ELEKTROTEHNIŠKI VESTNIK 86(3): 83-87, 2019
ORIGINAL SCIENTIFIC PAPER

Reference Standard Process Model for Farming: A conceptual model and target groups for its use

Rok Rupnik

University of Ljubljana, Faculty of computer and information science, Večna pot 113, 1000 Ljubljana, Slovenia
E-mail: rok.rupnik@fri.uni-lj.si

Abstract. The paper presents the idea of a reference standard process model for farming (RSPMF). The motivation of creation of RSPMF is to facilitate the work and increase the efficiency of the following target groups: product managers in software companies developing software products and IoT systems for farming, managers and owners of bigger farms and consultants for farming. We introduce the conceptual model of RSPMF through the introduce concepts on which RSPMF is being built, the structure of the model and the relations between the concepts. For the creation of the conceptual model entity-relationship diagramming technique is used. We have built RSPMF based on the idea and concepts of COBIT framework which is defined for the area of IT governance and which represents a de-facto standard for IT governance. We are not transforming COBIT concepts to RSPMF in one-to-one manner: only those concepts are used which can be adapted and updated by expert knowledge of farming to be useful and appropriate for farming.

Keywords: conceptual model, standard process model, farming

Referenčni standardni procesni model za kmetijstvo: konceptualni model in ciljne skupine za uporabo modela

Članek predstavlja idejo in koncept za standardni referenčni procesni model za kmetijstvo (RSPMF - Reference Standard Process Model for Farming). Motivacija za izdelavo RSPMF je omogočiti delo in povečati učinkovitost naslednjim ciljnim skupinam: produktnim vodjem v programskih podjetjih, ki razvijajo programske produkte in IoT sisteme za kmetijstvo, direktorjem in lastnikom večji kmetij in svetovalcem za kmetijstvo. Konceptualni model je predstavljen skozi koncepte, skozi strukturo konceptualnega modela in skozi razmerja med koncepti. Za RSPMF smo predstavili konceptualni model z uporabo diagramske tehnike entitetno-relacijskega modeliranja. Prva verzija RSPMF, ki jo predstavljamo, je nastala na podlagi konceptov ogrodja COBIT, ki je mednarodni de facto standard za obvladovanje informatike. Pri tem konceptov od COBIT ne povzemamo povsem, temveč le tiste, ki jih je možno kakovostno prilagoditi potrebam kmetijstva.

Ključne besede: konceptualni model, standardni procesni model, kmetijstvo

1 INTRODUCTION

In the recent years, farming has become an area with an extensive need for the use of information systems and IoT technologies [1]. The experience gained on an EU funded project has revealed that software companies have diverse and unequal knowledge and understanding of farming processes, activities within processes and metrics. This causes a problem when software products and IoT systems need to be integrated. There are many software products and IoT systems on the market today, but each of them covers quite a narrow functional area and for this treason integration is simply a necessity [2].

A reference standard process model is a way to help various target groups to improve the efficiency of their work: *product managers in software companies*, *managers and owners of bigger farms* and *consultants for farming*. RSPMF can become a common denominator, a kind of *Esperanto or a knowledge base* for the development of software products and IoT systems for farming. And, RSPMF can also become a tool to support farm managers and owners at performing farm management activities. Such model can also support consultants for farming at their work.

We build and design RSPMF based on the idea and concepts of COBIT framework which is defined for the area of IT governance [3], [4]. The paper presents the first version of RSPMF through concepts of a model and relations between them.

The structure of the paper is as follows. The second chapter introduces EU funded project AgroIT which was a trigger for the idea and the creation of RSPMF. The project aspects relevant for the content of this paper are introduced. The third chapter briefly discusses the mission of RSPMF: target groups for its use and expected benefits. To support the idea of RSPMF, the COBIT framework for IT governance is introduced. The fourth chapter presents the conceptual model of

Received 27 January 2019
Accepted 5 March 2019

RSPMF. And the last chapter presents the conclusion and directions for our future work on RSPMF.

2 THE IDEA AND BASIS FOR REFERENCE STANDARD PROCESS MODEL (RSPMF)

AgroIT is an EU funded project covering various above mentioned aspects and problems in today's implementation of IT and IoT in farming [5], [6]. First, the project covered the implementation of ERP systems for farming which facilitate farm management: traditional ERP system for small and medium enterprises with additionall modules for livestock, fruit growing, winery, etc [7]. The area of farm management was covered in several papers in the recent years [8], [1], [2], [6], [7], [9], [10]. Second, the project includes the implementation of a decision support system using advanced methods to support decision processes on farming [8]. The use of decision support within farm management was covered by that, and this is also the subject of several papers in the recent years [1], [6]. Third, the project includes the implementation of IoT systems where various sensors were used to collect data about several measurements [2], [11], [12]. With a lot of data available farm management and operations of farms can be more efficient [13]. And fourth, the project includes also the implementation of cloud integration platform: all applications and IoT systems were integrated through cloud integration platform to facilitate data exchange over one single point (and not peer-to-peer) between them [6], [12], [14].

