



INTERNET OF FOOD & FARM

KPI CATALOGUE FOR EACH USE CASE

WP 4

September 22, 2017

Methodology for the economic impact measurement for
IoF2020 IoT use cases.



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Authors	Gohar Nuhoff-Isakhanyan, Jan Willem Kruize, Alexander Berlin
Contact details of the coordinator	George Beers george.beers@wur.nl



PROJECT SUMMARY

The internet of things (IoT) has a revolutionary potential. A smart web of sensors, actuators, cameras, robots, drones and other connected devices allows for an unprecedented level of control and automated decision-making. The project Internet of Food & Farm 2020 (IoF2020) explores the potential of IoT-technologies for the European food and farming industry.

The goal is ambitious: to make precision farming a reality and to take a vital step towards a more sustainable food value chain. With the help of IoT technologies higher yields and better-quality produce are within reach. Pesticide and fertilizer use will drop and overall efficiency is optimized. IoT technologies also enable better traceability of food, leading to increased food safety.

Nineteen use-cases organised around five trials (arable, dairy, fruits, meat and vegetables) develop, test and demonstrate IoT technologies in an operational farm environment all over Europe, with the first results expected in the first quarter of 2018.

IoF2020 uses a lean multi-actor approach focusing on user acceptability, stakeholder engagement and the development of sustainable business models. IoF2020 aims to increase the economic viability and market share of developed technologies, while bringing end-users' and farmers' adoption of these technological solutions to the next stage. The aim of IoF2020 is to build a lasting innovation ecosystem that fosters the uptake of IoT technologies. Therefore, key stakeholders along the food value chain are involved in IoF2020, together with technology service providers, software companies and academic research institutions.

Led by the Wageningen University and Research (WUR), the 70+ members consortium includes partners from agriculture and ICT sectors, and uses open source technology provided by other initiatives (e.g. FIWARE). IoF2020 is part of Horizon2020 Industrial Leadership and is supported by the European Commission with a budget of €30 million.

EXECUTIVE SUMMARY

This deliverable is an outcome of task 4.1 within WP4 of the IoF2020 project. The deliverable presents methods to analyse value networks of IoF2020 use cases and provides the catalogue of key performance indicators and measurement methods. The deliverable helps to answer the question “In which parts of the value network and for which actors the ICT solutions create added value, and how this value can be measured?”

First, a literature review has been conducted to define a value network analysis method. The value network analysis method covers the goal of value network analysis, the roles of stakeholders, and relationships between them. Second, a literature study, desk study of use case descriptions and interviews with use case partners have been conducted to develop the KPI catalogue and measurement methods. This deliverable defines KPIs, the goal of KPIs, methodology and KPI measurement methods.

The preliminary conclusion from the value network analysis method is that directly engaged stakeholders are easily identifiable, whereas indirectly engaged stakeholders that can be affected by the IoF solutions are not visible at the first glance. Exploring the roles and relationships among stakeholders and actors, mapping the flow of value relationships between them can give a powerful insight into the value networks to understand how values are realised, and what is required to achieve the maximum value benefit across the entire system.

Regarding the KPIs, we can conclude that the KPIs provided by the literature are of a wide range. The KPIs indicated by the use case teams, though, are narrow. Teams often overlooked KPIs that have impact, but are not explicitly noticeable. It is the task of our expert team to explore these KPIs and complete the catalogue along the project period. The KPI impacts can be used to draw value networks and to analyse them per case.

As a result, use case teams developed a living spreadsheet document which presents the KPI catalogue and will be continuously improved.

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LIST OF ABBREVIATIONS

ICT – Information and Communication Technologies

IoF – Internet of Food and Farm

IoT – Internet of Things

KPI – Key Performance Indicator

MVP – Minimum Viable Product

1. INTRODUCTION

Currently, ICTs transform business processes in many industries. Companies in agriculture use ICT components, such as computer-based systems and data to monitor, plan and control processes (Kruize, 2017).

ICT components usually do not function stand alone, but often as part of a larger integrated system (Kruize, 2017). Integration of ICT components requires that various actors collaborate in their development and exploitation (Kruize, 2017). Farmers can benefit from (integrated) ICT components. Benefits are, among others, increased yields, decreased environmental impact, eased cross-compliance and product traceability, increased efficiency of resource use, better animal health and welfare, reduced pre- and post-harvest losses, increased quality, improved production control throughout the supply chain, optimized labour (IoF2020 proposal).

Urged to apply ICT components in their business strategies, companies extensively search for new business models that enable collaboration with related actors. However, the available business models often reflect one perspective and offer one best option for companies as such. New complementary business models are needed to offer companies alternative business options to implement and create integrated plans, set and solve challenging objectives in ICT component integration, create a view on the business development opportunities and challenges.

