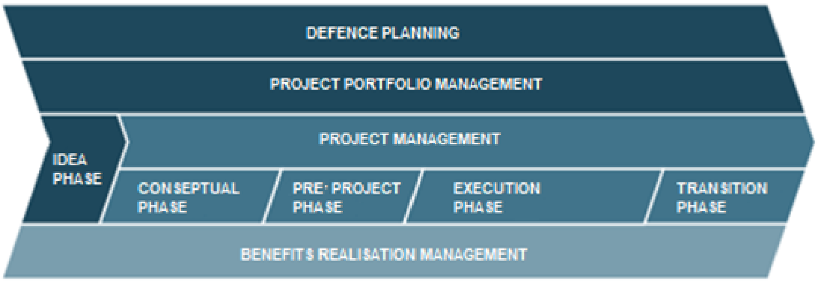

Figure 4. PRINSIX Project framework, (Forsvarsmateriell, 2020), translation by the author.

Respondents in the interviews described the current situation. There are no overall regulations or procedures controls on how each project handles its information. The PRINSIX project framework contains templates for project management documents for most project phases but has some shortcomings, especially in the execution phase.

The quality system of NDMA contains templates and descriptions for some information elements. Respondents characterize them as being created for a specific project case, such as a large and complex project, and unsuitable for a small and less complex one. Sometimes, the knowledge necessary for using the template is not available. One respondent described a case where they were expected to create a document based on a mostly empty template without suitable guidance or training. Individual templates and procedures can also be well described but challenging to combine in a project. This can be due to the writing focusing on the individual topic without the overall process in mind. These shortcomings are usually mitigated by sharing knowledge with colleagues.

The current use of information technology platforms for storing information also varies from project to project. The choices reported by the respondents were Unclassified Teams with a folder structure, Classified folder structure, Forsvarets Investment Database (FID) based on SharePoint with folder structure, and specialized software for file handling. Selecting an unclassified or classified folder structure mainly depends on the need to cooperate with people outside NDMA who do not have access to the classified system. Projects started recently favored FID over a plain folder structure. The actual structure of the information was defined by the project members and, in some cases, documented in an IM description. One large and complex project used specialized software for file handling. Due to the size of the project organization, they have a dedicated information manager to administrate the specialized database.

The research contribution in this paper is to collect information elements from the existing processes and present them in a coherent information model. The information model is described in three different ways in this paper. It is not a data model as described in (Digitaliseringsdirektoratet, 2021), but the different ways correspond to their definitions:

- A conceptual model describes the most important aspects and their connections in a systemigram.
- The logical model describes the types of information in a defined context.
- The physical model describes information exchange and storage for a defined solution.

Proposed Information Model

The term “information element” is used to describe a collection of data that belongs together. This is the same as a document, but the term will keep the model agnostic regarding software tools. An element can be stored as information in a database or as a document without changing the model. We combined knowledge from several sources to create the information model. In the interviews, we gathered information elements from project members and how they used these information elements in their current and previous projects. This was combined with information elements from existing descriptions and literature. The model was created using SysML, but a version with regular graphics is used in this paper and can be used in training courses because they are easier to understand for a reader not familiar with SysML.

The context of the proposed information model describes the elements that influence it, as shown in Figure 5. The information model is governed by the management documents, which are everything that controls how NDMA must work and how each project has to work. Some elements are generic to NDMA: laws and regulations, PRINSIX project framework (Forsvarsmateriell, 2020), and NDMA quality system.

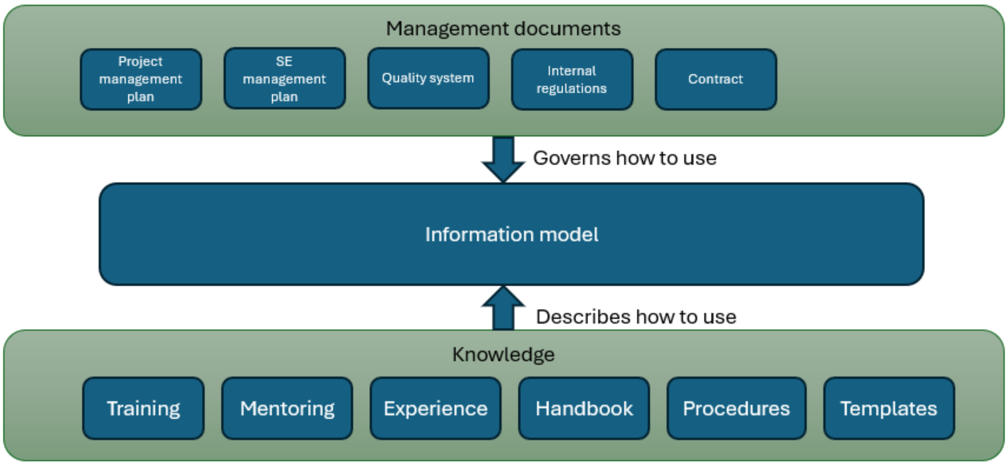

Figure 5. Information model context.

