Comparative Analysis of Digitalization Efficiency Estimation Methods using Desktop Grid[1]

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Introduction

Digitalization is essential for the digital transformation of businesses.

Measuring the economic efficiency of digitalization is crucial but challenging.

Digitalization of agriculture and aquaculture is a novel trend due to introduction of the aqua(agri)culture 4.0 concept implemented irregularly in the world.

The fishing industry in the Republic of Karelia is a significant sector, particularly in commercial trout production.

There is a lack of methods to measure the efficiency of digitalization in aquaculture industries.

Rapid Economic Justification (REJ)

Rapid Economic Justification (REJ) is the most comprehensive and applicable method proposed by Microsoft. The scheme of the method:

- Understanding business: correlation of business indicators and business processes with planned changes in the implementation of digital solutions;
- Choosing the solution itself;
- Detailed analysis of business processes;
- Profiling of all benefits of the project;
- Assessment of changes in monetary terms;
- Risk analysis;
- Calculation of financial metrics.

Steps of Modified Method

1. calculation of a simple (non-discounted) *Payback Period* (when customer returns the costs incurred for digitalization),

$$PP = IC/Proc,$$

   where IC are the initial costs incurred for digitalization, $Proc$ is the input of the project implementation which is calculated as the amount of actual savings, i.e. the effect;

2. calculation of a group of indicators of the consumer index (*Customer Index*) — answers the question of evaluating the results of digitalization by measuring the actual savings, i.e. the effect obtained, depending on the tasks where the measurement points are (increase in income, turnover, customer base, cost reduction, minimizing risks and costs for them);

3. calculation of a group of indicators of key risk parameters based on the FERMA (Federation European Risk Management Associations) risk management standard.

Advantages of the Modified Method

- specific for the aquaculture field the customer index indicators;
- consideration of key risks: technical failure and data loss, failure in the RAS aeration system, biological risks;
- customer indices expressed in monetary terms;
- can be used for estimation of the digitalization efficiency of a single company or a group of companies;
- optimizing the digitalization strategy of a company under given budget and time constraints.

Model

V - volume of production expressed in monetary terms

M - number of technical/digital solutions available in the market

a_i - the cost (capital expenses) of the solution i

b_i - operating expenses (as % per year of the cost) of the solution i

e_i - the effect that the solution i gives

x_i - binary variable, which indicates that the solution i is purchased

u - percentage of the production volume V (uV - available budget)

t_0 - acceptable payback period

$$\sum_{i=1}^{M}(Ve_i - a_ib_i)x_i \rightarrow max, \tag{1}$$

$$\sum_{i=1}^{M} a_i(1 + b_i)x_i \leq uV, \tag{2}$$

$$\frac{\sum_{i=1}^{M} a_ix_i}{\sum_{i=1}^{M}(Ve_i - a_ib_i)x_i} \leq t_0. \tag{3}$$

Numerical Experiments. Parameters

| Technical/digital solution	Cost, a_i, RUB	Efficiency, e_i, % of V	Operating costs, b_i, % of a_i
automatic feeding systems	43900	6	30
fish counters	170000	3	25
fish sorters	95000	3	25
automatic RAS systems	350000	10	30
autonomous power supply	150000	2	20
BIG DATA technology	1000000	3	17
sediment monitoring	400000	1	5
water quality assessment	70000	10	5
security/video surveillance	24000	3	10
fish pumps/manipulators	250000	5	15
fish farm management software	90000	3	10

Numerical Experiments
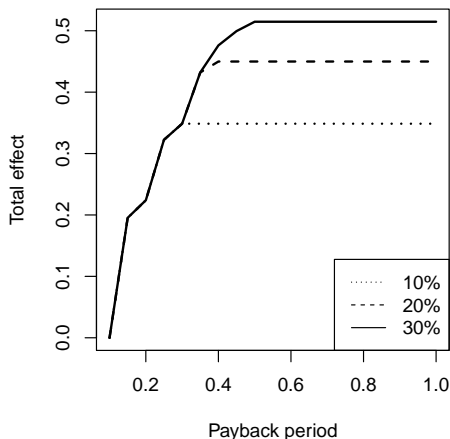
Figure: Normalized total effect vs. payback period for a small-scale aquaculture production subject to digitalization. The graphs correspond to 10, 20 and 30% of the annual budget of the company for digitalization.

Results and Discussion

- The method allows for calculations under assumptions of random production volumes, efficiency of digital/technical solutions, and other random factors.

- The effect of digital/technical solutions can be expressed in a more detailed and time-dependent manner. For example, the purchase year of the specific solution.

- The method is BOINC-ready and can be run over BOINC using the RBOINC package, allowing for distributed computing and scalability.

- The method can be used to digitize aquaculture enterprises at a regional level, understanding the subsidy budget needed for successful digitalization programs.

- "Synergistic effects" can be achieved through the simultaneous implementation of multiple solutions.

- Nonlinear summands in the cumulative effect function can account for the combined effects of different solutions.

Thank you for attention!

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