Agris on-line Papers in Economics and Informatics

Volume IX Number 4, 2017

Strategic Importance of the Quality of Information Technology for Improved Competitiveness of Agricultural Companies And Its Evaluation

Jaromír Štůsek, Karel Kubata, Vladimír Očenášek

Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Abstract

The article discusses the issue of the use of information technology in the search for potential competitive advantages in agricultural companies. Information technology in agriculture should provide a clearly defined benefit for the management's decision-making. If information technology is not being used to its full potential and if the results are interpreted incorrectly, the overall impact may be damaging to the position of companies in the competitive environment. Investment in information technology requires considerable sums that should return in the form of faster and better decision-making in which digitalized corporate processes play a complex role. Strategic decision-making concerning investments in information technology in various types of agricultural businesses varies depending on their size, focus, economic situation etc. In the context of the current state of agriculture in the Czech Republic and after a detailed analysis of available literature, the authors conclude that the issues of quality of information technology have not yet been systematically examined and resolved in Czech agricultural companies. For this reason, they consider it fruitful to focus their attention on this subject. The main objective of the paper is to develop and apply a methodological model for evaluating the quality of information technology in an agricultural business. In addition, we want to examine the broader impact of the criterion of IT quality from the perspective of its strategic importance for competitiveness and the extent to which it supports strategic management in practice.

Keywords

Strategy, decision-making in management, competitiveness, information technology, information processes, IT quality evaluation, methodological model.

Štůsek, J., Kubata, K. and Očenášek, V. (2017) "Strategic Importance of the Quality of Information Technology for Improved Competitiveness of Agricultural Companies And Its Evaluation", *AGRIS on-line Papers in Economics and Informatics*, Vol. 9, No. 4, pp. 109-122. ISSN 1804-1930. DOI 10.7160/aol.2017.090411.

Introduction

The development of agricultural companies is influenced by changes in the economic, technical and social environment, both within the sector (microenvironment) and outside (macroenvironment). These changes are a source of uncertainty that complicates decision-making, increases costs and reduces competitiveness. For a company to be successful, it needs highly competent and well-trained managers.

The company management must be prepared to start using new opportunities, particularly those that have a strategic potential for the future. Efficient use of information technology (or IT) and the quality of information processes in a company is generally considered a particularly strong opportunity. The use of IT in agricultural enterprises as a source of competitive advantage is recommended (Šimek et al., 2018).

The importance of an information system to a company is evaluated through its characteristics. Most researchers emphasise the following two: functionality that corresponds to business processes and quality (Bruckner et al., 2012). Other authors (Kožíšek and Vrana, 2017; Kruczynski, 2010) call for the correct modelling of business processes as a basis for the processing of software applications. The importance of process diagrams in modelling business processes is emphasides by (Jošt et al., 2016).

An important role is here played by the strategic management process which primarily aims to secure its own future through deliberate development and maintenance of a competitive strategic position. The concept of this article is based on a validation of theoretical principles using examples from practice and on the authors' own research of the key role of strategic management processes in real-life companies, focusing on the quality of IT and information processes in smaller agricultural companies and specifically on the quality of work with SW tools. The Department of Information Technology has been devoted to the evaluation of research on the development and adoption of information technologies by agricultural enterprises (Vaněk et al., 2008).

The importance of the quality of information technology and information databases in the management of agriculture is very significant and is considered a factor of success – as noted by (Tyrychtr and Vostrovský, 2017; Vaněk et al., 2010).

Materials and methods

The main objective of this article is to propose a model for evaluating the quality of the use of IT in primary agricultural production, to verify this model in the context of smaller farms and to establish the conditions for its use and formulate recommendations that could improve the quality of information processes in this sector. The principle behind our model for the evaluation of the *quality of information processes in an agricultural company* (QIPAC) is that of a methodological model. The model is based on quality standards ISO/IEC 25010, 25023 and 25021. In its development, we also took into account various other standards: ISO/IEC 25021, 2011; ISO/IEC 25023, 2013; ISO/IEC 25010, 2014 and Sommerville (2013).

The main objective is supported by a partial objective which examines the fulfilment of other, and in terms of competitiveness the most important, requirements for SW in terms of its support of management processes, particularly strategic management.

The methodology of the QIPAC model is based on a concept in which QIPAC is the result of an evaluation of three areas of quality. These are the *quality of software* (QSW), the *quality of hardware equipment* (QHW) and the evaluation of computer literacy, or *user quality* (UQ). The development of a detailed methodology and the parametrisation of the QIPAC model requires the establishment of an expert group (Kubata, 2017).

The proposed structure of main and partial characteristics used in the model was designed by an expert group on the basis of a managed interview using ISO/IEC standards and results from the analytical part described in methodology steps 1, 2.a and 2.b.

Another output of the expert group is the methodology of the model and the definition of etalon values for measurements of the individual and partial characteristics (or sub-characteristics) in the model.

