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# Functional requirements for a future farm management information system

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ABSTRACT

As a subsequent step of the conceptual modelling and the information modelling involving the specification of the knowledge content of the decision processes and the involved data imbedded in the information entities, a derivation of the functional requirements was carried out to support and guide the selection of the technological infrastructure of a dedicated farm management information system (FMIS). The study employed the core-task analysis (CTA) method involving a combination of science-based modelling, practice-based modelling, and integrated information modelling.

The “process” entities of the information flow model which represent the usage processes of the information, and of the “information” entities which represent the data elements were identified for the specific case of fertilising. This identification of the usage processes as well as the associated data elements showed the complexity of the decision making process within the domain of field operations. In a fully structured and formalised information flow decomposition, many actors are required to deliver information to the decision processes in order to fully emulate the tacit knowledge that the farmer are currently using. Especially, the concept of assisting services has to evolve in order to sustain the need of more automated decision processes in the future. New information management concepts and designs mean that farmers have to be ready to adopt new working habits and perhaps also undergo further training.



## 1. Introduction

The agricultural production sector faces increased pressure in terms of reduced margins of earnings. Farmers are forced to reduce production cost, maximise their physical output while maintaining the highest product quality (e.g., Andersen et al., 2007; Sorensen and Bochtis, 2010). These requirements go hand in hand with adherence to strict environmental, social, health, and safety regulations (e.g., certification schemes such as International Food Standard (IFS) and GLOBALGAP, Albersmeier et al., 2009). The use of information and communication technology (ICT) and farm management information systems (FMIS) and decision support has shown great promise for achieving the above goals, especially in the context of precision agriculture (Godwin et al., 2003; Nikkila et al., 2010). Murakami et al. (2007) found that the most important requirements for a farm management information system (FMIS) include: (a) a design aimed at the specific needs of the farmers, (b) a simple user-interface, (c) automated and simple-to-use methods for data processing, (d) a user controlled interface allowing access to processing and analysis functions, (e) integration of expert knowledge and user preferences, (f) improved integration of standardised computer systems, (g) enhanced integration and interoperability, (h) scalability, (i) interchange-ability between applications, and (k) low cost. A dedicated design of a FMIS complying with the above requirements involves an identification and specification of the scope and boundaries, an identification of system components (actors, decision processes, etc.) combined with information modelling, and finally, as part of the overall knowledge management, an identification of knowledge content in decision processes and functional requirements.

An outline of the essential entities and boundaries of a dedicated FMIS were defined by Sørensen et al. (2010a). The boundaries and scope of the system were analysed and described in terms of actors (entities interfacing with the system such as managers, software, and databases) and functionalities. The soft systems methodology (SSM) (Checkland and Scholes, 1999) was used for the development of a conceptual model for an effective FMIS based on information derived from pilot farms representing diverse conditions across the EU. The conceptual model was divided into four sections: internal data collection, external information collection, plan generation and report generation. The data collection and processing are an automated monitoring system, whereas the report and plan subsystems are to be initiated by the farm manager. The external repository contains information on standards, rules, all types of

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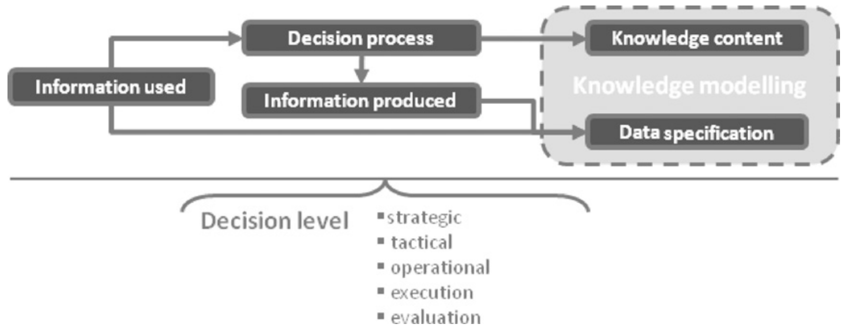


**Fig. 1.** Analysis and modelling approach.

guidelines for farm activities etc., made available for the FMIS. This conceptual model is the first step towards the actual design of a novel FMIS.