Value network analysis visualizes business activities and the relationships among the actors from the whole systems perspective and allows to develop new business models (Houghton and Joinson, 2010). Referring to the use cases of IoF2020, the question related to value networks is:

- In which parts of the value network and for which actors the ICT components create additional value, and how can these values be measured?

This deliverable is composed of two parts according to the two actions of Task 4.1: (1) Analysis of value network and (2) Development of KPI catalogues and measurement methods. First, this deliverable provides an overview of the value networks, clarifies the method to quantify the added values created for each actor within the networks of use cases considering the entire value chain. The value network analysis covers the entire value chain starting from farms to processing plants, logistic providers, retailers, and end-consumer. Second, this deliverable identifies KPIs per use case, followed by the development of a KPI catalogue and measurement methods. KPI catalogue and measurement methods help to quantify and measure the potential impact of IoF solution per use case. The quantification is based on the pre-defined variables, measurement procedures, the weight of each variable, and the final calculation.

At present, IoF2020 use cases are still in their start-up phase. Therefore, the exact performance and impact of use cases are difficult to measure and should be identified together with related actors and stakeholders. The baseline values and the additional created values can be measured through the application of ICT components and field measurements throughout the entire project period. The KPI catalogue and measurement methods allow to measure the impact of the IoT solution focusing on economic dimension of sustainability and considering environmental and social aspects.

2. VALUE NETWORK ANALYSIS METHOD

This deliverable presents a method to identify the value networks of IoF2020 use cases by identifying the relevant roles, actors and stakeholders, and interactions between them. The analysis itself will be done in the coming months.

Definition value networks

Value networks are structures that enable stakeholders to collaborate by pooling their assets and resources in such a way that they can create added value (Nuhoff-Isakhanyan, 2016). The stakeholders can deploy that value in business opportunities, commercialize products and services engaging wider communities.

In short, value networks connect actors and stakeholders that interact. Interactions create added values not only for the actors alone, but also for the group. At network level, however, actors and stakeholders need to deal with trust, privacy, security and ownership issues. Therefore, the challenges of IoF implementation goes beyond the control of an individual actor/stakeholder and becomes a network level challenge (Nuhoff-Isakhanyan, 2016).

Goal of value network analysis

The goal of value network analysis is to take a broader view of value networks considering value created for all stakeholders from a whole system perspective. In general, radical innovations need strong value-creating relationships, which brings the businesses to a new level of complexity. This deliverable will deal with value-creating complexities and define the characteristics of the value networks of IoT applications, quantify added value for each actors and stakeholders engaged and analyse interactions in value networks.

Roles

Innovations often involve many stakeholders that play a specific role. Although the stakeholders that are affected by the project can be invisible at the first sight, it is important to identify the roles the stakeholders might play to boost innovation. In IoF use cases, roles, such as planner, coordinator, farmer, processor, producer, supplier, ICT Provider, investor, data user, consumer, controller, partner,



etc. can be identified. The roles are often neither unique nor exclusive. Thus, stakeholders can have more than one role at the same time, and the same role can be fulfilled by more than one stakeholder.

Stakeholders

Stakeholders are any identifiable groups or individuals who has impact on achieving the targeted objectives, and who is considerably affected by the achievement of the objectives (Freeman and Reed, 1983). In the scope of this project, we identify stakeholders that are engaged in IoF implementation, and have significant impact. The stakeholders per IoF use case will be grouped as shown in Table 1. By taking a step-wise approach, we will start with one use case and adapt the approach when necessary for the others.

Table 1: Stakeholders per IoF2020 use case in Trial 1: Arable Farming

Use case name	Roles	Stakeholders
UC1.1: Within field management zoning	<i>Fill-in the roles</i>	<i>Indicate who (i.e.) name of the person or organization plays the specific role</i>
UC 1.2: Precision crop management		
UC 1.3: Soya protein management		
UC 1.4: Farm machine interoperability		

Relationships

Business relationships usually include contractual/formal activities between stakeholders. Formal relationships are essential if trust is low, and risks are high. However, informal relationships are equally important. Informal relationships are non-contractual ties reflecting non-contractual agreements, exchanging information and advice. Networks with actors that have tight informal relationships proved to be more successful in upgrading the collaboration (Nuhoff-Isakhanyan et al., 2017).

In the scope of IoF2020, we will explore values created for stakeholders and map the flow of value relationships between them. This can give a powerful insight into the value networks to understand how values are realised, and what is required to achieve the maximum value benefit across the entire system.



Value network analysis will help to manage stakeholder relationships, develop business ecosystems, arrange mergers and acquisitions, develop new business models, support innovation, and knowledge management.

2.1. KEY PERFORMANCE INDICATORS

Definition KPIs

In general, a KPI is a measurable value that shows the effectiveness in achieving key objectives. KPIs are usually used to evaluate the success in reaching defined targets at various levels. KPIs may focus on the overall impact of the IoT solution on the use case, on the performance of the companies engaged in the use cases, on the progress towards strategic goals, and impact on other stakeholders. Thus, key performance indicators indicate measurable values to demonstrate the efficiency of use cases in achieving their key business objectives. In the scope of IoF, three levels of KPIs are indicated (Table 2).