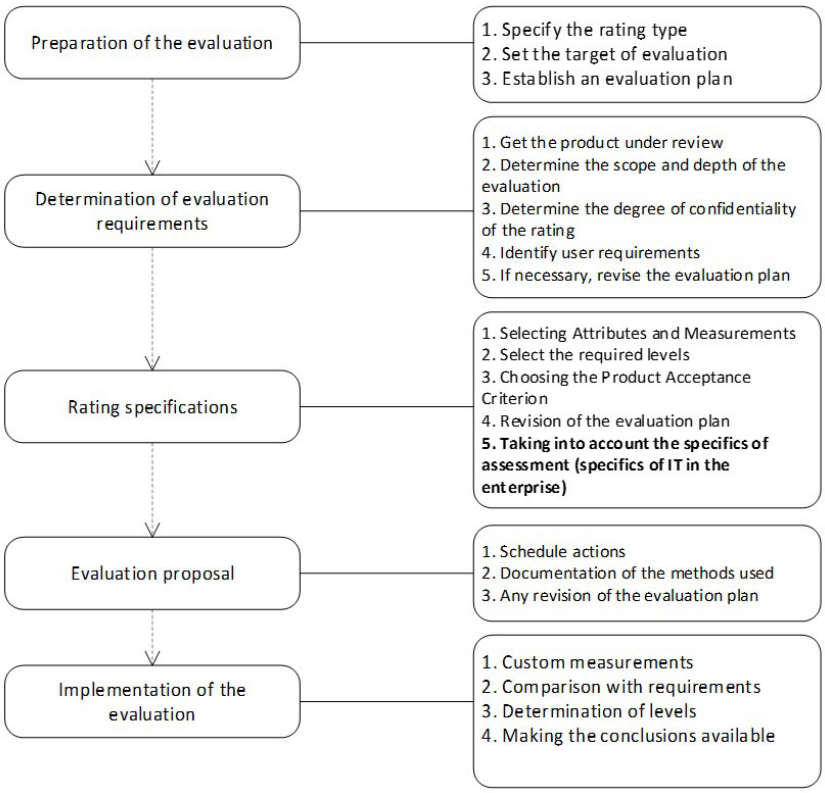
Metrics and attributes of model quality evaluation were determined in accordance with the standards ISO/IEC 25010, 25023 and 25021. The measured values are related to the selected etalon or a determined maximum. In the case of attributes used in the model, measured values are expressed by a percentage. Selected measures use an absolute and ordinal scale and the questions used in the evaluation were designed to lead towards unambiguous answers. The benefit of this approach is that it allows easy comparison of values and is independent of used units.

Results and discussion

1. Proposal of the initial reference model for evaluating the quality of information systems in companies

In order to propose a model for the evaluation of IT in an agricultural company, we have developed an evaluation procedure based on the reference model for the evaluation of quality of a software product (Vaníček, 2006). A modified process diagram (variant extended with further specifics of IT evaluation) has been designed through analysis and synthesis of available literature and known practical needs of agriculture (Figure 1).

The methodological model for evaluating IT (Buchalcevová, 2016) in an agricultural company (Fountas, 2015; Shifeng et al., 2011) was developed with reference to the principles of IT audits (Vrana, 2005). The validity of the model was then experimentally verified in a case study, identifying and evaluating the outputs including found limitations and shortcomings. The case study is described in the following part of this article. The conclusions of measurements made in the case study are interpreted in a table



Source: own work

Figure 1: Diagram of the reference model of the quality evaluation of a software product.

with a final evaluation comment on the individual parts of QIPAC and a radar chart.

An important difference is t at the application of the basic model of IT quality evaluation in an agriculturals must respect the proposed procedure as well as the specifics of information processes in agricultural company (Sorense et.al.,2010) and the availability of the evaluation of public services (Rysová et al.,2013). For this reason, the reference model used as the basis has been expanded with the specifics of evaluating ICT in an agricultural company (Vaněk et.al., 2011). This is a new feature that can be considered essential for the selected area of primary agricultural production.

The actual procedure of the evaluation of the quality of information processes in an agricultural company is shown in the Figure 2.

The procedure shown in Figure 2 should be interpreted as follows:

Horizontally: the top line shows the individual participants (identified by their role in the expert team) in the quality evaluation process; each of these persons is assigned certain activities (vertical).

Vertically: the individual stages of evaluation: Preparation, QME Identification, Development of a Model and Measurement Evaluation.

In order to apply the procedure evaluating the quality of information processes in an agricultural company, the following roles must be established:

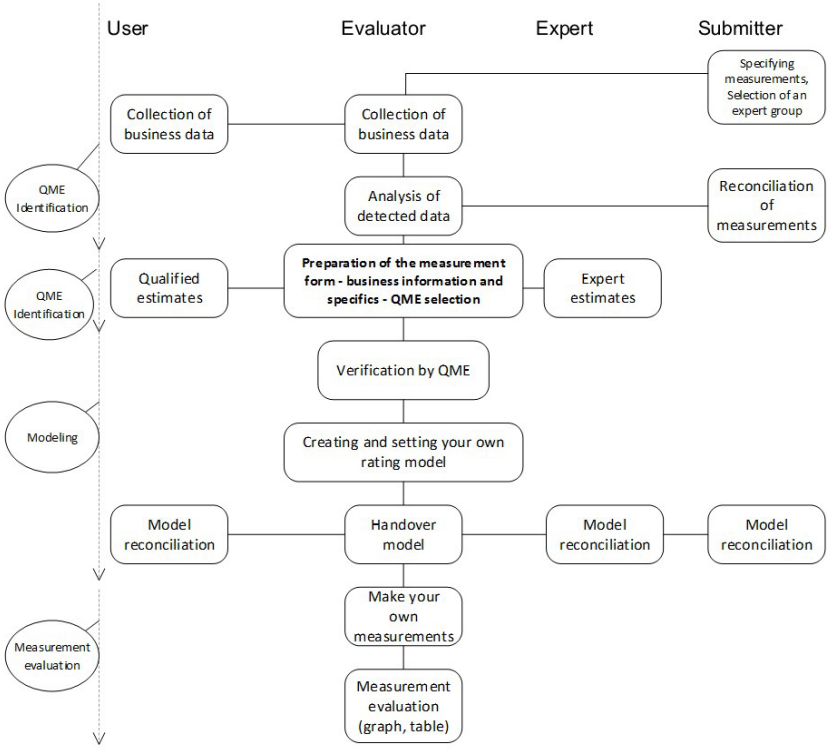
Client – submits a request for an evaluation of quality (usually company management or owner)

Expert – understands in detail the issues of IT implementation in the specific agricultural company. In the group, the expert provides estimates that are used to develop the model.

Evaluator – applies the evaluation methodology in practice; is in charge of the entire quality evaluation process (as a relatively impartial and objective moderator)

User – user of IT components in the agricultural company who understands the issues in detail and has been appointed by company management to take part in the evaluation process (competent user).

Preparing the form – information and company specifics – QME selection – this is a **newly added**



Source: own work

Figure 2: Diagram of the evaluation of the quality of information processes in an agricultural company.