Each project is governed by the Project Management Plan (PMP) and the Systems Engineering Management Plan (SEMP). They are created by the Project Manager and Technical Coordinator as either two separate documents or one combined document depending on the size and complexity of the project. In the PRINSIX project framework, the PMP is not created until the execution phase, and no SEMP exists nor is required. However, this proposed information model suggests that both plans are created as early as possible. When a supplier is awarded a contract, the requirements in the Statement of Work (SOW) will control the process and how information is shared between the NDMA and the supplier.

Employees need to know how to use the model. This knowledge is first gained from training courses and later refined from experience. The knowledge should be explicit and codified as far as possible, and the different types will complement each other to increase the usefulness of the information model (Hansen, Nohria, & Tierney, 1999).

The actors involved in the acquisition processes are shown in Figure 6. The MoD is the delegating authority, and the Norwegian Defence Staff is usually the project owner who monitor the project execution. Both NAF and NDMA will participate with several parts of the organization and individuals with different roles in each project phase. There will typically be several potential suppliers in the evaluation and negotiation phases, but will, in most cases, be reduced to one supplier when the contract is signed.

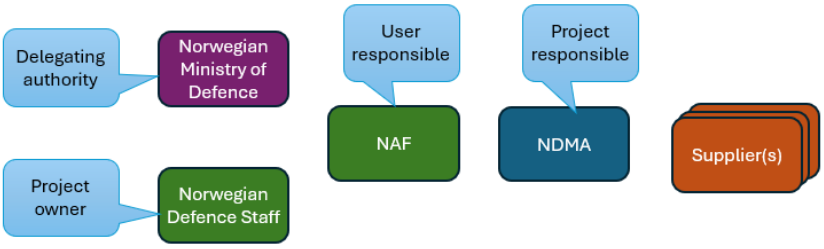

Figure 6. Actors in acquisition processes.

The PRINSIX Project Framework defines five project phases: Idea Phase, Conceptual Phase, Pre-project Phase, Execution Phase, and Termination Phase. In this model, we split the Execution Phase into six subphases to separate the activities and relevant information. We placed the information elements from the research into the phase where they mostly belonged. Elements that are relevant in several phases were placed in the phase where they first appeared. The high-level view of the model in Figure 7 contains all the phases and the main information elements. Each element can also have sub-elements that are not shown in this view. Some examples will be described later in this paper.

