Cross-Functional Quality Management: Case Study of Sowing of Spring Plants

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Abstract

Recently Cross-functional Quality Management (CFQM) increased intensively. However, the applications of CFQM in agriculture are not much. This article describes an approach for examination of job of several producer groups using the fuzzy indicator methodology, and its application for evaluation of sowing of spring wheat is proposed. The main advantage of the developed approach is the ease with which the condition attributes defined by producer groups can be estimated by expert panel.

Keywords: cross-functional quality management, fuzzy indicator, sowing of spring plants


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1. Introduction

In recent years there has been intense interest in a new approach to management that has been developed called Cross-functional Quality Management (CFQM). According to Vadim Kotelnikov, the CFQM approach manages business processes across the traditional boundaries of functional areas (http://www.1000ventures.com/business_guide/mgmt_cross-functional.html). CFQM relates to coordinating and synergizing the activities of different units to develop cross-functional goals and realizing superior policy and deployment. It is concerned with building a better system for achieving such cross-functional goals as innovation, quality, cost, and delivery.

There are many publications related directly or indirectly with CFQM (Hackman & Wageman, 1995; March, 1981; McDonnell, 1992; Sashkin & Kenneth, 1993; Olian & Sara, 1991; Wruck et al., 1994). For example, Hackman & Wageman (1995) provided empirical, conceptual, and practical issues of total quality management. Lawrence et al. (2009) introduced the functional quality management systems for livestock producers. However, there has been very little other published on the application of CFQM in agriculture (Lawrence et al., 2009; Ikerd, 2002).

Application of CFQM for sowing of spring crops would be of interest for management from a practical point of view. With the sowing of spring crops, there are three major management functions that must be performed throughout spring: planning, implementation, and control. The planning function involves defining issues and collecting data, and also relates to planning for operations.

The objective of the current study is the development of method for examination of management options of several producer groups using the fuzzy indicator methodology as a method of CFQM, and the application of this method for evaluation of sowing of spring wheat.

2. Method

Generally fulfilment of CFQM is very difficult because the factors influencing quality are usually complex. The nonlinear relationships between the various causes and the problems they create for production lead to increased complexity. Recently, several tools have been developed to address a variety of questions and problems related with CFQM (Pau, 1981; Yang et al., 2001; Dooley, & Kapoor, 1990; Debao, 2011; Hassan et al., 2003; Thissen et al., 2001; Bocaniala et al., 2006). Yang et al. (2001) described two types of model-based tools for diagnosis of failures: in one statistical knowledge is used, while in the other analytical knowledge is utilized. In work discussed by Hassan et al. (2003) existing tools for monitoring and diagnosis of problems have been improved using statistical features. Thissen et al. (2001) considered the multi-variable statistical process of diagnosis of failures using neural network.

Bocaniala et al. (2006) described a novel fuzzy classification methodology for fault diagnosis. They considered three main directions of applying fuzzy classifiers for diagnosis of failures. These
classifiers were neuro-fuzzy classifiers, classifiers based on collections of fuzzy rules, and classifiers based on collections of fuzzy subsets.

A method for examination of concerns of several producer groups regarding sowing of spring crops using the fuzzy indicator methodology can be carried out using several procedures.

1. Definition of producer groups. Among them could be: a) Seed groups, b) Agrometeorological groups, c) Soil groups, etc.

2. Definition of Influence factors (condition attributes). Among them could be:
   1. The purity of seeds (viable), %
   2. The purity of seeds (weeds), %
   3. Seed germination, %
   4. Fuzzy Factor of Hidden Internal Damages (FFHID)
   5. Forecast of the ten-day precipitation probability, %
   6. Forecast of the ten-day air temperature, °C
   7. Soil quality, points (1-10)
   8. Forecast of the soil temperature before sowing, °C
   9. Forecast of the soil moisture before sowing, %
   10. Availability of NPK, %

3. Definition of the product quality characteristics (decision attributes). Among them could be fuzzy indicators: 1) Individual Fuzzy Indicator (IFI), and 2) Combined Fuzzy Indicator (CFI) (Krueger et al., 2010; Torbert et al., 2008). The SFI is defined as a number in the range from 0 to 1, and modeled by an appropriate membership function. A CFI can be made with the use of fuzzy aggregation algorithms. In this study, weighted average was utilized.

3. Example

The goal of this example was to examine the management needs of several producer groups for the preparation of plans for sowing spring wheat. In connection with this, four producer groups are defined (Table 1). Also, the number of condition attributes was defined as equal to 14. The Gas Discharge Visualization (GDV) group used the GDV technique for diagnoses of hidden internal damage of seed material. This group measured the GDV parameters (glow area and shape factor) and defined a Fuzzy Factor of Hidden Internal Damages (FFHID).

Assessments of condition attributes are given by calculations of IFI (Table 1). Assessments of the producer group activity were carried out by comparison of CFI. The seed group ranked highest (CFI = 0.94), while the soil group was ranked into the second position (CFI = 0.87).
Table 1. Data of examinations of the producer groups

<table>
<thead>
<tr>
<th>Producer group</th>
<th>Condition attributes</th>
<th>Values of condition attributes given by producer group</th>
<th>Assessments of condition attributes using IFI</th>
<th>Assessment of the producer group activity using CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed group</td>
<td>Quality of varieties (elite or reproduction), index (1-5)</td>
<td>2</td>
<td>0.95</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>The purity of seeds (varietal), %</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The purity of seeds (weeds), %</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mass of 1000 seeds, g</td>
<td>48</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seed germination, %</td>
<td>85</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group used the Gas Discharge Visualization (GDV) for diagnoses of the seeding material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fuzzy Factor of Hidden Internal Damages (FFHID)</td>
<td>0.2</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Agrometeorological group</td>
<td>Forecast of the ten-day precipitation probability, %</td>
<td>20</td>
<td>0.8</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Forecast of the ten-day air temperature, °C</td>
<td>12</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Soil group</td>
<td>Soil quality, points (1-10)</td>
<td>7</td>
<td>1</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>Forecast of the soil temperature before sowing, °C</td>
<td>8</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forecast of the soil moisture before sowing, %</td>
<td>85</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Availability of NPK, %</td>
<td>75</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
4. Conclusion

Recently, the use of Cross-functional Quality Management (CFQM) has intensively increased. However, very little utilization of the CFQM methodology has been seen in agriculture. This article describes a novel approach for examination of management factors of several producer groups using the fuzzy indicator methodology, and its application for evaluation of sowing of spring wheat was proposed. The main advantage of the developed approach is the ease with which the condition attributes defined by producer groups can be estimated by an expert panel.
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