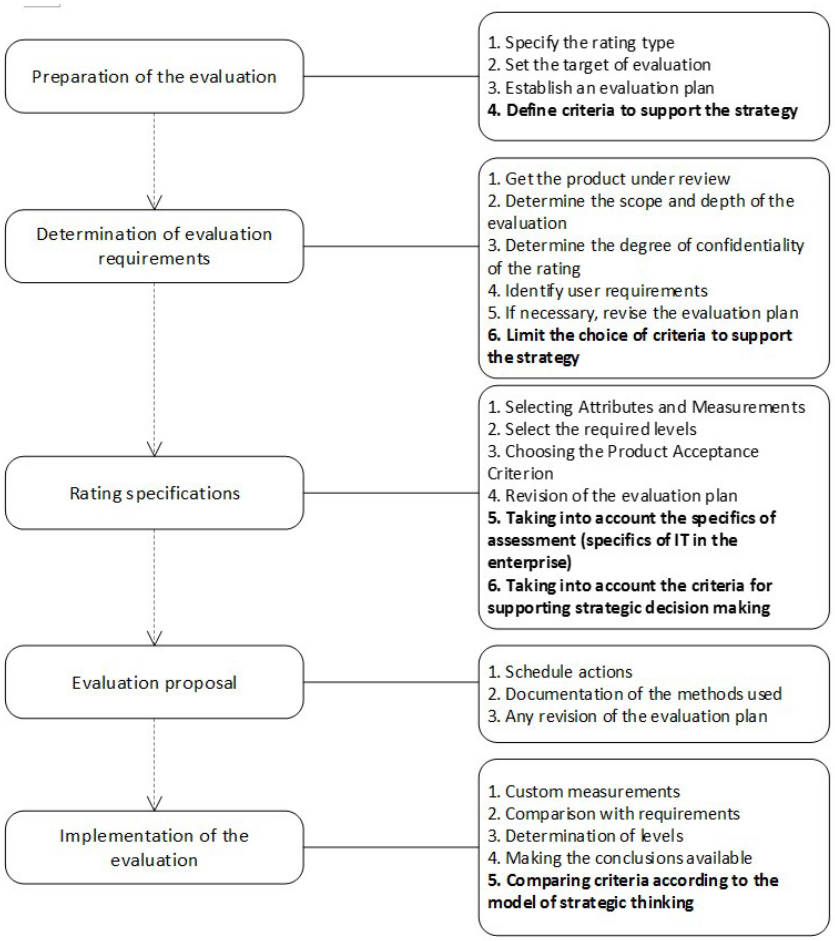
part to the reference model of quality evaluation applied in the "QME Identification" step.

The design of the model had to first decide on the form of the modelling (method and used tool) in order to describe the methodological procedure and its application in a SW tool (application prototype). To achieve flexibility and adaptability, we have decided to select from the three most widespread modelling languages as described by Kožišek and Vrána (2017): process-oriented BPMN, the most general UML and the event-driven process chain diagram, or EPC. We have selected a combination of UML (for user interaction, to capture the workflow and to map processes) and BPMN for a more detailed description of partial processes, using prepared data (controlling decision-making procedures in the decision-making tree based on the results of questions and user selection) in the workflow and a set of questions in the form of an Excel table that was imported directly into the database.

In further considerations of the future development of the methodological model and proposals for future research, we have decided to discuss a new variant of the model that would allow a closer look at the methodological approach in the selection of criteria. The objective of this variant is to not just evaluate the quality of information processes based on the requirements of individual sectors and typical factors of competitiveness, but also to view the issue from the perspective of the support of strategic development of a competitive position (see Figure 3). For further research, we proposed a solution that assumes the use of integrating software for strategic management and defined requirements that should be met by the methodological procedure (applied in the prototype application as the basic workflow) in the form of a succession of decision-making points in evaluation stages and nodes in the decision-making tree for a selected type of strategy. According to Vanderfeesten (2008), there is a certain similarity between a software programme and a workflow process.

The procedure shown in Figure 3 should be interpreted as follows:

The newly added elements in the evaluation of the quality of IT use and the quality of individual SW tools supporting strategies could be implemented in various ways. Either the expert team uses the methodology as guidance in asking questions, or also uses the SW application (still in prototype stage) to evaluate the newly added strategic decision-making support criterion. The basic principle of the application-supported evaluation



Source: own work

Figure 3: Diagram of a modified reference model for evaluating the quality of SW with support of strategic decision-making.

lies in the use of a pre-defined set of questions for all nodes of the decision-making tree and the evaluation of answers to determine whether the node is in line with strategy support or not. This could be partially implemented through an interactive form with no particular requirements for the time of the expert team. To ensure the questions give a clear picture of the situation and to simplify their formulation, various types of questions are used. The majority are binary questions allowing YES/NO answers (e.g. if the SW is purchased to perform activities that are not directly or indirectly mentioned in the company strategy, it does not support said strategy etc.). There are also multiple choice questions (allowing one answer) and questions asking for clear symptoms of a certain phenomenon (e.g. the amount of dead capital is a symptom of low adaptability of a strategy; a low degree of innovation in licensed SW is a symptom indicating that the strategic position of a company with respect to competitors will not improve etc.).

The final summary is, at this stage of development, left to the competence of the expert team. It is however recommended to include from all the 32 decision-making nodes at least the key elements of strategy support in the workflow, namely: *character of a strategy, existence of a vision, adaptability, uniqueness, thinking, efficiency and verification (or verification metrics)* (Štůsek, 2008; Morris and Gotel, 2012). .

Figure 4 illustrates the methodology procedure for evaluating strategy support criteria in the form of a snapshot of the structure of data used to fill in the workflow map in the application prototype. The set of questions for individual nodes is extensive and represents a knowledge base open for modifications based on the needs of the expert team. The team is responsible for adapting the questions to the situation in the company. For example the question concerning a mainframe can be reformulated and extended to the entire backbone infrastructure, use of the cloud, outsourcing etc.