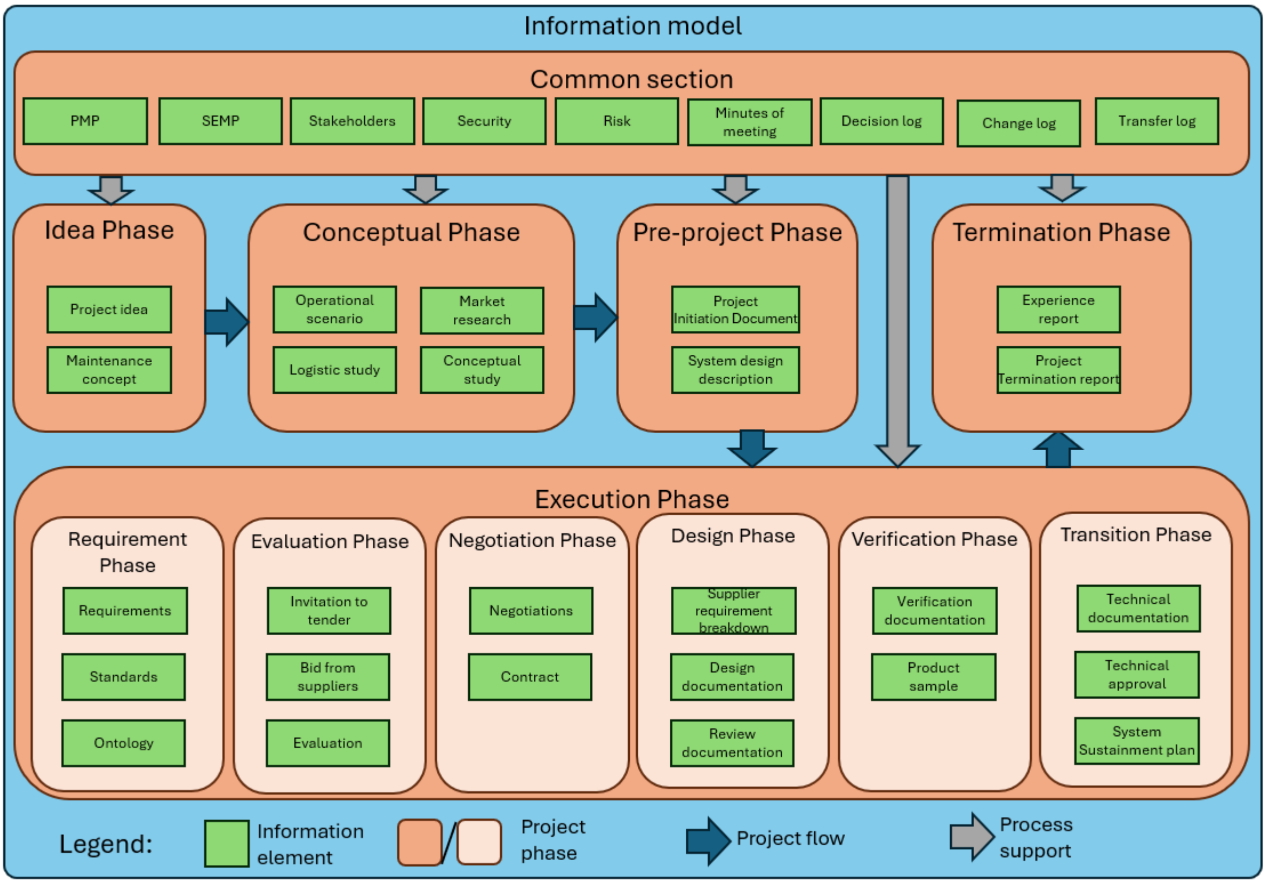

Figure 7. Project phases and information elements.

The information elements in the common section are relevant for all project phases. Some are created early in the project and updated throughout the phases, while others are more like databases for information created during the project. See Table 1 for a description of each element.

The top-level information elements can also contain sub-elements. As an example, the element “Review documentation” contains all the information created and shared with the supplier during reviews. The number of reviews depends on the complexity and nature of the project, but the types follow the description in ISO 15288, such as preliminary design review, critical design review, test readiness review, etc. A project procuring of-the-shelf components may have fewer reviews, whereas a project developing a new capability will have more reviews. The tailoring of reviews for a specific project is described in PMP/SEMP and formalized in the SOW of the contract.

Table 1. Information elements in the common section.

Information element	Description
Project Management Plan	A plan for the topics relevant to the project manager
Systems Engineering Management Plan	A plan for the topics relevant to the technical coordinator. This can be combined with PMP in a small project
Stakeholders	A list of all internal and external stakeholders with interest in the project
Security	A threat assessment and mitigation of security, including physical-, personal-, and information security
Risk	Periodically updated to reflect the risk to the execution of the project
Minutes of meeting (MoM)	From all meetings in the project, internal and external, to keep track of information shared and topics discussed
Decision log	Log with all important decisions
Change log	Log of important changes in the scope of the project
Transfer log	Log of documents sent to or received from the other actors

Each review follows typically the same structure, see Figure 8, where the supplier sends a package containing the documentation to be reviewed ahead of the review as specified in the SOW. NDMA reviews this documentation, and sends feedback to the supplier. A formal review meeting is held, which results in a Minutes of Meeting with action items. The supplier sends updated review documentation within a defined deadline, and NDMA issues an Authorization to Proceed given that the review outcome is positive. If necessary, the process is repeated until the quality of the documentation is sufficient.

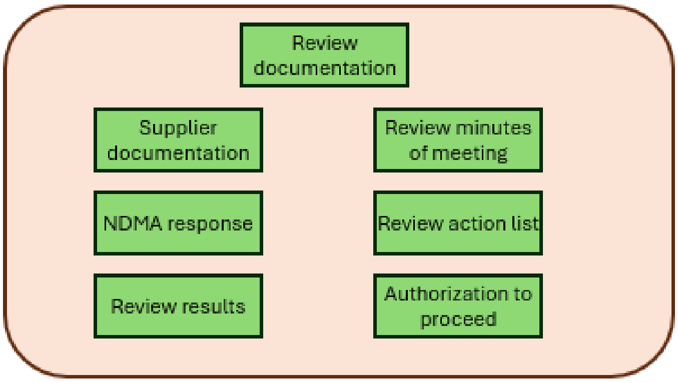

Figure 8. Review documentation.

Linking Information Elements

The information elements in the model depend on each other, and project members need to understand the dependencies. A graphical way to show dependencies is with a systemigram, as shown in Figure 9. The color of the node represents the actor responsible for that information element. The mainstay is represented with a bold line. It shows the story of how the operational need is transferred to requirements and ends up as a delivered system and an operational capability.

