

DIGITAL AGRICULTURE INDUSTRY – DEVELOPMENT OF SUSTAINABLE STRATEGIES FOR INDUSTRY AUTOMATIZATION

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Abstract—Despite the big and rapid growth of technologies during the 21st century, there is still an industry that is lagging behind with the optimization and launch of its digital transformation. In fact, this is the agricultural sector. Therefore, in recent years, many attempts have been made to develop and implement optimized processes and technologies, in order to increase production and reduce costs while maintaining product quality. But the automatization and digitization itself is very complicated to implement. When not done by proficient experts, this can cause huge losses and downgrade. The purpose of this publication is distinguish the critical factors while developing strategies for plant production automatization.

Keywords—digital agriculture industry, smart production, automated systems, smart greenhouses, automated plant production, digital transformation, digitalization

I. INTRODUCTION

Today, we are witnessing something which was thought to be imaginarily and extraordinary – the world is changing drastically! It firstly started long time ago with our personal data, such as documents, photos, music, etc. It didn't took much time until the next phase began - the business realized the true potential of the globalization and started adopting it, while changing its needs drastically, making the digital transformation irreversible. There is no more doubt whether the digital transformation is happening or not. It has already started and believe it or not - we are part of it.

The promise of digital transformation is to help companies, and even industries, to create new value, by adopting and implementing digital technologies, like artificial intelligence (AI), cloud computing, augmented reality (AR), virtual reality (VR), industrial internet of things (IIoT), Blockchain etc. The leading companies are already showing bright signs of improvements, thanks to the data-driven decisions. The main thing which they are doing is transforming their business models according the new trend, such as connecting their operations, gaining access to relevant data and digitizing processes.

But implementing such large-scale changes in an organization might be risky. Capturing the benefits of the modern trends is a key factor in keeping up with the competitors. There comes the tricky part – a proper risk analysis of the as is – to be and the creation of clear roadmap, pursuant with the weaknesses of the industry. Although the

benefits may seem predominant, a poorly managed transformation can downgrade the organization.

Despite the many positive factors and signs, there is still an entire industry (with small exceptions) which was delaying the implementation of this new trend. The agricultural farmers and companies were keen on keeping the traditional way of working, which made them fall behind the business and economic evolution. This slow down led to multiple challenges in the industry. Because of the rapid urbanization and the global population growth rapidly (from 7.6 billion in 2018 to over 9.6 billion in 2050), there will be a remarkable increase in the food demands. At the same time, there is a lack of natural resources as fresh water and arable land. This requires an urgent alteration of the whole agricultural system. Digital technologies are opening up an entire 'new world' regarding crop management. Producers' and agronomists' jobs are changing due to large amounts of data and tools they have at their disposal. However, how to incorporate these properly at a farm level, is still a learning process for most of them [1]. Digital transformation may be part of the solution. It is main part of the next industrial revolution, named the "Fourth Industrial Revolution" (or simply Industry 4.0).

II. DESCRIPTION OF THE PROBLEM

The efficiency of farming lies in a farmer's ability to predict natural conditions and react to them in the quickest way possible. A few decades ago, the precision of such forecasts wasn't so reliable — now, it's impressively high thanks to instant data gathering and distribution [14]. Despite its conservatism and stiffness, the agricultural industry realized that globalization without digitalization is impossible. Nowadays agriculture doesn't only limit to cultivate crops rather following convenient and efficient way to grow more crops. The demand & usefulness of greenhouse technology is increasing with increase in population and there is no alternative of it to cope with epicurean lifestyles of people. Not only that, it is not convenient to rely on natural climatic condition in agriculture [5].

Before deep-diving into the problem, firstly we will define the terms of digitalization and digital transformation. According to the market forecasts for the next decade, "the digital agricultural revolution will be the newest shift which could help ensure agriculture meets the needs of the global population into the future. Digitalization will change every part of the agri-food chain. Management of resources through-

out the system can become highly optimized, individualized, intelligent and anticipatory. It will function in real time in a hyper-connected way, driven by data. Value chains will become traceable and coordinated at the most detailed level whilst different fields, crops and animals can be accurately managed to their own optimal prescriptions. Digital agriculture will create systems that are highly productive, anticipatory and adaptable to changes such as those caused by climate change. This, in turn, could lead to greater food security, profitability and sustainability [3]. The correlation between industrial revolutions and agricultural revolutions is clearly visible. There is only one thing left – the acceptance of the change. As Daniel Newman said “people in the industry—farmers, food producers—must embrace the digital transformation trends in agriculture. By using technology as a sustainable and scalable resource, we will be able to take agriculture to new heights, keeping farm to fork in our future [4].

So, what is this “digitalization” and what does the “digital transformation” mean?

According to Gartner’s IT Glossary, “digitization is the process of changing from analog to digital form”, while the “digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business”. Also, from there we have the definition of digital transformation – it can refer to anything from IT modernization (for example, cloud computing), to digital optimization, to the invention of new digital business models. The term is widely used in public-sector organizations to refer to modest initiatives such as putting services online or legacy modernization. Thus, the term is more like “digitization” than “digital business transformation [2].

