



Future Mindset and Challenge
A2 Future Narrative Memo (Final)

Project: AI and IOT technologies in factory meat production

Team 28

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Objectives and goals

According to the World Health Organization in 2008, “There has been an increasing pressure on the livestock sector to meet the growing demand for high-value animal protein. The world’s livestock sector is growing at an unprecedented rate and the driving force behind this enormous surge is a combination of population growth, rising incomes and urbanization. Annual meat production is projected to increase from 218 million tons in 1997-1999 to 376 million tons by 2030” (Appendix 1). Therefore, the production of meat has large environmental, ethical and consumer health impacts.

The main objective of our project is to improve the quality of factory produced meat with help of modern technology to provide a new source of meat for end-consumers. The tech-solution that we recommend has a main goal of improving the end-to-end meat production with three main deliverables:

- 1) to reduce the stress levels for each individual animal throughout their lives and slaughter;
- 2) to track and collect data for better control and improvement of farms’ and slaughterhouses’ operations;
- 3) to ensure that the meat produced fulfills quality standards and is “humanely” produced, elevating the level of meat and providing visibility of this process to the end consumer.

Key future scenarios

During the year 2020 the humanity around the globe has met new challenges it had never experienced before in such a scale: COVID-19, a virus which apparently appeared on a wet market in China only few months earlier (LiveScience, 2020), has spread around the world in the shortest time, paralyzing country economies, ruining healthcare systems and devastating households through both, economic effects and sudden health risks. After a decade of unknown viruses coming from animals we consume, every person in the world questioned, what dangers brings a piece of meat on his or her plate, and why has food become deadly for us?

The earlier cases of SARS, mad cow disease, swine- and bird flu that already impacted the world, were closely looked at, but did not seem to change much the factory farming practices. Animal activists (PETA, 2015) continue to publish investigations discovering miserable conditions and practices still in use by major meat producers, sick animals and pain they experience before being processed into cheap food, remain standard practice despite official guidelines

emphasizing humane treatment to animals. The factory farms are pushed by the demand for very cheap meat, and current laws allow them to hide their practices behind thick walls (Samuel Goldwyn Films, 2019). According to Bob Wolpert, Corporate Senior Vice President, Chief Strategy and Innovation Officer at Golden State Foods (2020), “only 1 in 4 consumers trust today’s food ecosystem” due to lack of transparency.

The current situation is frightening, apocalyptic and brings pessimism about the nearest future. But it finally can become a moment to change the paradigm of mass food production. The massive risks grow demand for transparency of practices used by major companies, and makes customers re-consider their choices.

In comparison, we can refer to the case of cheap fashion and fires on Bangladeshi factories, when H&M voluntarily took the first step to improve the conditions for factory workers, and other companies followed the practice (Erb Institute, 2014).

The customers are changing, and it would be in the companies’ interests to adjust. This change is already there. For example, a German poultry producer Rügenwalder Mühle introduced a line of vegetarian imitations, outlining their mastery of preparing these products, now available in any supermarket. The new customers, concerned about animal welfare, would purchase from a company with better practices, and now the company implemented better chicken farming standards in collaboration with European animal activists (Albert Schweitzer Stiftung, 2019).

Nonetheless we also expect that governments as well as international organizations such as WHO will demand higher animal welfare standards and introduce new legal requirements and controls, making current procedures a savage practice of the past. For example, in 2019 FDA started developing a Strategic Blueprint that will outline its plans to leverage technology and other tools to create a more digital, traceable and safer food system called “Smarter Food Safety”. The interesting part is that this project is more than just technology. It is about leadership and creativity. “It’s also about simpler, more effective, and modern approaches and processes.” (FDA, 2019)

Solution

Firstly, we would like to raise the actual problems of the industry that we are going to deal with. The problems are assumed to happen in markets with high meat consumption rates, relatively affordable prices and presence of big industrial farming of livestock and poultry such as USA, China, European countries, Brazil. Our solutions will be aimed on the industry players: major meat

producers, factory farms, slaughterhouses and governmental controlling bodies. The prototype of our solution we'll focus on the USA as main meat consumption country in the world counting with 25 billion pounds per year (4th place in per capita consumption in 2019, see Appendix 2) and also because the FDA as main regulator organ has a direct interest in it.