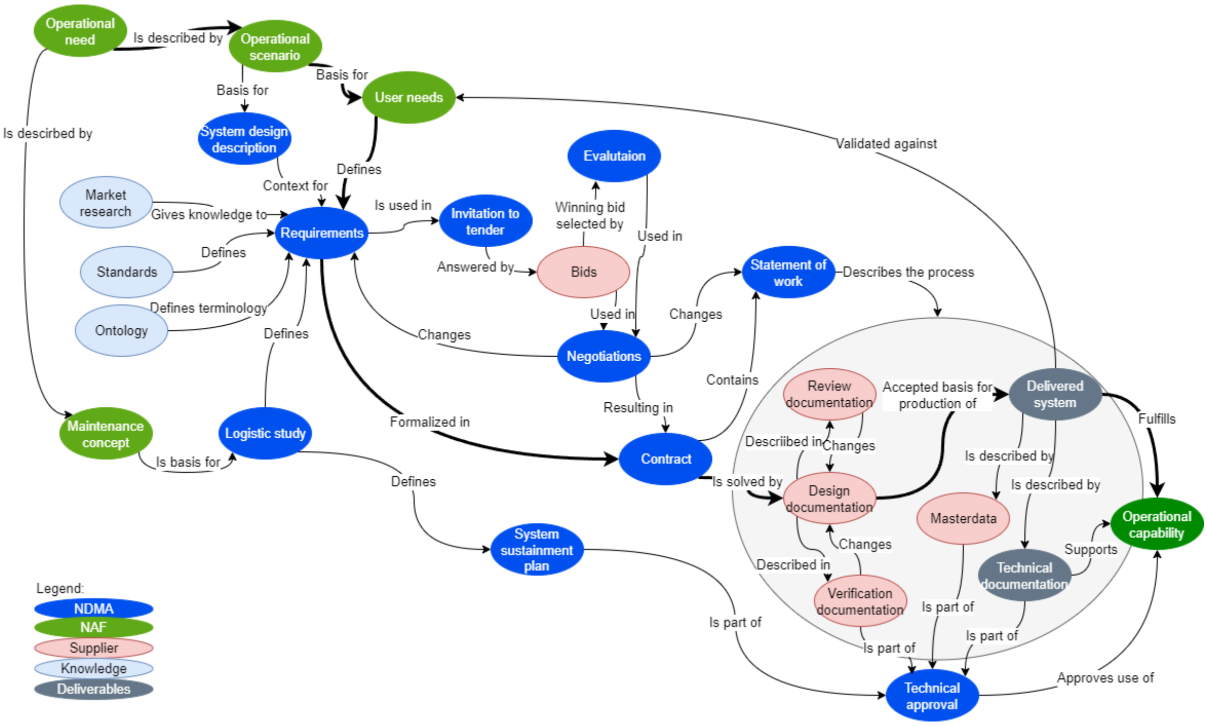

Figure 9. Systemigram of information model

Story of Integrated Logistic Support. The systemigram can be adapted to show different aspects of a project. In Figure 10, the systemigram shows how the integrated logistic support, known as ILS, is handled. ILS shall "*make sure the delivered system is designed, procured, transited into use, and used, maintained, supported, stored, and phased out in a way that requirements for performance and operational reliability are satisfied cost-effectively*." (Forsvarsmateriell, 2020). Using the adapted systemigram, we can see that:

- Early effort to create a maintenance concept is vital to support the operational capability.
- Requirements for ILS are part of the system requirements.
- The same design-review-verification process covers topics for ILS as the rest of the system.

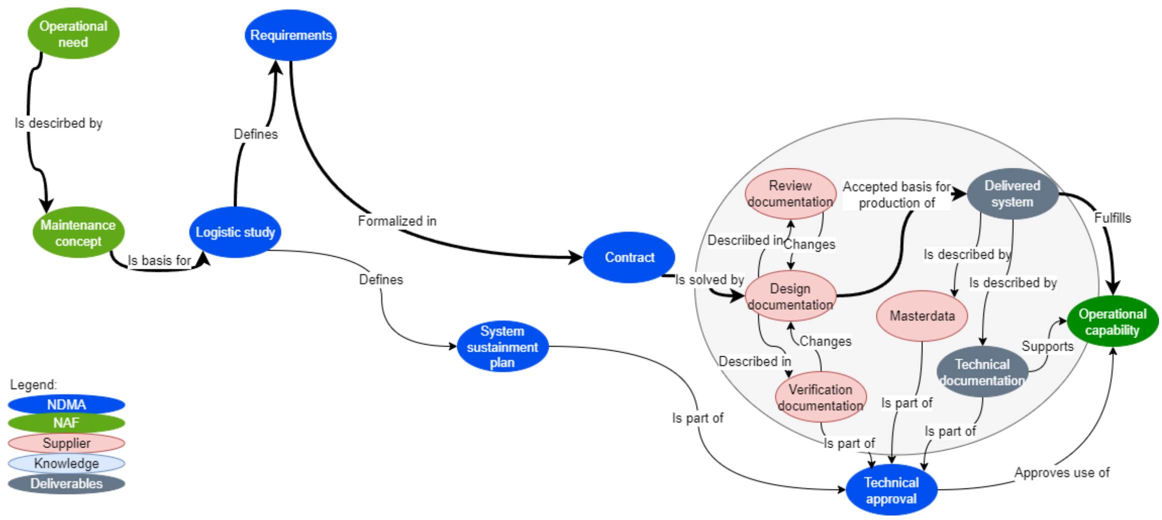

Figure 10. Systemigram with the story of ILS.