Model	Model variant	Model code	Model identification	Strategic thinking model
Decision-making tree	1	STM	Strategic thinking model	
Model variant	**Type of strategy (submodel)**	**Type code**	**Type identification**	
STM	1	SHORT	short-term strategy	
STM	2	MEDIUM	medium-term strategy	
STM	3	LONG	long-term strategy	
STM	4	CONTINUOUS	continuous strategy	
STM	5	POSITION	position strategy	
STM	6	KEY	key strategy	
STM	7	INTEGRATED	integrated strategy	
Model component	**Decision-making phase**	**Phase code**	**Phase identification**	**Workflow (link to previous phase)**
STM	1	STRUCTURE	Basic documentation – describing the structure of the general model	0
STM	2	OPTIONS	Landing dialogue of the application – selecting options corresponding to the issue that the user is trying to resolve	1
STM	3	METHODOLOGY	A framework methodology covering the process from the start of the problem until it is resolved (achieving a long-term competitive strategic advantage)	2
STM	4	PROBLEM	Support of decision-making in the definition of the problem (checking compliance of the user's approach with methodology)	3
STM	5	SOLUTION	Support of decision-making in the process of resolving the problem (checking compliance of the user's approach with methodology)	4
Corresponding phase (workflow)	**Decision-making node**	**Node code**	**Node identification**	**Workflow (link to previous phase)**
STRUCTURE	1	PROJECT	Description of the structure of methodological models in a project	S
STRUCTURE	2	MODEL	Description of the structure of the general model	S
STRUCTURE	3	PROTOTYPE	Description of the structure of specific models in the application – prototype 3a	S
OPTIONS	4	USERS	Selection of user type (manager, student, stakeholder)	O
OPTIONS	5	MODES	Selection of options (modes of operation) from the programme branches	O
OPTIONS	6	SELECTION	Selection of options: a) verification of a proposed solution, or b) search for a new solution	O
OPTIONS	7	OFFERS	Selection of offers prepared for specific models	O
METHODOLOGY	8	MOTIVATION	Methodological guidance towards the realisation of the impact motivation has on style of work, progress and result	M
METHODOLOGY	9	MISSION	Methodological guidance towards the realisation of the mission of a company and a personal mission	M
METHODOLOGY	10	VISION	Methodological guidance towards expressing the vision of a company's future position and role	M
METHODOLOGY	11	INTENTIONS	Methodological guidance in the transformation of a vision into objectives	M
METHODOLOGY	12	CONCEPT	Methodological assistance in discussions concerning the conceptualisation of objectives and possible approaches	M
METHODOLOGY	13	OBJECTIVES	Support in the formulation of the basic ideas, intentions and approaches to define a framework objective – key problem	M
METHODOLOGY	14	MAPPING	Definition of the broadest possible scope of activities where the process of solving the key problem could start	M
METHODOLOGY	15	LOCALISATION	Support in the definition (targeting) of narrower potential opportunities for strategic competitive development	M
METHODOLOGY	16	DEFINITION	Support in the conversion of localised potential opportunities into a standardised form	M
METHODOLOGY	17	SPECIFICATION	Support in the process of expanding the definition with partial objectives, directions and procedures	M
METHODOLOGY	18	VARIANTS	Support in the definition of all conceivable variants of the proposed strategy	M
METHODOLOGY	19	EVALUATION	Support in the analysis and optimisation of all variants – mechanism selecting the best variants	M
METHODOLOGY	20	DECISION-MAKING	Support of the standard procedure for selecting a final variant of the strategy	M
METHODOLOGY	21	VERIFICATION	Support of a consistency check between the solution, the original vision and implementation possibilities	M

Source: own work

Figure 4: Illustration of the procedure for evaluating strategy support criteria in the form of a snapshot of the structure of data used to fill in the workflow map in the application.

We have concluded that a suitable SW tool of this type that would support strategic thinking is very necessary for current practice. However, the research required for the development of this tool must, in our opinion, also emphasise other attributes (integral properties) of the strategic thinking model that are essential for implementation in practice. In terms of SW quality requirements, the main attribute is interactivity. Interactivity is therefore (in the strategy design and verification process) provided in the logic of a dynamic selection of questions based on context, the result of previous answers and (in the ex-post evaluation of a finished strategy) the availability of a what-if analysis.

2. Preparation – collection and analysis of data for model parametrisation

Measurement brief – the actual task given by the management to evaluate the situation and create an environment for the evaluation. Selection of the experts who will carry out the measurement.

Collecting data on the company – the evaluator together with the user identifies problematic aspects of IT in the agricultural company based on objective and subjective findings; examples include poor economic performance, information processes that are insufficiently linked to one another or doubts about proper functioning of the IT system in the company coming from the management (owner, director). Data collection is not limited just to these issues, but involves a description of all factors related to IT in the agricultural company. The examination itself has the form of a directed interview which is recorded in a structured format.

In the modified variant (that includes the criteria of strategic decision-making support), there are also additional questions concerning symptoms that aim to determine whether the issue lies in the development of a strategy or its implementation – in other words, whether the issue is strategic or not. If an integrating SW is used, the procedure follows the workflow of the application (interactively using the methodology in a decision-making tree); otherwise, a directed interview is carried out using the same methodological diagram.

Analysis of obtained data – identification of objective and subjective reasons for the evaluation of the IT environment in the agricultural company and an analysis of the structured output. The next stage in this step is approval of the measured results by the management, obtained by the evaluator. If the need to measure the quality of information processes in the agricultural company is not clearly stated, then there is no reason to perform any measurement. Should this situation occur, for any reason, there is no point in starting the measurement process.

If integrating SW is used, the requirements listed in the previous stage also include support of strategic decision-making. Should the result be negative,

the expert team may continue in the evaluation with the caveat that the SW is not primarily intended to support strategic decision-making in a company.

QME Identification

Preparing the measurement form – based on the outputs of the analysis, a form is created that includes the aspects of quality measurement. The creation of the form uses the basic QME set from the ISO/IEC 25021 standard and the results of the performed analysis. The next activity in this stage, i.e. the stage of discussions in the expert team (consisting of the user, evaluator and expert), is to propose and verify etalon values in the model.