1. It had been proven that stress, depression, boredom and anxiety that farm animals experience, have a direct influence on the quality of their meat. The post-mortem veterinary controls estimate the quality and, in some cases, declares the meat unfit for consumption (HSI, 2001).

2. Factory farms keep the minimum allowed standards which do not reduce animal suffering during growth and transportation, and do not bother how it influences the quality of meat (PETA, 2015).

3. Slaughterhouses have long established guidelines: before animals are slaughtered, they are also required to be in a coma, so that they are slaughtered unconscious (see Appendix 3). Slaughtering is generally divided into two phases: stunning and exsanguination (see FAQ). Sheep and pigs are stunned directly with high-voltage electricity: place an electrode on each side of the pig's head and turn on the power. The current will flow through the brain, causing the animal to lose consciousness. But in order to save costs, the voltage applied is often too low, and the stress and suffering of the agonizing bodies can spoil the meat quality up to completely wasted meat even when meant and raised for premium markets.

4. Due to low wages in the industry (Food Empowerment Project, 2020), factory and slaughterhouse employees are pushed to perform at high speed and have little motivation to humanely treating animals. For example, a cow is generally stunned by the instantaneous high-voltage electric spark emitted by the stun gun. This work requires a very high skill. The gun must be accurately aimed at the right brain of the cattle, and the distance is short or short that will not cause cattle completely unconscious (Humane Slaughter Association, 2006). Lack of transparency gives slaughterhouse's employees freedom to ignore the guidelines and allow immense suffering.

Our solution represents an eco-system of technologies and consumer awareness.

1) IoT in a form of RFID (Radio Frequency Identification, Lowry solutions, 2015) ear tags to track the data of each individual animal, capturing since their birth until slaughtering their feeding, water and life habits. It uses electromagnetic fields to transmit data from an RFID tag to a reader, providing accurate, real-time tracking information. The technology could potentially record physical and mental health coordinating it with current age, conditions and location (Appendix4).

2) AI including face, voice, distance and/or movement recognition to see patterns in condition of

each animal. On a farm, the technology based on deep learning, can recognize sick, injured, or dead animals, record it in a database, send the information to the individual chips on animals and to inform responsible employees as well as management. In slaughterhouses the technology checks if an animal is actually stunned before being killed, sends alarm signals to employees to interfere, informs the controlling bodies and records the information on the animal individual chip. This surveillance will help improve the use of humane handling techniques and correct use of stunning and restraining equipment.

3) Software for accumulation, analysis and presentation of the data. We can apply the raw data to do machine learning to help the farm owners improve the farm operations. In addition, all operational standard data from the herd, including slaughter data, unit temperature, food consumption are incorporated into the digital platform, what can also help track the quality of the humane slaughter. The tendency of this industry is to use technology not only in manufacturing but in the whole supply chain, and our technology will also transform production to more efficiency, and will change production relationships between suppliers, producers and customers. This transformation is only possible when we gather and analyze data, improve processes, make them faster, more flexible and efficient by increasing the quality of the product and reducing the cost of quality issues.

4) The meat produced will be provided with a quality label “Stress Free Production” and a QR Code, preferably FDA approved. They will enable the end consumer to check and ensure the quality of the meat before the purchase, growing trust and brand loyalty (Bob Wolpert, 2020). The blockchain will ensure the proper transparency and reliability of the information. It is a complete system of tracking and QA that delivers more than food but also trust and quality for those that care for their health and animal welfare.

If the new technology will not be widely accepted by companies and for the implementation of our system we need to consider challenges (see Appendix 5, 6).