There are many circumstances which cannot be neglected when talking about digital transformation. Some constraints are the required technology, including availability, connectivity, affordability etc. Also, there are some basic conditions, which has to be fulfilled, like infrastructure and connectivity (mobile subscriptions, network coverage, internet access, and electricity sup-ply), affordability, educational attainment (literacy, ICT education) and institutional support. Most of the developing countries have seen the gap in this industry and started many initiatives in the context of creating a good environment for development of new processes and methodologies.

Digital agriculture is the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders within the agriculture value chain to improve food production. But less than 20 percent of acreage to-day is managed using digital agriculture technologies (e.g., variable-rate spraying) due to the high cost of gathering precise field data. The fourth agricultural revolution is associated with many innovations in sustainable agriculture, some emerging and some more established, which are interacting and co-evolving in a wider “ecology of innovation”; Such an ecology of innovation includes “big” emerging smart technologies (e.g., AI, Internet of Things, Cloud Computing, robotics), as well as “smaller” farmer and/or community-led innovations. When it comes to technology and data available within the agricultural industry, there’s a large amount of choices these days. It’s important that retailers understand and are able to provide guidance for growers about what works and what doesn’t work as well.

Understanding the technologies and datasets are important and how to best use them is even more crucial. Precision agriculture is a term widely used in the industry today. Precision agriculture is an approach to farming that employs data sensors, connected devices, remote control tools, and other advanced technologies to give farmers more control over the field and the team [14]. It helps growers better respond to variability within a field or series of fields to improve overall crop health and increase yields. Digital agriculture tools include the variety of technology and software systems that provide data to enhance decision making in precision farming, and if used properly, can help reduce waste, increase profits and protect the environment. Using technology for farm management in-creases data accessibility. With precision agriculture, the team members are no longer bound to the office space. Thanks to cloud-based technologies, all the necessary data is free for access any time from any device.

According to a research done by Altimeter Group “Only one-quarter of the companies we surveyed have a clear understanding of new and underperforming digital touchpoints, yet 88% of the same cohort reports that they are undergoing digital transformation efforts.”[15] Briefly said, a big part of the organizations Altimeter spoke to reported that they are performing their Digital Transformation without even knowing what it actually is.

III. PROBLEM SOLUTION

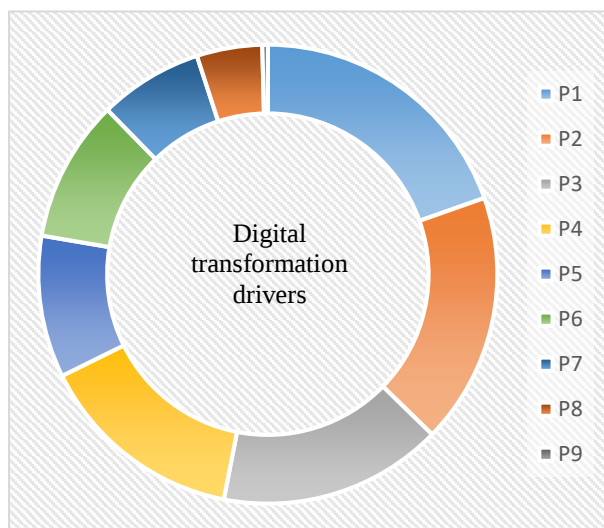
With the help of smart sensing elements, growers can predict best conditions for plant growth and what nutrients their crops need. At the moment our ability to collect vast amounts of data easily outstrips our ability to convert it in-to usable information. Predictive analytics can play a critical role for decision makers who need to interpolate and forecast from a current situation to an alternative state. There are many technological solutions to implement this. And there we need the answer of the question - how to do this without putting a whole industry into risk? Unfortunately there is no one and only answer of this question.

Many seniors in this area today are aggressively seeking for ways to transform their companies and business models, aiming to improve their performance and yield.

According to a research performed by Altimeter based on a survey of 554 professionals from brands, consulting firms and other organizations with at least 1000 employees across North America, Europe and China, the top drivers of the digital transformation are:

- P1 - Growth opportunities in new markets – 51%
- P2 - Evolving customer behaviours and preferences – 46%
- P3 - Increased competitive pressure – 41%
- P4 - New standards in regulatory and compliance – 38%
- P5 - Evolving employee behaviours and preferences – 26%
- P6 - Proactive investment to fight disruption – 26%
- P7 - Lack of expertise, literacy and understanding of digital trends – 19%
- P8 - Decline in business performance – 12%

- P9 - Other – 1%



These transformation drivers may be assumed also for the industry of agriculture. In order to perform the change management properly, every leader should be aware of his change driver. The first step before starting this kind of transformation is to realize that it doesn't have a set of beginning or endpoint. It can be better explained as a state of mind for an organization for continuous improvement. After finding himself in one of these situations listed above, every change manager has to identify the benefits which the transformation will bring to the stakeholders. Every development strategy has to be accompanied with a proper risk management. There are many tools, which can be used in order to identify the critical points. The easiest to use and understand tool is the Risk Matrix.