3. Creation of the model – parametrising the model based on real conditions

Verification of identified QME – the evaluator verifies elements of quality measurement (QME) by comparing them with data about the company and the real state of IT processes in the agricultural company. The results are used to specify the requirements for adding more necessary characteristics and metrics to the quality levels.

Creation and set-up of a model – based on the previous verifications, the evaluator selects characteristics and sub-characteristics and assigns selected metrics.

Handover of the model – the model is approved by all involved parties (the entire expert group).

The measurement itself – the evaluator carries out all the pre-defined measurements by filling in the tables that are part of the model.

The measurements must be performed accurately and objectively within one time period.

The obtained values must be carefully recorded in the measurement evaluation table.

If the strategic decision-making support methodology is used in the form of the decision-making tree that enables performing an interactive what-if analysis, its conclusions are added to the other quality criteria.

Evaluation of the measurement – the evaluator performs the evaluation in the form of a radar chart and an evaluation table, supported by written comments on the results of the measurement. This article provides the example of one measurement evaluation (due to length constraints, this example does not include the strategic decision-making support criterion).

4. Case study – verification of the model in practice

The case study verifying the model and the procedure for evaluating the quality of the information environment in an agricultural company was carried out in farms engaged in primary agricultural production at a size not greater than 1,000 ha, following the defined limitations.

The participants were selected randomly; they were informed in detail about the model and the procedure aiming to evaluate the quality of their information processes as well as its purpose. They were also asked to be as objective a possible while carrying out their evaluations performed to verify the model. Before the measurement itself, the procedure was approved together with the client who ordered the evaluation and an expert group was selected. The evaluation was anonymous and followed an original methodology created exclusively for this research.

5. Case study – results of the evaluation of the quality of information technology in an agricultural company

The following part provides a selection of the resulting values of attribute metrics used in the case study of the evaluation of the quality of information processes in an agricultural company (tested company TC1). For the case study, 30 agricultural companies were contacted in total, and 5 agreed with the evaluation of their information environment (performed through measurement); the results have been recorded in tables. Every measurement in this research was evaluated separately (table of calculated values, resulting chart).

The interpretation of the results of each measurement (calculated values, charts) is expanded with written comments on the overall evaluation of the information environment in the agricultural company.

Tested company 1 (TC1)

The evaluation used the full scale of results obtained in this research of primary agricultural production.

Question	Value	Answer
Acreage?	ha	820
Engaged in plant production?	yes/no	yes
Engaged in animal production?	yes/no	no
Number of people working with a PC?	number of persons	6
Connected to the internet?	yes/no	yes
Receives subsidies?	yes/no	yes
Which accounting system do you use?	name	Premier
Are you planning to invest in production technology at your company?	yes/no	yes
Are you planning to invest in production and storage areas?	yes/no	yes
Are you planning to invest in human resources?	yes/no	yes
Are you planning to invest in information technology – modernising HW?	yes/no	yes
Are you planning to invest in information technology – innovating company IS?	yes/no	yes
Are you planning to invest in information technology – investment in SW used in production?	yes/no	yes
Are you planning to invest in information technology – investment in office SW?	yes/no	no
Is the deciding factor in investment planning the company's budget?	yes/no	yes
Do you evaluate your return on IT investment?	yes/no if so, state how	yes – the system must be efficient
Who decides on IT investment (director, owner, chairman)?	position	owner
What is the impact of information technology on the fulfilment of the company's objectives?	Select an option from A, B or C	B
A – essential		
B – only a necessary technological solution		
C – no impact		

Source: own work

Table 1: Identification of the agricultural company where the evaluation of the quality of information environment (IE) was carried out.

	Question	Values	Metric	Answer
1	Is your IS and its parts useful and beneficial in meeting the company's production needs?	0 % – the system is not very useful 50% – the system is useful 100% – the system is very useful	insert %	70
2	Does your information system support the functions necessary to enable your company's production processes?	% – the system supports most or all of the necessary functions 50% – the system supports only some of the necessary functions 100% – the system supports few of the necessary functions	insert %	50
3	Does your system support other functions suitable for your business processes beyond the scope of what is necessary (used e.g. in company development)?	0% – the system supports most or all of the other functions 50% – the system supports only some of the other functions 100% – the system supports few or none of the other functions	insert %	60
4	Is your system compatible with other systems (special SW outside the company's main IS in individual operations, e.g. plant production, animal production, precision agriculture etc.)?	where n is the number of systems working alongside the main company IS max. (n) is the number of all systems in the company	insert number	n = 4 n (max) = 10
5	Does your system allow data transfers to and from other systems (XML, WMS, CSV)?	0% – the system does not enable open communication 50% – the system enables open communication only when further SW modification and development services are purchased 100% – the system enables open communication	insert %	100 %

Source: own work

Table 2: Questions for the evaluation of the information environment in an agricultural company (IE) (to be continued)