Strategy

Based on the Moore’s laws, we assume that the price of the new technology will be affordable compared to the value of the information the system would allow to collect and the increase on sales and transparency for end consumers. Nonetheless in the initial phase companies may have different interest and budgets for implementation, hence we consider a possibility to

roll-out the technology step-by-step, from basic QA functionality to complete maintenance of innovative AI-supported farms keeping animal welfare in the center of attention.

We would like first to approach sustainable premium-segment companies who are interested in higher transparency. For example, implementation and analysis of collected data in slaughterhouses can immediately prove the efficiency of the new technology and the meat quality improvement. We would also consult on application of collected data in collaboration with scientists, and providing recommendations if process improvements are needed, such as: handling pigs in groups to reduce stress on individual animals, installation of blue lamps to calm poultry, use of non-slip floors and low-angle ramps to stop animals falling and getting injured (World Animal Protection, 2018). To make sure that the changes last, we can also help companies introduce policies and new guidelines on humane slaughter.

We hope that this practice will be interesting to governments to implement and will push other companies to introduce it. We intend to collaborate with governments calling for better legislation and codes of practice on humane slaughter, to introduce these practices in vet schools.

Thanks to same algorithms, the technology is applicable for all kind of farmed animals (cattle, pigs, poultry and even fish). To expand in each industry, we would need deep observation and learning with assistance of veterinarians and behaviorists.

Stakeholders/Impact

The technology proposed might revolutionize not only the industry, but the food production processes, the way humans deal with animals and supply chains around the world, changing the paradigm and influencing numerous players. For the list and analysis of stakeholders please see Appendix 7a and 7b.

Key performance metrics

We will divide our KPIs into 2 groups: Internal KPIs which will be measured by our system, recorded on ear tags and delivered to controlling units:

- Food/Water Deprivation Index: % of time when food/water is given based on animal needs;
- Environmental Challenge: % of average farm conditions fulfilled based on animal needs;
- Treatment Rate: number of treatments related to number of hurt/sick animals;
- Stress Index: time period of stress/anxiety caused by isolation/horror scenes;

- Behavioral Restriction: adverse of willingness to lying/moving;
- Society Comfort: time period of happiness;
- Mortality Rate: animals still conscious after stunning related to number of stunned.
- Processing Time: time period between stunning of animal and its brain death;
- Meat quality as estimated by veterinarians post-mortem.

Our external KPIs characterize the success of our company, developing and implementing the above described technology and the “stress free production” label by the end consumers:

- Traceability: ability to access and analyze the full history of each animal within minutes, improved quality, and transparent production processes;
- Reliability: proven recognition patterns, safely stored data and stable hardware; in best-case scenario: FDA adoption of our technology as standard QA process;
- Animal welfare: our goal is not only profit but spread of humane technologies to reduce animals suffering across the globe, so we will measure the increase of farms number and production areas that will adopt this technology and new procedures of animal treatment;
- Market Share: increment of market share for “stress free” products vs mainstream;
- Consumer awareness: labeled product pounds sold/consumer vs mainstream;
- Customer Brand loyalty: new price paid by customers and improved profitability of the companies that adopted the solution;
- Return on Investment: to ensure profitability and financial stability throughout the years.

Attachments and additional information.**FAQ**

Slaughtering practices in industrial slaughterhouses according to animalbiosciences (2020): “There are several criteria for a good slaughter method: 1) animals must not be treated cruelly, 2) animals must not be unnecessarily stressed, 3) exsanguination must be as rapid and as complete as possible, 4) damage to the carcass must be minimal, and the method of slaughter must be 5) hygienic, 6) economical and 7) safe for abattoir workers. To avoid the risk of cruelty, animals must be stunned or rendered unconscious before they are exsanguinated.”