Physical Model

In the proposed model, the information elements can be stored in databases or as documents. Databases are preferred for information that is updated regularly. Documents are preferred for information that is shared between organizations since software compatibility for reading documents is more straightforward than for databases. The physical model should be tailored to the size and complexity of the project. A small project could use a folder structure with documents, whereas a big, complex project should use a database for handling information.

The proposed information model can be adapted to all cases and tailored to each project. The specific tailoring should be described in an information management description in the PMP. Properties when selecting physical models and describing information management include access control, version handling, and change tracking.

Figure 11 shows an example of a physical model for a generic project. When creating this kind of implementation, the project should consider what is essential for the individual project. In this example, they use two databases, one for requirements and one for technical documentation, and store the other information in documents in a folder structure.

The requirement database is first populated with the user needs in the conceptual and pre-project phase, and later used for engineering the requirements, evaluating the offers, and checking verification results. Having all this information in the same database, makes it easy to follow and trace a verification result back to a user need. Information from the database is shared as a spreadsheet because it is easy for all external actors to use without specialized software. The supplier creates technical documentation, which in this example is received in a database format. To do this, it is necessary to agree on a database format and having compatible software.

When information is sent or received, a copy is stored in the transfer log, making it possible to check what information was received at what time. Most documents are shared as PDF files to conserve integrity, especially for information that is part of formal documents like the invitation to tender or the contract.

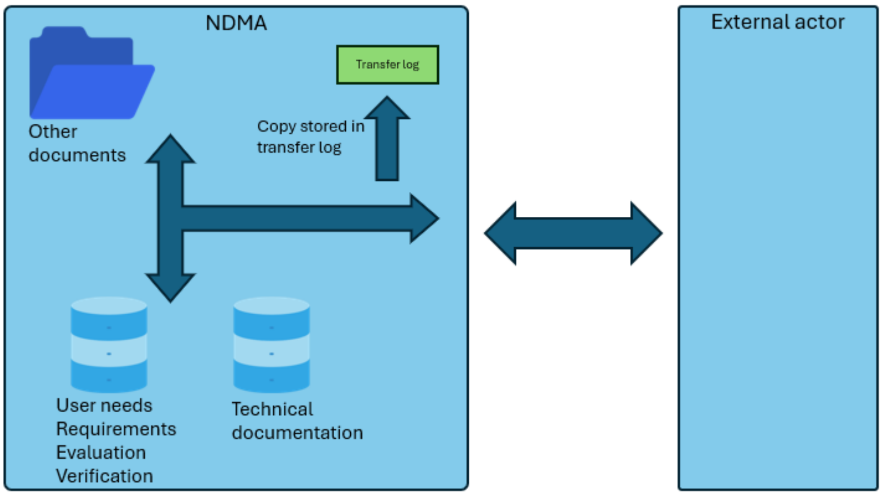

Figure 11. Example physical model.

Success Factors

In the interview, respondents were asked for success factors for them using the suggested information model. One factor reported by most of the respondents was that the model had to be easy to use. Different people had different inputs on what would make it easy to use. The most important aspect was that the information model was presented in a way they could understand. Some suggested that it should be presented in a graphical way with hyperlinks, so it is possible to get more information on the information elements. This can include templates, process descriptions, and support documents. This research did not explore this approach due to lack of time. A related topic was support and training, where just receiving training at one time would not be sufficient. It would also be necessary to have mentors or experienced colleagues for help during the use.

Another factor was that the information model had to be *fit-for-purpose*. Not too comprehensive and adding unnecessary overhead for a simple project, and not too small and simple for a complex project. This can be achieved by having an information model that can be adapted for simple projects by removing elements and having possibilities for extensions for the most complex projects. This is also relevant for templates where not all paragraphs are always needed.

To give the model credibility, its creators should be familiar with project processes and have good insight into how projects create and use information. The model should have a clear line throughout all project phases, and it must be easy for project members to understand how to use it and what to do.

Respondents disagreed on whether it was important that all projects in NDMA used the information model for them to use it. For some it was enough that management said it should be used. The amount of training and support from colleagues would benefit from widespread use.

Software tools could support the information model to further increase usability. For some respondents, this would be an important factor for using it. Tools for requirements management are already in use in NDMA, but this could be extended with tools for handling other aspects of the information elements including information that is stored in documents today.