Question		Values	Metric	Answer
6	Is documentation for your IS available to end users?	0% – documentation is not available 50% – information has the form of initial training or the option to contact helpdesk and support 100% – documentation is fully available	insert %	100 %
7	Is your system easy to use for end users?	0% – the system is not easy to use 50% – the system is not particularly easy to use 100% – the system is easy to use Etalon 50 %	insert %	100 %
8	How many steps (clicks) does it take to issue an invoice?	where n is the number of steps to issue an invoice max. (n) is the highest number of steps in your system stated by the manufacturer (seller) in the documentation	insert the real number of steps n and n (max.) from manual or support	n = 5 n (max.) = 5
9	Measuring error rate (in SW operation – e.g. wrong printout, wrongly edited characters, wrong calculation etc.) in standard operation (8 h).	0 errors (n = 5) 3 errors or fewer (n = 4) 6 errors or fewer (n = 3) 10 errors or fewer (n = 2) more than 10 errors (n = 1)	insert number of errors	1
10	Is your system's external communication secured (e.g. using a password, communicating under a security protocol, firewall settings etc.)?	0 % – the system is not safe 50 % – the system is not very safe (there is a security issue) 100 % – the system is safe	insert %	100
11	Number of security incidents (e.g. in communication with a bank, farmer portal etc.) in the last 12 months	0 % – the system is not safe (there was a security incident) 100 % – the system is safe (there was no security incident	insert %	100
12	Is it possible to update your system based on: 1) external factors, such as new legislation (finance) 2) communication with another system within the company – e.g. when extending production?	100% – the system supports updates of external and internal factors 50% – the system partially supports updates of external and internal factors 0% – the system does not support updates of external and internal factors	insert %	100
13	How old is your central PC used for IE?	excellent – less than 2 years (n = 3) good – less than 4 years (n = 2) insufficient – 4+ years (n = 1)	insert age – years	3
14	CPU (processor) performance – measured with the Benchmark tool	80 % – Core i3 (or equivalent) 100 % – Core i5 (or equivalent) 120 % – Core i7 (or equivalent)	insert %	100
15	RAM (system memory) capacity – measured with the Benchmark tool	4 GB – RAM capacity (n = 1) 8 GB – RAM capacity (n = 2) 12 GB and more – RAM capacity (n = 3)	insert %	50
16	What is the highest achieved education of the IE user in your company?	1. vocational (n = 1) 2. certificate of apprenticeship (n = 2) 3. secondary school (n = 3) 4. tertiary school (n = 4)	insert number	4
17	Do you take part in ongoing education (training) to ensure high quality of IE operation?	1. every course (n = 5) 2. most courses (n = 4) 3. only the most important courses (n = 3) 4. irregularly (n = 2) 5. never (n = 1)	insert number	1

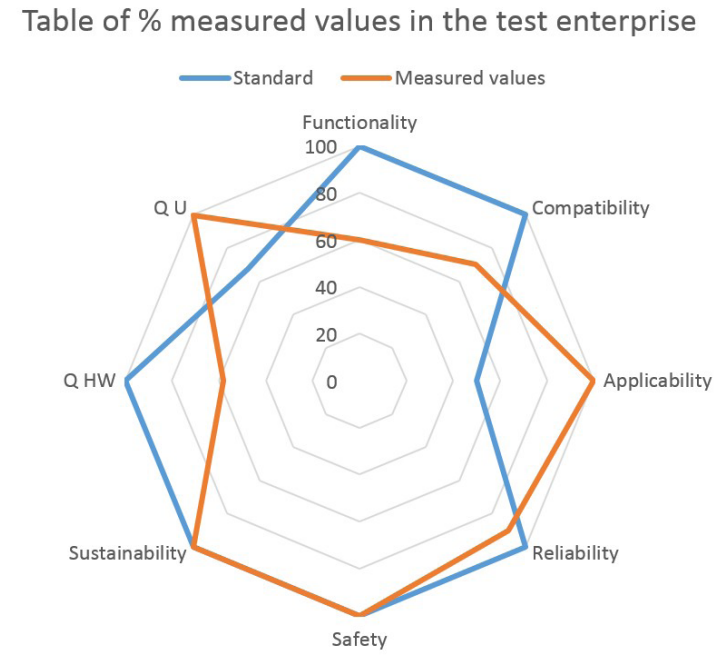
Source: own work

Table 2: Questions for the evaluation of the information environment in an agricultural company (IE) (continuation).

	Quality QSW						QHW	QU
	Functionality	Compatibility	Applicability	Reliability	Safety	Sustainability		
Standard	100	100	50	100	100	100	100	67.5
Measured values	60	70	100	90	100	100	58	100

Source: own work

Table 3: Table of measured % values in the tested company 1 (TC1).



Source: own work

Chart 1: Chart of measured % values in the tested company 1 (TC1).

Overall status evaluation QIZP		
QSW	**QHW**	**QU (user)**
Rating good	Rating good	Rating excellent

Source: own work

Table 4: Overall evaluation of the quality of information processes in the agricultural company TC1.

6. Case study – interpreting the results of the model

Interpretation of the state of QIPAC – comments and suggestions for improvement of the determined state (TC1)

QSW criteria:

Functionality – in terms of functionality, it is recommended to more extensively use the support of the developer/vendor of the company's main IS to better understand how it can be used in a broader scope in the company and better match the structure of production.

The farmer's statement: we only use some simple modules.

Compatibility – the values of this characteristic are relatively low, mainly because the main IS does not communicate with most other systems.

This is not merely a fault of the main IS, but the other systems' lack of communication features as well.

There is significant room for improvement here. In the other characteristics, the results of the measurement do not indicate the need for any changes.

Criteria: QHW – Improvement was not necessary at the time of evaluation, but the purchase of new HW will be necessary within 2 years.

Criteria: QU – Improvement was not necessary at the time of evaluation (education level – a university degree in a related field).

Interpretation of the overall state of QIPAC – comments and overall evaluation of the state of information processes in the agricultural company TC1

In the area of investment linked to the development of the information environment directly related to production in an agricultural company, the company is planning to invest and, which is a positive finding, is planning to invest in human resources – users of IT in the agricultural company. The company's approach to IT is however not ideal, as it sees the impact of IT on the achievement of its objectives as a "necessary technological solution".

Based on the defined model, procedure and the implemented case study evaluating the quality of information processes in the agricultural company, it was determined that the model is useful and easy to understand for the evaluator.

Conclusion

It has been established that in contemporary primary agricultural production, particularly in the case of small farms, not enough emphasis is placed on maximal possible use of information systems and IT in the broader context of information processes in agricultural companies in general. In other analysed companies, the results (differences against etalon values) were even more pronounced.

When selecting and specifying the objective of our research, we started with the state that we had encountered in our earlier research and practical collaboration with agricultural businesses.

The efficiency of the use of IT is poor, or, to be more accurate, very different and varied. Partial problem areas or controlling technology (lines, sensors, animal feeding systems, data gathering and collation etc.) and database and information sources are generally at a relatively high level of quality, but for example expert knowledge systems rarely support strategic management. Systems managing plant protection and nourishment are typically also excellent, but our experience from smaller farms indicates they are not used because they are too complicated and not seen as suitable for typical practical situations.

