Quality assurance of job analysis in agriculture

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ABSTRACT

The measurement of working time requirement in agriculture is a very time-consuming process. As well, the manual measurements of working time and its influence factors are very error-prone. Measurement errors are mostly due to the measuring person. On the other hand there is an influence of the presence of the measuring personnel on the observed working person (Haidn, 1992; Schick 2005).
The aim of the project is to develop new methods of work time measurement which can be used for labour in outdoor-work and livestock farming. Therefore different sensor technology like GPS, radar technology, infrared, ultrasonic technique, RFID or video analysis will be examined.

Keywords: Quality assurance, automated work time measurement, indoor location

1. Problem definition

On agricultural farming, human work is the most limited production factor. The aim of job analysis is i.e. to capture and increase the productivity of farms (Schick, 2006). Working time measurement can be separated in causal and final methods (Luczak 1998). Final methods determine the working time with the help of working diaries and questionnaires and work indirectly. Causal methods work with the direct observation and measurement with electronic time measurement tools and software. Therefore the operation will be separated in working elements and its influence factors will be determined (Auernhammer, 1986). The disadvantage of the causal method is a high time-consuming of the measurement and the data evaluation process. Although it is very difficult to observe more than one person simultaneously (Schrade et al., 2004). The attendance of a measuring person induce the working person and so the results (Haidn, 1992).
It can be assumed that there are measuring errors in every step of the process of generating working time data. Key factors are the manual operation of measuring working time and the batched process.

2. Objectives

The aim of the project is, to evolve a quality assurance system for current methods of working time measurement. First quality criteria of working time measurement will be determined and applied. An example of quality criteria is the epsilon-test which is used for evaluation of measurement of cycled work elements.
Derived from this, new methods of working time measurement will be developed and valued with the same criteria. The newly developed methods of working time measurement characterized by a high automation level. Methods should be applicable for different agricultural activities.

3. Material and methods

Working time measurement on agricultural holdings are performed with the help of electronic time recording devices (Tablet-, Pocket-PC). Some measurements of main influence factors, such as distance, volume or driving speed are carried out manually. During the measuring of working time as well as influence factors, a standardised procedure enables the optimisation of data quality. Checklists are used to assist in the process of working time measurement and so ensure data quality, when carried out by multiple people. Further significant aspects of the process ‘working time assessment’ should always use similar quality criteria such as the Epsilon test in cyclic work elements (Figure 1).

It is possible to automate particular processes. This is of certain benefit for workload intensive and error prone procedures of data assessment and evaluation. In near future the developing of optimised and automated methods of working time analysis will be addressed in a requirements catalogue.

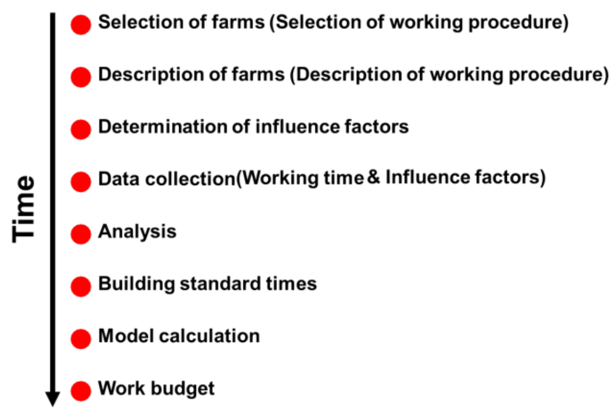

Fig. 1: Process for carrying out working-time studies (Schick, 2006)

First mandatory and optional criteria will be determined, subsequently existing systems and sensor techniques for the measuring of working time will be verified in terms of data quality.
Approaches for outdoor and indoor working procedures already exist. Further the quality of systems from the non-agricultural sector will be evaluated and so give indications on data accuracy. In the next step experiments and working time studies will be carried out in a practical setting.

4. Results

A requirements catalogue with different criteria to an automated working time measurement has been generated. Important criteria include accuracy of data, data structure and flexibility. Requirements are separated in mandatory and optional criteria (Table 1).

Tab. 1: Examples of mandatory and optional criteria for the development of an automatic working-time measurement

Mandatory-criteria	Observations
measurement of work elements	For modelling with work elements they should be measured in this form.
real-time measurement	Data of working time measurement should be available directly at little expense.
open data structure	As part of an complete measuring process data structure has to be open.
Optional-criteria	
Measurement for indoor- and outdoor- work procedures simultaneously	Continuous measurement of the influence factor „distance“ indoor and outdoor with an accuracy of < 1m
Continuous measurement of a few days	To get maximum of data and variance a measurement of a few days is to aspire

4.1 Working time measurement for outdoor-work

A variety of procedures, which are already being used to document working time in a practical setting (indoors and outdoors), were explored. Agricultural work that is performed outdoors, is usually monitored by Global Positioning Units (GPS). Time and travelled distance of fieldwork are hereby monitored. GPS are used to capture influence factors such as yield per hectare or working width and interact with agricultural machinery (Fleuren, 2009).

Initial studies of two different measurement methods for outdoor work procedures indicate, that GPS accuracy is roughly 2m. Additionally, data structure is encrypted and not applicable for working time assessment. Currently it is not possible to locate working people in building by GPS-technologies, as the signals have to communicate with outdoor satellites.

4.2 Working time measurement for indoor-work

Basic approaches of automated working time measurements for work procedures of indoor livestock farming already exist. The dairy industry developed a measurement system which captures the working time input per cow. The system can recommend an efficient milking-routine. It is however not possible to measure further influence factors such as the milkers walked distance.
Based on the catalogue of requirements different sensor technology, such as WLAN, RFID, ultrasound, radar-based systems or video analysis, are yet to be verified. This technology is already being used in the emergency services and could potentially be used as an element of automated working time measurements (i.e. to locate persons and to track the traveled distance). The most important criteria is the accuracy of location. Table 2 compares accuracy of different sensor technologies (Mautz, 2009).

Tab. 2: Comparison of different sensor technology for measuring influence factors

Sensor technology	Max. accuracy	Observations
WLAN	+/- 5m	Interferences
Radar	+/-2 km/h	Recording distance, not position
RFID	+/- 0.5m	Interferences
Infrared	+/- 0.05m	Disturbance of dust and light
Video analysis	+/- 0.4m	Disturbance of light
Ultrasonic	+/- 0.02m	Interferences

Additionally to accuracy, it is essential that the entire measuring procedure can be integrated into the system. Further it needs to be compatible with additional sensors and working time measuring devices.

For the development of an automated working time measurement and measurement of influence factors, different sensor technologies of high accuracy should be appropriated.
However, as agricultural buildings usually include large amounts of metal, humidity and dust, the potential for errors is increased. It is therefore essential to evaluate a sensor technique that is ideal for the use in such challenging environment. In order to develop a sensor technique that is applicable for both, the indoor and outdoor environment, flexibility of the system is paramount.

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