Table 2: Levels of KPIs

Levels	Definition	Examples
Operational	Indicators on achieving IoF use case objectives	Number of sensors installed, number of farmers participating, number of ICT component used, etc.
Strategic	Indicators on achieving better and sustainable performance for actors (e.g. farmers and active organizations) considering economic, environmental and social aspects	Yield increase, efficiency, improved market access, less water use, work time efficiency, etc.
Visionary	Indicators on achieving better sustainability for stakeholders	Less CO ₂ , user satisfaction, work stress reduction, farmers' livelihood, etc.

The overall goal of the KPI measurement is to assess the impact of all IoF2020 use cases in terms of their economic, environmental and social impact along the three levels (Table 2) and to quantify this impact into an economical value. Thus, each impact criteria will be reviewed and translated into a revenue gain or cost decrease in agricultural value chains. The analysis of KPIs across the chain will uncover the added value of IoT solutions for engaged actors and stakeholders.

Methodology

In preparation of the KPIs per use case, the business support team scanned through all use case descriptions. The purpose was to characterise the IoT solutions and business cases behind them. However, the KPIs stated in the use case descriptions of the proposal were not sufficient to define

clear implication on the impact of the IoT solutions. Therefore, we conducted 15 interviews with 15 use case leaders and experts, did a literature review, and used the interview results to confirm and complete the list of potential KPIs. The list of new and potential KPIs for all use cases are created focusing mainly on the economic and environmental dimensions. KPIs related to social dimension of sustainability were more difficult to define and will be developed along with the further improvement and adaption of already defined KPIs.

Using this list, the WP4 team created individual KPI catalogues per use case and asked partners engaged in use cases to review and discuss the indicators. In an iterative review process, the KPIs that are fully supported by the use case teams are added to a spread sheet.

As already mentioned above, the use cases are in a start-up phase. Therefore, the baseline values for KPI indication are often unknown and need to be defined by use case teams together with end-users. The teams will use various sources, such as own data, available literature, statistical data, sector average, expert knowledge to define the baseline values for the use case. The baseline values will be used to calculate the effect of the IoT solution.

In case no source is available due to the lack of historical data or alternative data, and the baseline values are unknown, use case teams will need more time to retrieve the relevant data from testbed farms. Accordingly, the values for their targeted impacts might not be possible to define yet. In these cases, intended impacts will be used instead of targeted impacts. WP4 will constantly monitor the use cases and require the use case teams to re-define the related KPIs before they start the MVP test phases.

Furthermore, the impact of horizontal use cases, such as 1.4, 3.4 and 5.3, is more difficult to define by precise KPIs as these cases enable IoT innovation via standardization and interoperability. Standardization and interoperability have impact on the entire sector, and not on a specific use case alone. These KPIs will be further defined in the process of IoF2020. Therefore, creating a KPI catalogue is an evolutionary process in line with use case developments.

3. KPI MEASUREMENT

KPI underlying indicators

In general, the KPIs are classified into economic, social, environmental dimensions. Below we present the potential categories of KPIs found in the literature (Rodrigues et al., 2016, Nuhoff-Isakhanyan, 2016).

Economic dimension represents a set of measures to assess the value creation, captures the aspects that have to be addressed in order to remain competitive in the market in the short and long terms. The underlying indicators of economic sustainability dimension includes (Rodrigues et al., 2016) among others,

- Turnover;
- Profit and value (assessed by traditional financial measures);
- Sales volume;
- Investments (capital employed and Research and Development – R&D);
- Relationship with investors (corporate governance and shareholder's remunerations);
- Crisis management;
- Innovation and technology, collaboration, knowledge management, processes, purchase and sustainability reporting,
- Risks.

Environmental dimension represents the environmental impacts, and encompasses the following indicators:

- Emissions to air (atmospheric acidification, photochemical ozone formation, CO₂, and GHG, etc.);
- Emissions into ground (usage and waste generation);
- Emissions into water (consumption, acidification, aquatic oxygen demand, eco-toxicity to aquatic life and eutrophication)
- Minerals (consumption and use of hazardous materials);
- Fossil resource use reduction;
- Energy consumption;
- Waste reduction
- Increasing biodiversity (ecosystems, protected areas and species) and environmental issues of products and services over the whole life cycle;



Social dimension is related to the impacts on the social system dealing with human wellbeing, the fulfilment of human needs, and the equal development of opportunities for all people. Social dimension encompass the following indicators (Rodrigues et al., 2016):

- Labour practices and decent work (such as employee's education, training and development, diversity and opportunity, health and safety, job creation, talent attraction and retention and human rights);
- Human toxicity;
- Quality of food;
- Customer relationship management (customer satisfaction, customer health and safety, products and labels, advertising and respect for customer privacy);
- Corporate citizenship (social actions, political contributions, codes of conduct, corruption & bribery, competition and pricing and society communication);
- Education.