As an example, we could mention a moment from a case study in which a small farmer, based on the results of leaf analysis, uses cheaper combined fertilisers (the limiting factor being nitrogen which is used as per need) and before stock fertilizing needs to know the balance of nutrients including the impact of nutrient loss (caused by the removal of the crops from the field, washed away or tied to the soil complex) in order to optimise stock fertilizing and implement it as additional fertilizing, thus significantly reducing costs compared to competing large companies; as an additional effect, this would improve yields and help conserve the environment. Being given this task, we started looking for software that would contain an expert knowledge base including optimisation curves that could be linked to the results of soil and plant analysis on the site, but could not find any.

The reason for this situation is that neither the systematic and holistic view of partial processes in for-profit companies, nor strategic management are very well understood by SMEs (and, it seems, by software developers) as a path leading to a more certain future. In large companies that have the capacity and the means and are subjected to greater pressure by the owners (even though the managers may of course be sometimes wrong), the situation is better, but the more complex situation also means that it's difficult to trace back any errors to their root causes.

From the perspective of strategy support, we have concluded that every information system that is to efficiently support a company's strategy must on the one hand be able to implement (bring in from the outside) good practice and principles of strategic decision-making into the process of creating and implementing a business strategy, forcing the company management to utilise experience and best practices described in theory and practice. On the other hand, however, such information systems, including individual SW tools, must undoubtedly also allow the inclusion of good practice and know-how of the company's own management, as this knowledge is specific to the company itself and as such irreplaceable.

Of course there is software on the market that meets generally accepted methodology standards. This, however, is just looking at the issue from the perspective of prerequisites. In terms of the requirements for the information system, the entity guaranteeing its quality is the company management itself; key role is then played

by the management's ability to navigate the offer of software useful for the support of strategic and operational decision-making. A large proportion of the software that the company IS connects to or uses directly (sometimes free of charge) is deployed because of other entities such as ministries or non-governmental institutions (e.g. the agriculture portal agris.cz or an application maintaining records of land use and matching subsidies etc.). In the case of these entities, an analysis of information systems, both mandatory and optional, in smaller farms shows that a targeted support of strategic management is practically non-existent. And where it does exist, it's usually a strategy that is more beneficial to suppliers and consumers. For this reason, we have decided to conclude this article with recommended requirements that should be taken into account by everyone who influences the practical usability of software that improves the competitiveness of agricultural companies and optimises their strategic decision-making. The list of some of the recommendations drawn from the research is as follows:

- The proposed model and its methodology enable objective evaluations of the quality and use of information technology and processes in an agricultural company. It covers the quality of software, hardware and computer literacy of users (QSW, QHW and QU).
- It has been confirmed that a well configured information environment in an agricultural company can support its competitiveness. This competitiveness must be perceived in a long-term context taking into account the structure and character of agricultural production in the company.
- We recommend applying the model once a year with respect to proposed changes in legislation and ICT development. The methodology also includes a process for evaluating quality which was in the "Specification of the evaluation" step extended with a new important item – "Taking into account the specifics of information technology in an agricultural company".
- The outcomes of the research include also conclusions and recommendations of requirements that should be taken into account by everyone who influences the practical usability of software that improves the competitiveness of agricultural companies and optimises their strategic decision-making.
- IT tools and processes in the company must be directly linked to production and business processes in compliance with all security standards.
- Each part of the information system of an agricultural company should have a clearly defined role and especially inputs and outputs.
- The added value should lie in a specific tangible benefit for the company's competitiveness and the ability to support easier strategic decision-making while developing a long-term strategic competitive position.
- The information environment in an agricultural company must allow clear, transparent and unambiguous interpretation of data.
- The knowledge level of the users must correspond to the general requirements to ensure that use and control of the technology is efficient and the outputs useful; at the same time, it is important to stress the need for user-friendliness wherever possible and wherever it has an impact on efficiency (intuitive interfaces, reducing data redundancy, maximum automation of data entry and outputs to reduce user workload, advanced verification and validation systems, rapid response, visualisation of results, minimisation of steps, ergonomy…).
- This must be supported by the management of the agricultural company in the deployment and innovation process and continuously for the entire time in which the system is deployed at the company.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grants. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20171008, „Acquisition, processing and evaluation of data obtained from laboratory testing of software usability and user experience".

Corresponding author:
Doc. Ing. Jaromír Štůsek, CSc.
Department of Management, Faculty of Economics and Management,
Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Praha 6 – Suchdol
E-mail: stusek@pef.czu.cz

References

[1] Bruckner, T., Voříšek, J., Buchalcevová, A. Chlapek, D., Řepa, V., Stanovská, I. and Voříšek, J. (2012) "*Tvorba informačních systémů*", Grada Publishing, edice Management informační společnosti, ISBN 978-80-247-4153-6.

[2] Buchalcevová, A. (2016) "Analysis of the management of business informatics framework from the green ICT viewpoint", *International Journal of Information Technology and Management*, Vol. 15, No. 1, pp. 41-58. ISSN 14614111. DOI 10.1504/IJITM.2016.073913.

[3] Conte, S. D., Dunsmore, H. E., and Shen, V. Y. (1986) „*Software engineering metrics and models*", Benjamin-Cummings Publishing Co., Inc. Redwood City, CA, USA. ISBN 0-8053-2162-4.

[4] Fountas, S. Sorensen C. G., Tsiropoulos Z., Cavalaris C., Liakos V. and Gemtos T. (2015) "Farm machinery management information systém", *Computers and Electronics in Agriculture*, Vol. 110, pp. 131-138. ISSN 0168-1699. DOI 10.1016/j.compag.2014.11.011.

[5] Jošt, G., Huber, J., Heričko, M. and Polančič, G. (2016) „An empirical investigation of intuitive understandability of process diagrams", *Computer Standards & Interfaces, Elsevier*, Vol. 48, pp. 90-111. ISSN 09205489.