Six software companies cooperated AgroIT project with their software products: applications, IoT systems and cloud integration platform. Each software company "contributed" its products to the project and during the project software products were significantly improved, i.e. upgraded and extended. And they were also implicitly improved through integrations between each other.

For the pilot use of integrated software products and IoT systems *pilot projects* were organised in 5 EU countries where pilot farms were supported in the use of software products by pilot partners: project partners with extensive knowledge in agriculture and experience in consulting for farming.

2.1 The Knowledge of farming for the implementation of software products and IoT systems

Improving the software products and IoT systems is based on extending the existing functionalities of software products and IoT systems and upgrading them with the new ones. Key goal of the project was to design functionalities which are based on integrating software products and IoT systems. This means that a software product also can use data from another software product or IoT system.

During analysis and design phase it has become apparent that software partners in the project have diverse and unequal knowledge and understanding of farming processes, activities within processes and metrics. The gap was even bigger compared to the knowledge of pilot partners.

2.2 COBIT framework for IT governance

In the recent years, COBIT has become a *de-facto* standard for IT governance in companies and organizations. It defines a set of generic processes (they are called IT processes) for the management of IT. For each IT process, the following is defined: process inputs and outputs, process goals, key process activities, metrics of a process (performance measures) and levels of process maturity (maturity model) [3]. The development of COBIT has been progressing since 1996: from version 1 to current version 5. COBIT is the result of several working groups of highly experienced experts through the coordinated work within ISACA which is an international professional association focused on IT governance.

The diversity of farming knowledge by project partners mentioned and having the expertise of COBIT has step-by-step led to the idea of using the idea of COBIT in farming [3], [4].

3 THE MISSION OF RSPMF AND ITS EXPECTED BENEFITS

When designing a standard process model, regardless of the area it is intended for, the group designing it must first decide which are the *target groups* who will be using the model and what should be the benefits of its use. For target groups, this should become a reference standard process model. We design RSPMF for the following target groups:

- *Product managers* in software companies developing software products and IoT systems for farming,
- *Managers and owners* of bigger farms: COBIT is in the first place meant for bigger companies. Each standard process model should, in our opinion, be sized for bigger institutions (organisations in general). Smaller institutions then use it to the extent for which they believe is suitable for them. This is considered at the designing of RSPMF,
- *Consultants for farming* which support farms in achieving better results of their work.

The expected benefits for *product managers* are as follows:

- Based on experience from AgroIT project, we can state that there is diversity of farming knowledge of product managers in software companies. We see RSPMF as a common denominator, a kind of *Esperanto*, a *knowledge base*, for the development of software products and IoT systems for farming. Namely, each process in RSPMF is described through the following components: process goals, process

metrics, KPI's (*Key Performance Indicators*) and process activities,
- The integrations between various software products and IoT systems will be more straightforward and "softer" if product managers will base functionalities on RSPMF.

The expected benefits for *managers and owners* of bigger farms are as follows:
- *Knowledge and experience* of farming experts and academics will be step by step transferred to RSPMF to introduce *best practices* for farming,
- RSPMF will provide *best practice guidelines* for processes and their activities on farms. This helps managers ensure that the processes are performed according to best practice,
- Metrics and KPI's defined for processes will help managers to set goals and perform monitoring. Such approach will also contribute to lower the risks,
- Managers will identify gaps in process execution and monitoring. This will help them to avoid gaps identified, improve processes and improve monitoring,
- Managers will be better prepared for any auditing. When a particular audited farm is *RSPMF compliant*, the trust of auditors and creditors will be higher,
- Besides managers, also other personnel working on farm will learn about processes, metrices and KPI's.

Consultants for farming will use RSPMF as knowledge base for their work. RSPMF meant to be opened to any other sources, standards, guidelines: in general, to any *source of knowledge*. As such, RSPMF will represent a gateway to other relevant sources of knowledge.

If *product managers* and *consultants for farming* will use RSPMF then we can expect that for consultants it will be *per se* easier to get familiar with software products developed based on the use of RSPMF.