These indicators are broad and need to be tailored to the use case characteristics. Therefore, the relevant KPIs should be defined per use case.

Measurement units

Unit of measurement can take the form of financial or non-financial instances and be expressed in terms of a metric or a measure. The measurement units are identified per indicator given in the KPI catalogues.

Data input

The KPIs of all use cases in IoF2020 will be stored in one central project database that handles all data as fully confidential. The input of data can be done threefold:

- Password-protected Web Interface

We are offering an online interface with individual logins to each use case. The online interface will offer an opportunity to enter all data regarding the agreed KPIs for each test farm individually.

- 365 Farm Net

365 Farm Net data platform and marketplace are already being used by many use cases. 365FarmNet will offer an interface through which the users can directly access all relevant data for the KPI measurement per registered test farm. Thus, the use case data will be uploaded upfront, and use case teams will not have to enter the data again via the web interface.

- Excel import from third-party systems

If use cases use other data management systems, it is possible to import the data in csv or excel format through the web interface. Importing KPI relevant data in csv or excel format can be done in a few minutes.

Data input structure is presented in Figure 1.

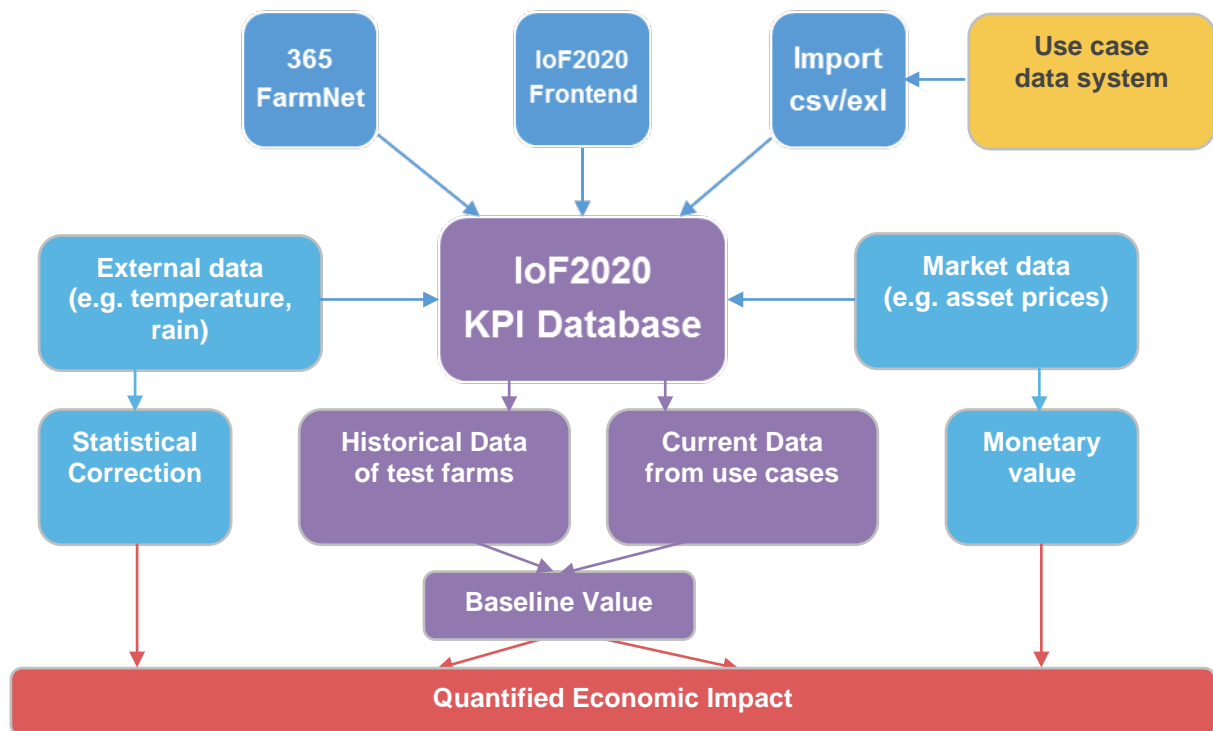


Figure 1: Data input at KPI database

Data storage

The entire database is structured to be very flexible with large capacity. The database can handle new KPIs and an extended number of use cases. However, the database will consider only the most relevant data to calculate the impact of a use case solution correctly. Note that the private data will remain confidential.

The frontend interface will offer the following features:

- Login and profile for each use case,
- Separate measurement of several products/services per use case,
- Separate measurement of several test farms,
- Flexible KPI catalogue per use case.