[6] Kožíšek, F. and Vrana, I. (2017) "Business Oricess Modelling Languages", A*GRIS on-line Papers in Economics and Informatics*, Vol. 9, No. 3, pp. 39-49. ISSN 1804-1930. DOI 10.7160/aol.2017.090304

[7] Kruczynski, K. (2010) „Business process modelling in the context of SOA – an empirical study of the acceptance between EPC and BPMN", *World Review of Science, Technology and Sustainable Development*, Inderscience Publishers, Leipzig University of Applied Sciences, Germany, Vol. 7, No. 1-2, pp. 161-168. ISSN 17412242. DOI 10.1504/WRSTSD.2010.032351.

[8] Kubata,K. (2017) "Vliv informatiky na zvýšení konkurenceschopnosti zemědělského podniku", Prague, Dissertation Thesis, Dept. of Information Technologies, FEM, Czech University of Life Sciences Prague

[9] Kubata, K. and Šimek, P. (2016) "Identification of Business Informatics Specifics in Agricultural Enterprises", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 3, pp. 69 - 76. ISSN 1804-1930. DOI 10.7160/aol.2016.080307.

[10] Morris, S. and Gotel, O. (2012) "The diagram of flow: its departure from software engineering and its return", in *International Conference on Theory and Application of Diagrams*, Springer, Department of Computing, City University London, United Kingdom, pp. 256-269. ISSN 14332825. DOI 10.1007/978-3-642-31223-6_26.

[11] Pradabwong, J., Braziotis, C., Pawar, K. and Tannock, J. (2015) "Business process management and supply chain collaboration: a critical comparison ", *Logistics Research*, Vol. 8, No. 1, p. 6. ISSN 18650368.

[12] Rysova, H., Kubata,K., Tyrychtr,J., Ulman, M., Šmejkalová, M. and Vostrovský, V. (2013) "Evaluation of electronic public services in agriculture in the Czech Republic", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. LXI, No. 2, pp. 473–479. ISSN 24648310. DOI 10.11118/actaun201361020473.

[13] Shifeng, Y., Chungui, F., Yuanyuan, H. and Shiping, Z. (2011) "Application of IOT in agriculture". *Journal of Agricultural Mechanization Research*, No.7, pp. 190-193. ISSN 1003-188X. Index F323.3, SWUF2007026.

[14] Sommerville, I. (2013) "*Softwarové inženýrství*", Computer Press, Brno. ISBN 978-80-251-3826-7.

[15] Šimek, P., Vaněk, J., Jarolímek, J. and Šimek, P. (2008) "Development of communication infrastructure in rural areas of the Czech Republic", *Agricultural Economics*, Vol. 54, No. 3, pp. 129-134. ISSN 0139-570X.

[16] Šimek, P., Vaněk, J. and Jarolímek, J. (2008) "Information and communication technologies and multifunctional agri-food systems in the Czech Republic", *Plant, Soil and Environment*, Vol. 54, No. 12, pp. 547-551. ISSN 1214-1178.

[17] Sørensen, C. G, Fountas, S., Nash, E., Pesonen, L., Bochtis, D., Pedersen, S. M., Basso, B. and Blackmore, S. B. (2010) "Conceptual Model of a Future Farm Management Information System", *Computers and Electronics in Agriculture*. Vol. 72, No. 1, pp. 37-47. ISSN 01681699.

[18] Štůsek, J. and Vostrovský,V. (2008) "*Modely strategického myšlení*", TG Tisk s.r.o Lanškroun. ISBN 978-80-903680-8-8.

[19] Tyrychtr, J. (2017) "Economic Value of Information Systems in Agriculture: Cohesion and Coupling of Information Elements", *AGRIS on-line Papers in Economics and Informatics*, Vol. 9, No. 3, pp. 71 - 79. ISSN 1804-1930. DOI 10.7160/aol.2017.090307.

[20] Tyrychtr, J., and Vostrovský, V. (2017) "The current state of the issue of information needs and dispositions among small Czech farms", *Agricultural Economics*. Vol. 63, pp.164-174. ISSN 0139570X.

[21] Ulman, M. and Kubata, K. (2011) "Quality Evaluation of eGovernment services in the Czech Republic", In: *17th European Conference of Information Systems in Agriculture and Forestry 2011*, Prague: ICC FEM CULS.

[22] Vanderfeesten, I., Reijers, H. A. and Van der Aalst, W. M. (2008) "Evaluating workflow proces designs using cohesion and coupling metrics", *Computers in industry*, Vol. 59, No. 5, pp. 420-437. ISSN 0166-3615. DOI 10.1016/j.compind.2007.12.007.

[23] Vaněk, J., Jarolímek, J. and Šimek, P. (2008) "Development of communication infrastructure in rural areas of the Czech Republic", *Agricultural Economics*, Vol. 54, No. 3, pp. 129-134. ISSN 0139-570X.

[24] Vaněk, J., Kánská, E., Jarolímek, J. and Šimek, P. (2010) "State and evaluation of information and communication technologies development in agricultural enterprises in Czech Republic", *Plant, Soil and Environment*, Vol. 56, No. 3, pp. 143-147. ISSN 1214-1178.

[25] Vaněk, J., Jarolímek, J. and Vogeltanzová, T. (2011) "Information and Communication Technologies for Regional Development in the Czech Republic – Broadband Connectivity in Rural Areas, *AGRIS on-line Papers in Economics and Informatics*, Vol. 3, No. 3, pp. 67-76. ISSN 1804-1930.

[26] Vaníček, J. (2006) "Software Quality Requirements", *Agriculture Economics*. Vol. 52, No.4, pp. 29–37. ISSN 0139-570X.

[27] Vrana, I. and Rychta, K. (2005) "*Zásady a postupy zavádění podnikových informačních systémů*" Prague: Grada Publishing. ISBN 80-247-1103-6.

[28] ISO/IEC WD 25023 (2013) "Software engeniering SQuaRE – External Quality", Tokyo: Weseda University.

[29] ISO/IEC FCD 25010 (2014) "Systems and software engineering- SQuaRE Quality in use", Tokyo: Weseda University.

[30] ISO/IEC DIS 25021 (2011) "Systems and software engineering – System and software product Quality Requirements and Evaluation (SQuaRE) – Quality measure elements", Department of Industrial and Management Systems Eng. Tokyo: Waseda University.