4 THE CONCEPTUAL MODEL OF RSPMF

4.1 The current state of RSPMF

Our research on RSPMF is now in the stage of defining the concepts and the structure of the model. In this paper, the concepts and relations between them are introduced through the *conceptual model* using *entity-relationship* modelling technique. RSPMF is based on the idea of COBIT. Our aim is not to copy and paste the concepts of COBIT and also not only to base on one particular version of COBIT. We base only on those concepts of COBIT 4 and COBIT 5 for which we believe are suitable for farming. Besides that, we use other concepts based on our belief of their benefit. Every COBIT concept we use is then adapted and transformed to the appropriate structure for farming. The literature review has revealed that also two other fields have used the concepts of COBIT as the basis to define field standard and/or framework: flood management [15] and nursing [16].

4.2 High-level conceptual sub-model

In conceptual modelling, especially when using entity-relationship modelling technique, rarely a whole model is shown on one single diagram, mostly due to the transparency reasons. This is why RSPMF is presented through *conceptual sub-models*. The conceptual model is modelled on a high level: we do not define attributes and we do not transform M:N relationships into an intermediate entity. In diagrams, the names of relationships are shown with the arrow "--->" indicating the direction to read the name of relationship to understand the meaning of the relationship and by this the relation between two concepts.

Processes are divided in three hierarchical levels with its own domain: *Govern and Monitor* domain (GM) for the strategic level, *Plan and Manage* domain (PM) for the tactical level and *Implement and Execute* domain (IE) for the operational level. Farming has several branches: livestock, fruit growing, agriculture, winery (viticulture), etc. RSMPF enables modular definition of processes for every *area of agriculture*. For GM domain, only *common process module* is defined. *Common processes module* includes processes which are common to all *areas of agriculture* and are therefore executed on farm regardless of farm's profile. For other two domains, also a process module for every *area of agriculture* is added. For example: Plan and Manage (PM) – livestock, Implement and Execute (IE) – livestock.

High-level sub-model shown in the Figure 1 shows the hierarchy of key concepts of the model: domain is covered by process modules, process module includes various processes.

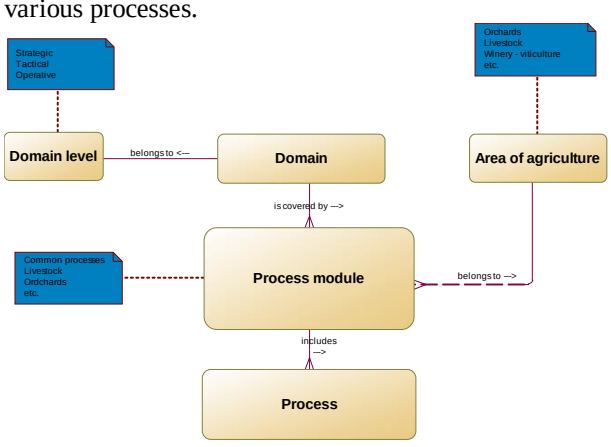

Figure 1: High-level conceptual sub-model

4.3 Meta data for describing processes: the core of conceptual model

Process as a concept represents a core of conceptual data model shown in Figure 2. Each *process* contributes to one or more *general agricultural economic goals.* A

process which does not belong to GM domain belongs to a particular *area of agriculture* and depending on *area of agriculture*, process contributes to one or more *general goals defined by the area of agriculture*. This way the process contribution part is defined.

Process definition part of the sub-model explains that *process* is executed through various *process activities* and that various *sources of knowledge* are the foundation to a particular process. Each *process* has unique code which reveals the *domain* and the *process module* to which process belongs. Codes for *domains* were already mentioned: GM, PM and IE. For the *process modules* the codes are as follows: the code of common processes is CP, the code for other process modules depends on the area of agriculture the process module belongs to. For example: for livestock the code is LS. The code of process module and a process are concatenated where also the number of a process within a module is added. For example: PM.LS.01 for the process *Manage animal sales.*

Process efficiency part of the sub-model explains that each *process* has various *goals* defined and that goals are measured by *process metrics*. For each process, also *key performance indicators* (KPI) are defined. Both, *process goals* and *key performance indicators* are categorised to *benefit category*.

4.4 Relations between processes

We have, as already mentioned, followed the top-down division into *strategic*, *tactical* and *operative* level where each level is represented by "own" domain. In such cases there are always *top-down* and *bottom-up* relations between processes on adjacent levels. When viewing on those relations between process in top-down direction, then a process on higher level *directs* one or more processes on a lower level. On the other hand, when viewing on those relations between process in bottom-up direction, then a process on a lower level *supports* one or more processes on a higher level.