The backend will offer the following features:



- Translation of KPIs into economic impact values,
- Correlation of KPI measures with external environmental data (e.g. weather and diseases) and market factors (e.g. price changes)

The database structure will ensure flexibility of KPIs and underlying categories, at the same time allowing to keep track on every single one. Thus, the use case teams can edit and add underlying categories per KPI independently, although the WP4 team need to approve changes in the KPIs. In this way, the system will maintain the KPIs defined as in the current document. However, the system offers an opportunity to review and adjust the measurement of KPIs by adding underlying categories throughout the course of the project.

Refining the data

Agriculture takes place mostly in a very dynamic environment. Several external factors have influence on the production and product quality. Therefore, measuring the direct impact of IoT solutions on the outcome of agricultural production and product quality is a challenging task. In order to control the influence of external factors and increase the accuracy of all impact values, a group of experts from the Wageningen University will review and evaluate the final outcome, guide the business support of IoF2020 in calculating not only the economic impact of IoT solution, but also the probability that the impact created is due to IoT solutions by comparing the results with a group of comparable producers or with the sector average.

3.1. KPI CATALOGUE OUTLINE

As already mentioned, the WP4 team has created individual KPI catalogues, a living spreadsheet per use case and asked partners engaged in use cases to review and discuss the indicators. Below we present the sustainability dimensions, categories and indicators by use case in five trials. These indicators have been provided by use case partners, and need to be further developed and clarified.

Table 3: KPIs by sustainability dimension, categories, by use case in **Arable trial**

Dimension	Categories	Indicators	Use Case code
Economic	Productivity increase	Yield increase	1.1; 1.2; 1.3
	Efficiency improvement	Work time use efficiency	1.2
		Pesticide use reduction	1.3
		Water use reduction	1.2; 1.3
		Resource use efficiency	1.1
		Cost reduction	Fertilizer use reduction (N-use)
		Production costs reduction	1.2;1.3
		Fungicide use (late blight control)	1.1
		Herbicide use reduction (Haulm killing)	1.1
		Pesticide use cost reduction	1.3
	Water cost reduction	1.2;1.3	
	Soil herbicide use reduction	1.1	
	Quality	Quality improvement	1.2; 1.3
Environmental	Lower Input	Fertilizer use reduction (N-use)	1.1
		Nitrogen use reduction	1.2
		Fungicide use (late blight control)	1.1
		herbicide use reduction (Haulm killing)	1.1
		Soil herbicide use reduction	1.1
		Pesticide use reduction	1.3
		Herbicide management	1.3
		Nitrogen and water use efficiencies	1.2
		Water use efficiency	1.3
		Water balance	1.3
	Lower emissions and leaching	Energy use(CO ₂ emission reduction)	1.1
		Nitrogen leaching reduction	1.2
	GHG reduction	1.2	
Soil health	Better soil structure	1.3	
Social	Ease of work	Effective time use	1.2
		Stress reduction	1.2
	User satisfaction	IoT user satisfaction	1.1;1.2;1.3

Table 4: KPIs by sustainability dimension, categories, by use case in **Dairy trial**

Dimension	Categories	Indicators	Use Case code
Economic	Productivity increase	Yield increase per cow	2.2;2.3
		Improved animal health	2.2
		Reduced of calving interval	2.2
		Reduced production assets	2.2
		Higher productivity per employee	2.3
		Higher Return-on Investment	2.3
		Calibrations sets provided and used for remotely monitored instruments	2.4
	Efficiency improvement	Increased production efficiency	2.3;2.4
	Cost reduction	Revenue increase	2.1
		Reduced work time	2.1; 2.2
Quality Improvement	Improved tractability	2.1	
	Improved precision of measurement values	2.1	
	Accuracy of determining if all cows are inside or outside the barn	2.1	
Environmental	Lower Input	Increased animal health and welfare	2.1; 2.2
		Reduced assets production	2.2
		Improved processing/resource use	2.4
		Less waste/not qualified product	2.4
Lower impact	Lower emissions and leaching	2.1;2.2	
Social	Ease of work	Reduction of worktime	2.1; 2.2
		Improved precision of values	2.1
		Disseminate to dairy farmers directly	2.1
	Public health	Increased quality food, food safety and security against terrorism	2.1; 2.4

Table 5: KPIs by sustainability dimension, categories, by use case in **Fruit** trial