The success factors from this research are similar to the ones from literature, and the proposed information model is created with them in mind where applicable. Some of the principles from the Norwegian Digitalisation Agency (Digitaliseringsdirektoratet, 2022) can be highlighted:

- **Coherent across levels of abstraction,** by using the same phases and names for information elements.
- **User focus,** by making the model as simple as possible but still useful.
- **Terminology,** by using existing terminology so that experienced employees will recognize the current processes, while still offering new value.
- **Documentation,** if NDMA decides to implement the model, a significant effort must be made to create the necessary support documentation.
- **Accessibility,** during interviews and the workshop, several respondents suggested making the model interactive for easy use.
- **Modularity,** a project needs to tailor the information model for its specific use.
- **Stable and extendable,** if implemented, the model should be updated regularly since new experiences will create a better model. However, having a stable model that anyone can use is important. Newer updates should also be compatible with the current version.
- **Tool independence,** the current model does not specify which tools to use. An information element can be created and stored in both specialized software and as a regular document in a folder structure.

Benefits

The main benefit of the information model is that it will shorten the time for a project. The time saved is due to decreased time necessary for training and easier understanding of the processes. It would also be less demanding to support a project for a short time since the information model would provide ontology and be recognizable from other projects, and it would not be necessary to use time to learn a new model. The information needed for a specific task would be stored in a known location and format.

An estimate of the time saved can be made by using the Constructive Systems Engineering Cost Model (COSYSMO) (Valerdi, 2006). When populated with project data, the model estimates how many systems engineering person months are necessary for all project phases. This model is calibrated by several large companies and implemented in an Excel spreadsheet. Some arbitrary values on a project size are entered to form a baseline. The model then uses 14 cost parameters to form a composite effort multiplier. A relevant cost parameter when introducing the information model is the *Stakeholder Team Cohesion*, with selected characteristics shown in Table 2. In the baseline, this is set to *nominal*, and the calculated SE person months is 222.2, as seen in Figure 12. After implementing the information model, we changed this parameter to *high* and got the new SE person months at 180.5, a 19% reduction. In a real-world application, the effort required to go from nominal to high on this parameter could be more than just implementing the information model. However, this number could be used as a rough indicator.

Table 2. Stakeholder Team Cohesion, extract from (Valerdi, 2006, p. 12).

Viewpoint	Nominal	High
Culture	Shared project culture.	Strong team cohesion and project culture. Multiple similarities in language and expertise.
Compatibility	Compatible organizational objectives.	Clear roles and responsibilities.
Familiarity	Some familiarity.	High level of familiarity.

If a software tool supported the information model, it could also include functionality for generating workflows. Respondents familiar with specialized software classified this as a benefit since it was easy to see if the proper process for a specific task was applied and the relevant employee had performed it.

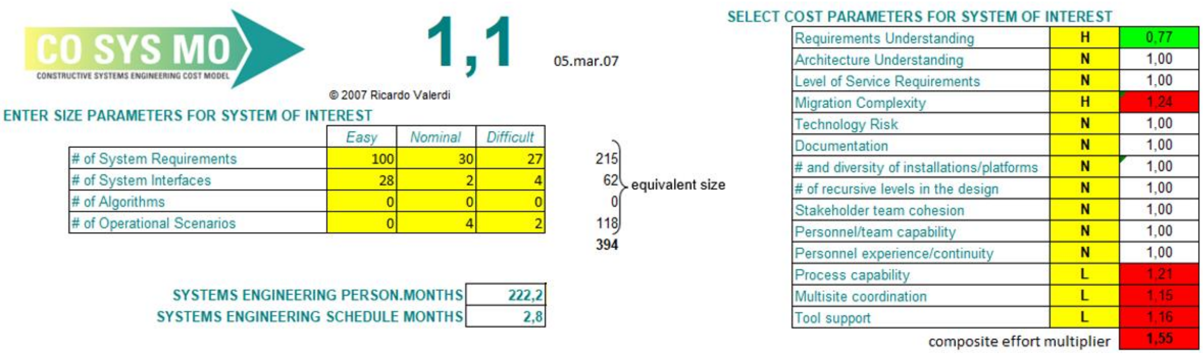

Figure 12. Baseline effort calculation (layout adapted for readability).

Most projects in NDMA run for an extended time, and it is normal for project members to change during the execution of a project. The information model includes a decision log to make it easier to track all the decisions made in earlier project stages. If there is a problem in the cooperation with a supplier, it is also possible to check what information was shared in the transfer log. When information is reviewed both internally by the project team and externally with the supplier, the information model and software tools should store all comments for later use.

Tailoring the Model

The information model should be tailored before being used in a project. Failure to tailor the model could mean that the project is doing things or creating information that is not necessary for that specific project and therefore wasting resources. By using the same baseline for COSYSMO as in Figure 12 and changing the *Documentation* parameter from *nominal* to *high* ("*High amounts of documentation, more rigorous relative to life cycle need*" (Valerdi, 2006, p. 10)), this situation is simulated and resulting in an increase of 29,2 SE person months (13% increase).