4.5 Openness of RSPMF

The aim of defining RSPMF is not to prevail over any existing standard for farming or any other *source of knowledge* from the farming area. RSMPF is defined and structured to be opened and enables the reference to source of knowledge in process definition part of sub-model.

5 CONCLUSION AND FUTURE WORK

In this paper we have introduced the first version of reference standard process model for farming - RSPMF. Our aim of the design of reference model is to improve the support for various stakeholders in farming: product managers in software companies which develop software products and IoT systems, managers and owners of bigger farms and consultants for farming.

We have various plans for the updates and extensions of RSPMF. First, we want RSPMF to be suitable also for government and EU officials who are responsible for farming. At the moment we plan to add the concept of *maturity level* of a process. Maturity level of a process will show or indicate the level of detail and expertise with which farm executes a process. This way the comparison of different farms will be enabled. Second, we are preparing questionnaires for the following focus groups: academics from the area of farming, product managers in software companies which develop software products and IoT systems, managers and owners of bigger farms, farmers working on farms and consultants for farming. Based on those questionnaires we will perform interviews based on Delphi method with the goal to test the concepts of a model with all relevant focus groups. Third, we plan to additionally explore the concept of relation between processes. For now, we only consider top-down and bottom-up relations. Through own research and through the interviews we expect to explore this area to find out the need for the relations and dependencies between processes on the same level. Fourth, we are following EU calls and working on forming a consortium for EU project to finance the broader and interdisciplinary work on RSPMF.

We are aware that there are two phases of defining RSPMF: first, to define its concepts and structure; second, to put content in the structure of processes descriptions. While inserting the content there will for sure arise new ideas to change/expand the structure of the model. And last, but not least: the model like RSPMF evolves through time through versions as milestones in model's overall life cycle.

LITERATURE

[1] A. Kaloxylos et al., "A cloud-based Farm Management System: Architecture and implementation," Comput. Electron. Agric., vol. 100, pp. 168–179, Jan. 2014.

[2] S. Fountas et al., "Farm management information systems: Current situation and future perspectives," Comput. Electron. Agric., vol. 115, pp. 40–50, 2015.

[3] ISACA, COBIT 4.1. 2007.

[4] ISACA, COBIT5: Enabling Processes. 2012.

[5] L. Ruiz-Garcia and L. Lunadei, "The role of RFID in agriculture: Applications, limitations and challenges," Comput. Electron. Agric., vol. 79, no. 1, pp. 42–50, Oct. 2011.

[6] A. Kaloxylos et al., "Farm management systems and the Future Internet era," Comput. Electron. Agric., vol. 89, no. null, pp. 130–144, Nov. 2012.

[7] C. N. Verdouw, R. M. Robbemond, and J. Wolfert, "ERP in agriculture: Lessons learned from the Dutch horticulture," Comput. Electron. Agric., vol. 114, pp. 125–133, 2015.

[8] R. Rupnik, M. Kukar, P. Vračar, D. Košir, D. Pevec, and Z. Bosnić, "AgroDSS: A decision support system for agriculture and farming," Comput. Electron. Agric., no. November 2017, 2018.

[9] R. Nikkilä, I. Seilonen, and K. Koskinen, "Software architecture for farm management information systems in precision agriculture," Comput. Electron. Agric., vol. 70, no. 2, pp. 328–336, Mar. 2010.

[10] C. G. Sørensen et al., "Conceptual model of a future farm management information system," Comput. Electron. Agric., vol. 72, no. 1, pp. 37–47, Jun. 2010.

[11] J. De Baerdemaeker, Precision Agriculture Technology and Robotics for Good Agricultural Practices, vol. 46, no. 4. IFAC, 2013.
[12] J. Santa, M. A. Zamora-Izquierdo, A. J. Jara, and A. F. Gómez-Skarmeta, "Telematic platform for integral management of agricultural/perishable goods in terrestrial logistics," Comput. Electron. Agric., vol. 80, no. null, pp. 31–40, Jan. 2012.
[13] J. W. Jones et al., "Toward a new generation of agricultural system data, models, and knowledge products: State of agricultural systems science," Agric. Syst., vol. 155, pp. 269–288, 2017.
[14] J. W. Kruize, R. M. Robbemond, H. Scholten, J. Wolfert, and a. J. M. Beulens, "Improving arable farm enterprise integration - Review of existing technologies and practices from a farmer's perspective," Comput. Electron. Agric., vol. 96, pp. 75–89, 2013.
[15] M. Othman, M. Nazir Ahmad, A. Suliman, N. Habibah Arshad, and S. Maidin, "COBIT principles to govern flood management," Int. J. Disaster Risk Reduct., vol. 9, 2014.
[16] M. Burnik, "The Approach for the Presentation of Nursing Processes," University of Primorska, 2011

Rok Rupnik received his B.Sc., M.Sc. and Ph.D. degrees in Computer and Information Engineering from the University of Ljubljana in 1994, 1998 and 2002, respectively. Since 2004 he has been assistant-professor at Faculty of Computer and Information Science. His research interests are data mining, project management, information systems strategic planning, information systems development methodologies and mobile applications. He is a member of PMI and ISACA.