Dimension	Categories	Indicators	Use Case code
Economic	Productivity increase	Yield increase	3.1; 3.3
		Increase of throughput speed	3.3
	Cost reduction	Water cost	3.1
		Phytosanitary measures	3.2
		Cost of control	3.2
		Decreased total average cost	3.3
Quality Improvement	Grape quality improvement	3.1	
	Higher proportion of kg extra olive oil/campaign (kg per campaign)	3.3	
Environmental	Resource efficiency	Water use reduction	3.1;3.3
	Waste reduction	Reduction of crop wasted/ rejected at harvest (%)	3.1
		Reduction of crop wasted during transport, storage, packaging (%)	3.1
		Moulds and or wine waste	3.2
	Lower emissions and leaching	Reduction in frequency of treatment (TFI)	3.2
		Potable water use reduced	3.2
		Energy use reduction	3.2
		CO ₂ emission reduction	3.2; 3.3
		Lower levels of fertilizer used (l per year/ha and kg per year/ha)	3.3
		Reduction of nitrogen or pests rests in the land / water	3.3
	Social	User satisfaction	IoT user satisfaction
Reduce toxic pesticide exposure			3.2
High added value jobs in winery			3.2

Table 6: KPIs by sustainability dimension, categories, by use case in **Vegetables** trial

Dimension	Categories	Indicators	Use Case code
Economic	Productivity increase	Yield increase (per ha)	4.1; 4.2; 4.3
		Reduced running hours	4.3
	Increase in sales turnover	Increase of number of machines sold	4.3
	Efficiency improvement	Reduced certification time	4.4
		Reduced number of human error	4.4
	Cost reduction	Reduced production costs	4.2
		Increase in turnover	4.3
		Increase in sale	4.3
		Reduced costs of certification	4.4
Quality Improvement	Longer shelf life	4.1	
	Nitrate content	4.1	
Environmental	Resource use efficiency	Reduced water use	4.1; 4.2
		Reduced land use	4.3
		Reduced use of paper	4.4
	Less pollution/emission	No use of pesticide	4.1
		No run off of pesticide	4.1
		Reduced pesticide use	4.2
	Reduced running hours	4.3	
Social	Public health	Lower level of pesticide active ingredients	4.2
	Satisfaction	Increased level of satisfaction of auditor	4.4
		Increased level of satisfaction of producer	4.4
	Transparency of food chain	More data available	4.2
		Predicted yield	4.3
		More weeding and growth data available	4.3
Trust in the quality of food products		4.4	

Table 7: KPIs by sustainability dimension, categories, by use case in **Meat** trial

Dimension	Categories	Indicators	Use Case code
Economic	Productivity increase	Increase average daily weight gain	5.1
		Reduced animal mortality	5.1; 5.2
	Efficiency improvement	Better feed conversion ration	5.1
		Cost reduction	Less antibiotics and veterinary costs
	Quality Improvement	Less water costs	5.1
		Reduced boar taint	5.1
		Improve uniformity and average weight	5.2
Environmental	Animal welfare	Improved traceability	5.3
		Less sick animals	5.1
		Reduced mortality	5.1;5.2
	Lower resource use	Improved physical condition	5.2
		Less feed use	5.1
	Reduced waste	Less water use	5.1;5.2
		Reduced mortality	5.1; 5.2
Social	IoT user satisfaction	IoT user satisfaction	5.1
	Public health	Less use of antibiotics	5.2

In an iterative review process, the KPIs that are fully supported by the use case teams will be confirmed, added to or removed from the spread sheets. To refine the KPIs and quantify them, we need additional data from use cases. The following questions will be used to collect the required data (Table 8).

Table 8: Questions related to KPIs

No	Name	Explanation
1	Dimension	First row - please indicate the operational KPIs that are related to use-case implementation (WP2) Second, third and fourth row - Economic, Environmental, Social KPIs Some KPIs given by users are at use-case implementation level (e.g. sensors installed or number of farmers engaged) , and some at use-case impact level on three sustainability dimensions (economic, environmental , social). Use-case implementation related KPIs need to be discussed with WP2. If you find any KPI related to this level, please indicate them on the top raw of each use-case sheet.
2	Categories	The KPIs categorised (grouped). You do not need to add/change. WEcR experts will define the categories. Nevertheless, feedback or suggestions are welcome.
3	Indicators	Indicators given by use-cases and suggested by experts. Please check the trial implementation plan (D2.1.2. Trial implementation plan, WP2, M6.docx). Sometimes, the use-cases provide different KPIs in the plan than indicated in the sheets of this file.
4	Definition	What does the KPI exactly mean? How to operationalize it to be able to measure properly?
5	Use case code	Fill-in the code of the use-case to which the specific KPI relates (e.g. 1.1; 2.2; 3.1; etc.)
6	Baseline value	Fill-in the baseline values if available. If not, then suggest alternative (e.g. sector average, average of similar farms in the region).
7	Target value	Target values per KPI - This is often, but not always, given in the Trial implementation plan. Attention: If a KPI is not quantitatively measurable, try to explore the underlying indicator(s) that are measurable and communicate about it with the business unit managers.
8	Unit	E.g. kg/ha, hours per...? , or maybe scale [1-10]
9	Timespan	E.g. year, quarter, day
10	Measurement Method	How the certain KPI will be measured? E.g. measurement using certain devices at field??