In our memo we refer to the following terms as to synonyms in regard to animal slaughter: **Stunned = comatose = unconscious = brain dead**. Brain death (BD) should be understood as the ultimate clinical expression of a brain catastrophe characterized by a complete and irreversible neurological stoppage, recognized by irreversible coma, absent brainstem reflexes, and apnea. The most common pattern is manifested by an elevation of intracranial pressure to a point beyond the mean arterial pressure, and hence cerebral perfusion pressure falls and, as a result, no net cerebral blood flow is present, in due course leading to permanent cytotoxic injury of the intracranial neuronal tissue. A second mechanism is an intrinsic injury affecting the nervous tissue at a cellular level which, if extensive and unremitting, can also lead to BD (Machado, Calixto, 2010).

Exsanguination means bleeding to death. Cattle and pigs are usually exsanguinated by a puncture wound which opens the major blood vessels at the base of the neck, not far from the heart. The trade name for this process is sticking. In sheep, lambs and small calves, the major blood vessels may be severed by a transverse cut across the throat, near to the head. Poultry can be exsanguinated with a diagonal cut from the corner of the jaw towards the ear on the other side, or by a knife thrust through the roof of the mouth to sever the brain and its major blood vessels. For poultry, the cut may be made on the side of the head if the head is later to be removed automatically by machine (animalbiosciences, 2020).

Data

Per capita consumption of livestock products

Region	Meat (kg per year)			Milk (kg per year)		
	1964 - 1966	1997 - 1999	2030	1964 - 1966	1997 - 1999	2030
World	24.2	36.4	45.3	73.9	78.1	89.5
Developing countries	10.2	25.5	36.7	28.0	44.6	65.8
Near East and North Africa	11.9	21.2	35.0	68.6	72.3	89.9
Sub-Saharan Africa ^a	9.9	9.4	13.4	28.5	29.1	33.8
Latin America and the Caribbean	31.7	53.8	76.6	80.1	110.2	139.8
East Asia	8.7	37.7	58.5	3.6	10.0	17.8
South Asia	3.9	5.3	11.7	37.0	67.5	106.9
Industrialized countries	61.5	88.2	100.1	185.5	212.2	221.0
Transition countries	42.5	46.2	60.7	156.6	159.1	178.7

^a Excludes South Africa.

Source: Adapted from reference 4 with the permission of the publisher.

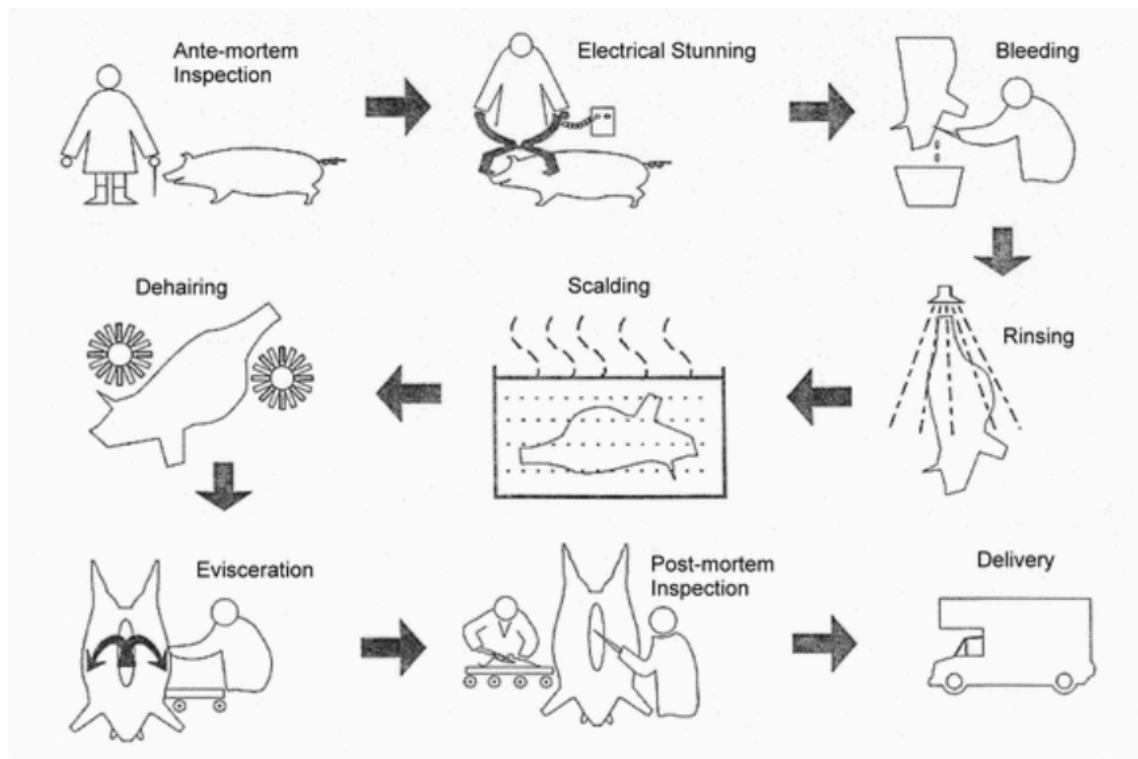
Appendix 1. WHO (2008). *Global and regional food consumption patterns and trends*. Retrieved from https://www.who.int/nutrition/topics/3_foodconsumption/en/index4.html