6 APPENDIX

This section shows the figure of the core of conceptual sub-model. Due to the complexity of the model it can not be shown in one column.

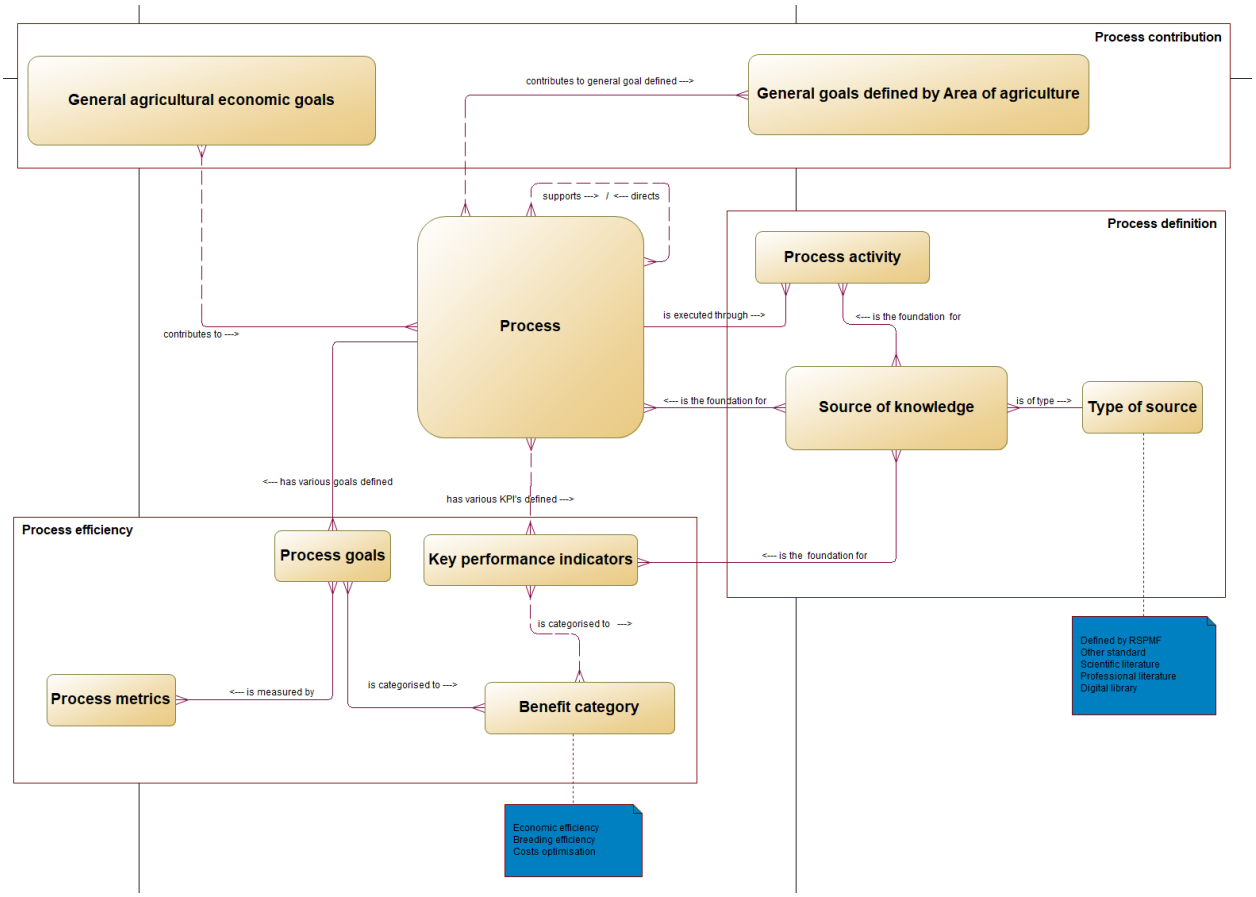

Figure 2: The core of conceptual model