11	Data source	E.g. farmer, use-case partner, sector average, business manager? Other WP? Yourself??
12	Stakeholder	Who has interest or is affected by the KPI? E.g. farmer, consumer, etc.
13	Data delivered by	Fill-in the name of a person or organization who will provide the data.
14	First data delivery date	Fill-in the in which month and year the data will be available.
15	Data delivery frequency	Fill-in the frequency of repetitive data collection.
16	Data format	E.g. excel, doc, text, paper, etc.
17	Remarks	Add any important remark

Table 8 represents a template that will be used to define each KPI and its boundaries, such as baseline values, time span and unit of measurement. Additionally, it will help to form a group of responsible persons who will provide data on time in an agreed frequency, and format.

Below we illustrate the KPIs defined by the use case partners of use case 1.1 as an example (Figure 2, Figure 3, and Figure 4).

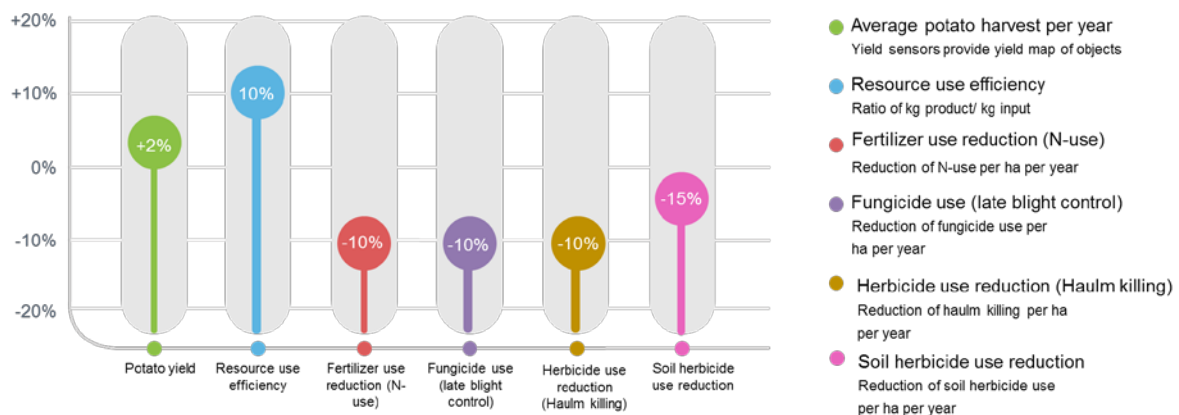


Figure 2: Economic KPIs; Use Case 1.1 - Within field management zoning

Figure 2 show the economic KPIs provided by the use case partners. The horizontal axis shows the specific KPIs that are relevant for the use case 1.1. Vertical axis shows the targeted KPI values that the use case aims to achieve as a result of IoF implementation, e.g. 2% increase of potato yield per year.

Similarly, Figure 3 and Figure 4 show the environmental and social KPIs provided by the use case 1.1. Each horizontal axis of the figures show respectively the environmental and social KPIs that are relevant for the use case. Each vertical axis shows the targeted KPI values that use-cases aim to achieve as a result of IoF implementation, e.g. decrease of CO₂ emission by 15%.