The second step of the specification of the FMIS concerned the material and information flows (Sørensen et al., 2010b). More specifically, the information flows and relevant input data were given for the strategic, tactical, and operational planning levels for field operations, together with the execution and evaluation phases. The information flow definitions included the actors and decision processes involved in the overall operation. Additionally, it was specified which information provided by designated partners and actors or produced by the system must be encoded. A user-centric approach to model the information flows for targeted field operations was used. From the six field operations (tillage, seeding, fertilising, spraying, irrigation, harvesting) analysed in the FutureFarm[1] project, the information model for the fertilisation case was selected for analysis. By specifying in detail the information provided and the information required for the information handling processes, the design and specification of the information flows was derived. This involved explicitly specifying tacit knowledge of the farmer as a way to extend the FMIS design into automated decision-making. Core-task analysis and core-task demands were utilised as premises for the modelling of information flow from the farmers' point of view (Norros, 2004). The information models were centred on the farmer as the principal decision maker and involved external entities as well as mobile unit entities as the main information producers.

The next step following the conceptual modelling and the information modelling involves the specification of the knowledge content of the decision processes and the involved data imbedded in the information entities. This finalizing step in the design process together with the derivation of the functional requirements is the objective of the study presented here, and the results are further intended to support and guide the selection of the technological infrastructure of a generalised FMIS. In this way, the current study covers the third part of the FMIS design phases and is a continuation of previously published studies covering the first phase (Sørensen et al., 2010a) and the second phase (Sørensen et al., 2010b) as part of the EU research project FutureFarm.[1]

## 2. Methodology

For the knowledge modelling and data specification, the core-task analysis (CTA) method was used. The CTA has been developed in earlier work by Norros (2004), Nurkka et al. (2007) and Pesonen et al. (2008) employing the ISO 13407 standard (ISO 13407, 1999, *Human-centred design processes for interactive systems*). The methodology employed in this study utilizes basic principles of the first four out of seven phases of the method, namely science-based modelling, analysis of orientation, practice-based modelling of the core task, and integrated information modelling. The first phase of the modelling relies on expert knowledge of the use of precision agriculture practices within crop production. Scientific and professional literature, expert interviews and workshops with the research group provided the data for the knowledge and data modelling. The second phase, analysis of orientation, was carried out in Finland among 11 interviewed producers to identify those farmers who possess a precision agriculture orientation (Nurkka et al., 2007).

In the third phase, practice-based modelling, individual farmer interviews were carried out in a half-day workshop organized at four farms in Finland (Nurkka et al., 2007) and at five farms in Sweden (Olsson and Rydberg, 2008). During the workshops, the farmers' practices were simulated by inviting the farmers to identify specific types of decision processes and the data embedded in the information flows connected to the decision processes.

In phase 4 involving integrated information modelling, all the specifications from the preceding modelling were brought together in a detailed structuring and formalisation of the decision processes and the information entities. In Fig. 1, it is shown how this knowledge identification and data specification are an integrated part of the overall analysis and modelling approach as it has been developed in the previous work (Sørensen et al., 2010a,b). An extensive description of the CTA methodology is presented in Norros (2004), while a detailed description of the implementation of the method for the FMIS modelling is presented in Sørensen et al. (2010b).

Here the method is used in connection with the following objectives:

1) In Sørensen et al. (2010b), the decision processes involved in the four planning levels (strategic, tactical, operational, and execution/evaluation) of field operations where defined as part of the development of the information flow diagrams. In this study, the CTA methodology is implemented to define the knowledge content and characteristics of the targeted decision processes in terms of the purpose and the corresponding level of automation, namely: manual, semi-automated, and fully automated.
2) In Sørensen et al. (2010b), two types of information entities were defined as part of the development of the information flows, the *information used by* a decision process and the *information produced by* a decision process. The first one is the required information for evaluating and selecting decision alternatives, whereas the second one comprises the planning, guidance and control information used for actual implementing the chosen decision alternative. In this study, based on the CTA method-

[1] FutureFarm has defined aims at meeting the challenges of the farm of tomorrow by integrating FMIS to support real-time management decisions and compliance to standards (http://www.futurefarm.eu).