		Impact					
			1	2	3	4	5
Likelihood	5	5	10	15	20	25	
	4	4	8	12	16	20	
	3	3	6	9	12	15	
	2	2	4	6	8	10	
	1	1	2	3	4	5	

According to the matrix above, 2 critical factors can be identified:

- Likelihood / Risk Probability
- Impact

These factors are giving the clear picture of the 4 different types of risks:

- Low – in green – can be accepted
- Moderate – in yellow – can be accepted after minimal changes
- High – in orange – can be accepted after major changes
- Extreme – in red – cannot be accepted

After performing a proper risk management and identifying the risks, they can be further analysed by using a SWOT diagram. SWOT analysis (or SWOT matrix) is a strategic planning technique used to help a person or organization identify strengths, weaknesses, opportunities, and threats related to business competition or project planning [16]. It consists of 4 parts:

- Strengths: characteristics of the business or project that give it an advantage over others.
- Weaknesses: characteristics of the business that place the business or project at a disadvantage relative to others.
- Opportunities: elements in the environment that the business or project could exploit to its advantage.
- Threats: elements in the environment that could cause trouble for the business or project.

	Helpful	Harmful
Internal origin	Strengths	Weaknesses
External Origin	Opportunities	Threats

Filling these tables might look a bit tricky at the beginning for every change manager. But without having the clear picture of possible outcomes, the project of implementing new technologies will be catastrophic. Although it seems easy, choosing the right technologies to implement is also very important. The choice of technology mostly depends on the process which is going to be optimized. The focus should be on the specific needs and business objectives.

After identifying the possible blockers and critical factors, the next step should be selecting a proper change management tool with the corresponding risk mitigation and prevention tools.. The process of digitization can be considered as a big change management project. There are many tools available, but according to the complexity of the project (the level of digitization) a different one may be used. The proposed ones by the authors are:

- PDCA – Plan/Do/Check/Act – recursive model that provides a framework for the improvement of a process or system. It can be used to monitor a single issues or guide an entire improvement project or initiative.
 - o Plan – define a clear problem statement, gather and analyse the data. Develop a plan for implementation.
 - o Do – execute the plan developed in the previous step.
 - o Check – gather the data from the DO step and compare to the expected outcomes.
 - o Act – also called Adjust. Improve the process.

- Kotter's 8 step model of change - The 8-Step Process for Leading Change was cultivated from over four decades of Dr. Kotter's observations of countless leaders and organizations as they were trying to transform or execute their strategies. [17]. This model may be used in bigger agricultural organizations, where bigger number of stakeholders are involved. In these situations, this model provides a better spread of the urgency for innovation and modernization.
 - o 1st step – create a sense of urgency
 - o 2nd step – build a guiding coalition
 - o 3rd step – form a strategic vision & initiatives
 - o 4th step – enlist a volunteer army
 - o 5th step – enable action by removing barriers
 - o 6th step – generate short-term wins
 - o 7th step – sustain acceleration
 - o 8th step – institute change
- ADKAR model for change management - The Prosci ADKAR® Model is a goal-oriented change management model that guides individual and organizational change [18]. This model is suitable for medium-to large organizations, where the stakeholders are not willing to accept the change, which might be the most common situation in the sector of aggrobusiness. The abbreviation stands for:
 - o Awareness of the need for change
 - o Desire to support the change
 - o Knowledge of how to change
 - o Ability to demonstrate skills & behaviours
 - o Reinforcement to make the change stick

IV. CONCLUSION

While traditional ICTs were the weak ties for diffusion of innovation, modern day ICTs are bringing vast amount of information to rural communities [9]. Precision agriculture is the key to farming that employs data sensors, connected devices, remote control tools, and other advanced technologies to give farmers more control over the field and the team. Increasing the productivity is an age-old ultimatum for the agricultural industry. The digital transformation of this industry will definitely help large and small scale farms improve processes, boost their yield, and increase profitability, helping to meet the growing global food demand and lowering the overall environmental impact of farming. Despite the fact that much work is needed in the area of digitalization in agriculture and rural areas, the potential environmental, economic and social benefits are significant. Only introducing technologies is not enough to generate good results. To be able to use the full potential of digitized agriculture, both literacy and education levels has to be increased

The digital transformation should be seen as a way of thinking and state of mind instead of just a trend. As this is going to be a very important part of every business, working with a specialized outsourcing provider may be a smart idea for organizations which are looking to introduce new technologies in their everyday processes. There are many tools

which can be used in order to create the best implementation strategy, but choosing the right one might be tricky for some individuals. As digital agriculture develops, it will be critical to make the technology available to as many farmers as possible and to implement it in ways that minimizes negative impacts on those who work in the sector [8]. This will vastly increase efficiency as well as create new markets and opportunities. This is a process which step by step takes organizations through different phases of innovation and needs to be carefully managed.

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