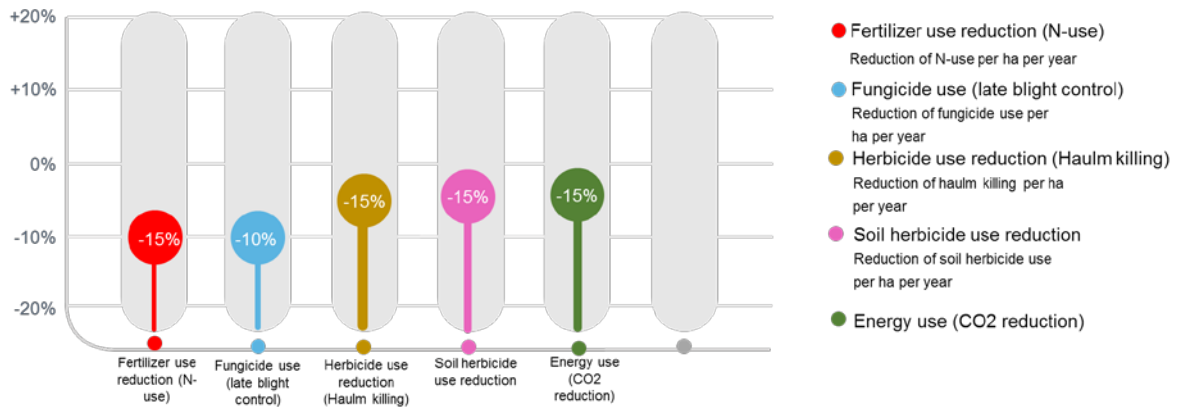


Figure 3: Environmental KPIs; Use Case 1.1 - Within field management zoning

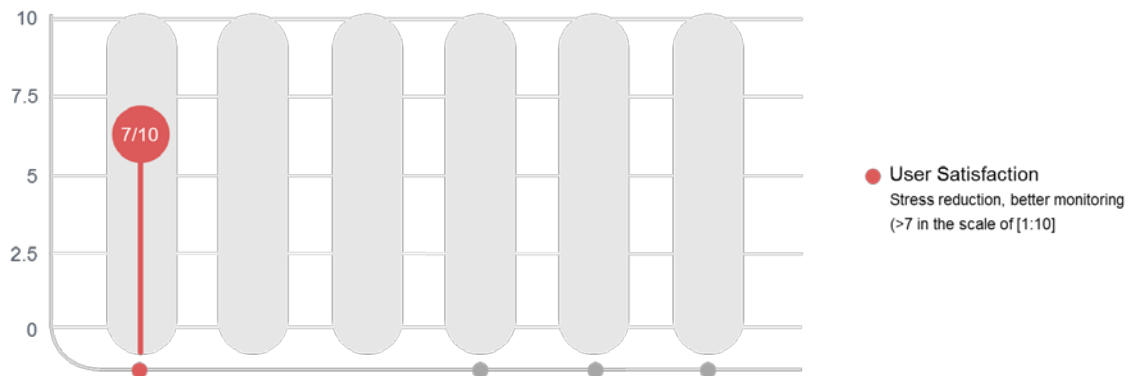


Figure 4: Social KPIs; Use Case 1.1 - Within field management zoning

Unfortunately, not all KPIs provided by all use case partners are quantifiable, and clearly defined. For instance, it is not known which costs are considered under cost reduction KPI, which quality criteria the product quality KPI refers to (e.g. taste, size, shelf-life). It is the challenge of the experts engaged in WP4 to further refine and identify quantifiable KPIs in order to calculate the impact which is due to IoF implementation.

Whenever the targeted KPIs for 19 use cases are defined and the units are refined, we will use the format presented in the figures 2-4 to communicate with the public.

4. CONCLUSIONS

General conclusions

This deliverable is an outcome of the task 4.1 within WP4 of IoF 2020 project. The deliverable presents methods to analyse value networks, defines key performance indicators, and measuring methods.

The main conclusion from value network analysis is that directly engaged actors are easily identifiable, whereas other stakeholders that can be affected by the IoF solutions are not visible at the first glance. Stakeholders and actors can play more than one role at the same time, and can share the same role among themselves. Therefore, it is essential to identify the roles of stakeholders and actors. Stakeholders and actors with same or similar roles can efficiently collaborate, and eventually avoid redundancies and potential conflicts.

Exploring the relationships among stakeholders and actors and mapping the flow of value relationships between them can give a powerful insight into the value networks to understand how values are realised, and what is required to achieve the maximum value benefit across the entire system. Value network analysis will help to manage stakeholder relationships, develop business ecosystem, arrange mergers and acquisitions, develop new business models, support innovation, and knowledge management.

As follow-up step, we need to identify the important roles per use case, identify which actors and stakeholders play the role, and which roles are not fulfilled yet. We will use the KPI impacts to draw the value networks and to analyse them per case.

Regarding the KPIs and KPI catalogue, the KPIs provided by the literature are of a wide range and include KPIs that have direct and indirect impacts. The KPIs indicated by the use case teams, though, are more narrow KPIs than literature and experts suggest. The use case teams often overlooked KPIs that have impact, but are not explicitly noticeable (especially at the 3rd level in Table 2). Some examples are KPIs related to crisis management, risks, corporate citizenship and education. Nevertheless, these KPIs can be measured only a few years after the ICT solution has been implemented. It is the task of our expert team to explore these KPIs and complete the catalogue along the project. Eventually, most of agricultural productions have a seasonal character and are sensitive to the external environment, such as weather and market changes. Therefore, we need to regularly (e.g. yearly) measure the KPIs to control the external influences and measure the impact which is due to IoF implementation.

Finally, we need to collect data regularly from the field to measure and indicate the KPIs and added values in value networks. Therefore, we will undertake the following actions:

Next actions

- Conduct several brainstorming sessions together with WP4 experts and use case partners.
- Identify all stakeholders per use case, their roles and relations.
- Map the flow of value relationships between stakeholders.
- Facilitate users to register their KPIs in an integrated KPI measurement system, and provide a convenient interface to the use case teams to input their data.
- Offer further support on the development and definition of social KPIs as this part is currently underdeveloped in the catalogue.
- Develop the KPI database.
- Conduct impact analysis (beginning of 2018) and start the first MVP cycle.
- Based on the outcomes of the KPIs, the business models will be reviewed and adjusted.
- Start the second cycle of MVP (mid 2018) and compare the impact with previous results.
- Open the follow-up cycles and update data yearly.

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