Early in the project, the project team should assess if information elements are relevant for the project, what the content of the information element would be, and if there is information in the project that the existing model does not cover. This tailoring should be described in the PMP or SEMP. The tailoring process for a typical project is estimated to take a few hours up to a day for a regular project team. The tailoring process should be revisited when entering a new phase. The context could have changed, and by that, the requirements for the information model. During negotiations and when signing the contract, it is essential to tailor the information model for the rest of the execution phase together with the supplier.

Discussion

Validation. The information model was validated in a workshop, where some of the respondents from the formal interviews participated. The workshop started with a short introduction to the information model, and then they were asked to assess if the model would be usable in their projects. All participants concluded the model would be usable, given that it was tailored to the project. All projects are different, and requiring all to use the same documents would cause extra effort where it is not necessary. One participant concluded that to tailor the model, the project team would need to have enough competence and insight to do it properly.

The information model was also tested during a 5-hour-long internal training session on writing requirements. The audience was mainly new to writing requirements, but some were more experienced. At the beginning of the session, the systemigram in Figure 9 was presented and used as a context for why requirements are essential since all other phases depended on them. The audience were asked at the end of the session if the systemigram helped them during the training. The model on its own, without any explanation, did not help in understanding the process since the systemigram contains a lot of nodes and connections and the audience did not have any prior experience with systemigrams. However, when the instructor explained the steps systematically, the systemigram was an excellent support for teaching the process and for audience to understand the flow of information. With more previous experience from projects, the systemigram was easier to understand without explanation.

Both the systemigram (in Figure 9) and the information model (in Figure 7) show a simplified version of the information model, excluding elements that can be equally important for some project members. This will always be the tension between showing the complete picture with all details and showing what is necessary to use of the model (SEBoK, 2023b). Looking at the complete model is necessary when creating templates or digitalization in NDMA. But for training purposes, the initial overview should use the conceptual model and then dive into the complete model.

Another benefit is the ability to track the history of information. One interview respondent claimed that problems will occur during a project execution, and being able to see what information was available at a specific point can be beneficial. This level of control will enhance the NDMA's professional image. The same argument is made in Wheatcraft (2023b) on why an organization should move towards MBSE: *"competitiveness and relevancy"*.

Contribution. Both the PRINSIX project framework (Forsvarsmateriell, 2020) and NDMA Quality System contain templates and elements that can be part of an information model. Our research has collected information elements from both sources and experienced project members' knowledge. The number of information elements in the different sources are compared in Figure 13 to visualize the contribution:

- In PRINSIX, the number of templates is counted.
- In the NDMA Quality system, which is modeled in Business Process Model and Notation, the number of nodes referencing documents or information is counted.
- For the proposed information model, a number is presented for the main elements in Figure 7 and the complete model with all sub-elements.

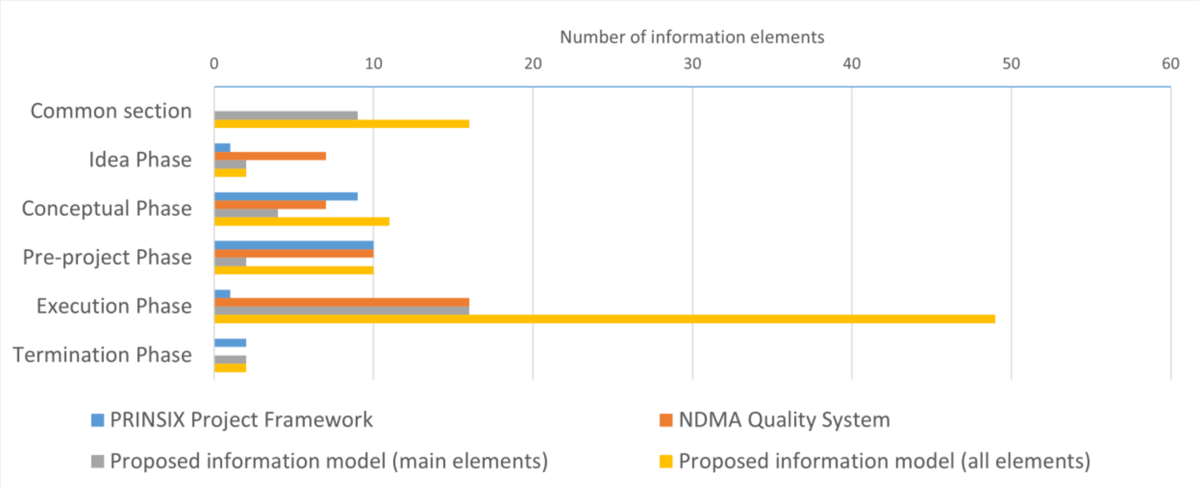

Figure 13. Comparing information elements from sources.

The proposed information model expands the current documentation in NDMA in most project phases. The only exception is the Idea Phase, where the quality system has separate descriptions for elements that are part of one template in PRINSIX and one element in the proposed information model. There is only one template for a change order in the execution phase in PRINSIX, but the NDMA Quality System contains 16 descriptions of information elements. The level of detail of the Quality System is comparable to that of the detailed information model. Therefore, we claim that our research has increased the amount of explicit knowledge.

Similar models. A similar model for MBSE is presented in (Hart & Hause, 2023). This model focuses on acquisition projects in the US context and under US law and has contract sections incompatible with the contract template in NDMA. The context and size of the acquisitions will also be larger than the size of most projects in NDMA, and introducing US models in NDMA context directly would not be *fit-for-purpose*. The data model UPDM (OMG, 2013) contains a comprehensive description of data elements and is not comparable to the information model presented in this paper.

Validity of research. The proposed information model is the result of interviews with employees in NDMA, the theoretical background from the support literature, and some existing process descriptions from NDMA. The selection of participants would have influenced results from interviews. Selecting other participants or more participants could give variations in the results. Participants in this research were from several subunits with different backgrounds and experiences. Their answers were similar, and no significant differences between the subunits relevant to the information model were found. This can be because all projects follow the PRINSIX project management framework. Projects are different, so there can be areas that would be better developed with other interview participants with other experience.

Conclusion

RQ1. What information is common for most acquisition projects, and how do project teams store and share information today? Based on the interviews, projects create similar information today. This can be explained by the fact that all projects follow the same PRINSIX framework. When it comes to physical storage, projects are more varied. Variations are justified in how project members cooperate internally and with external stakeholders.

Projects with well-organized information storage today have a governing document that describes how to store information, and in some cases a dedicated information manager. The research has not found a documented common way of doing this other than that good ways to organize information have been informally shared between employees.

RQ2.1. How can building an information model help NDMA to streamline projects? The most important benefit of the information model is reduced project time. The systemigram provides a new employee with a good starting point for understanding the processes at NDMA and will save time for training. If projects use the same information model, it will be easier for an employee to support a project in a specific phase because the information can be found in a familiar place. The COSYSMO model indicates that increasing the level of team cohesion can reduce project time by up to 19%.

NDMA will be more professional if all projects have the same information model. The project members will know better what information is relevant and their connections. The quality of the information early in a project will increase, leading to a better understanding of the requirements and, in turn, reducing the risk of delays and cost overruns.

RQ2.2. What are the success factors for selecting a common information model? The information model must be *fit-for-purpose* to get employees to use it. They need to understand the model and recognize their current processes. The proposed information model in this paper is based on the current PRINSIX project framework and should fulfill this requirement. It should be large enough to cover most information elements in a normal project, but at the same time not too large. The information model must be supported by training, both for new and experienced employees. The systemigram gives a good overview of the information elements and their relations.

RQ2.3. Can a variety of projects use a common information model? The information model needs to be tailored to be used in a variety of projects. The project team needs to have enough competence to do this, and the tailoring should be revisited during the project to change the model based on the changed context.

RQ3. What is the best practice in similar organizations for building an information model? This research did not find any model that could fit any acquisition organization. Each organization operates in a different context, and the context will heavily influence what is a useful information model. However, any organization can use the method of finding a useful information model described in this paper.

Future Research

Future research will improve the information model proposed in this paper. The first approach can be to validate the model on a complete project, described as a pilot project (Wheatcraft, 2023a). The research goal could be either refining and developing the information model or assessing how the information model has increased quality and decreased time in project execution. Secondly, a study could suggest how the information model can be used to elicit requirements for digitalization of the acquisition process. A third area of research can investigate the best balance of knowledge management techniques for using the information model in an organization like NDMA.

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Biography

Simen Lunke received his bachelor degree in engineering from the Norwegian Defence Cyber Academy in 2006, and served in the Norwegian Army until 2016. In 2016 he was employed in the Norwegian Defence Materiel Agency, and is now employed in a civilian position as a technical coordinator/systems engineer working with defence acquisition projects. In 2024 he finished an Executive master degree in Systems Engineering at University of South-Eastern Norway (USN).

Satyanarayana Kokkula received his PhD from the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. From 2006 to 2016, he served as a Specialist Engineer in Structural Analysis at FMC Kongsberg Subsea AS. In August 2017, Dr. Kokkula joined the University of South-Eastern Norway (USN) as an Associate Professor of Systems Engineering. He currently serves as the Program Coordinator for the Master's degree in Systems Engineering and oversees the Systems Engineering specialization for the Innovation and Technology Management Master's degree at USN. Dr. Kokkula is a Certified Systems Engineering Professional (CSEP) by the International Council on Systems Engineering, and a Senior Member of the Institute of Electrical and Electronics Engineers.