World Beef Consumption By Country				
World		129,472,923,360	7,432,663,275	17.4
Rank	Country	Consumption	Population	Per Capita
1	Uruguay	427,696,280	3,444,071	124.2
2	Argentina	5,269,041,800	43,847,277	120.2
3	Hong Kong	839,960,220	7,346,248	114.3
4	United States	25,714,687,680	324,118,787	79.3
5	Brazil	16,532,445,380	209,567,920	78.9
6	Paraguay	489,425,640	6,725,430	72.8
7	Australia	1,580,712,540	24,309,330	65.0
8	Canada	2,094,389,000	36,286,378	57.7
9	Kazakhstan	981,055,900	17,855,384	54.9
10	Chile	952,395,840	18,131,850	52.5
11	Israel	396,831,600	8,192,463	48.4
12	Switzerland	388,013,120	8,379,477	46.3
13	Turkey	3,571,484,400	79,622,062	44.9
14	New Zealand	178,574,220	4,565,185	39.1
15	Costa Rica	189,597,320	4,857,218	39.0
16	Colombia	1,834,243,840	48,654,392	37.7
17	South Africa	1,990,771,860	54,978,907	36.2
18	South Korea	1,728,422,080	50,503,933	34.2
19	Bosnia	121,254,100	3,802,134	31.9
20	Mexico	3,979,339,100	128,632,004	30.9
21	Kuwait	121,254,100	4,007,146	30.3
22	Lebanon	176,369,600	5,988,153	29.5
23	Russia	4,221,847,300	143,439,832	29.4
24	Gabon	46,297,020	1,763,142	26.3
25	Oman	116,844,860	4,654,471	25.1
26	Dom. Republic	238,098,960	10,648,613	22.4

Appendix 2. Beef for live (2019) *World Beef Consumption Per Capita (Ranking of Countries)*.

Retrieved from <https://beef2live.com/story-world-beef-consumption-per-capita-ranking-countries-0-111634>

Slaughter of pigs



Appendix 3. Slaughterhouses and Meat Inspection (2019). *Slaughterhouses and Meat Inspection*.

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Animal welfare factors



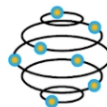
Appendix 4. Animals: an open access journal from MDPI (2017). *Operational Details Of the Five Domains Model and Its Key Applications To the Assessment and Management Of Animal Welfare*.

Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5575572/>

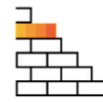
Machine learning will reinvent business, but there are more challenges



Missing link
between Big Data and
enterprise data



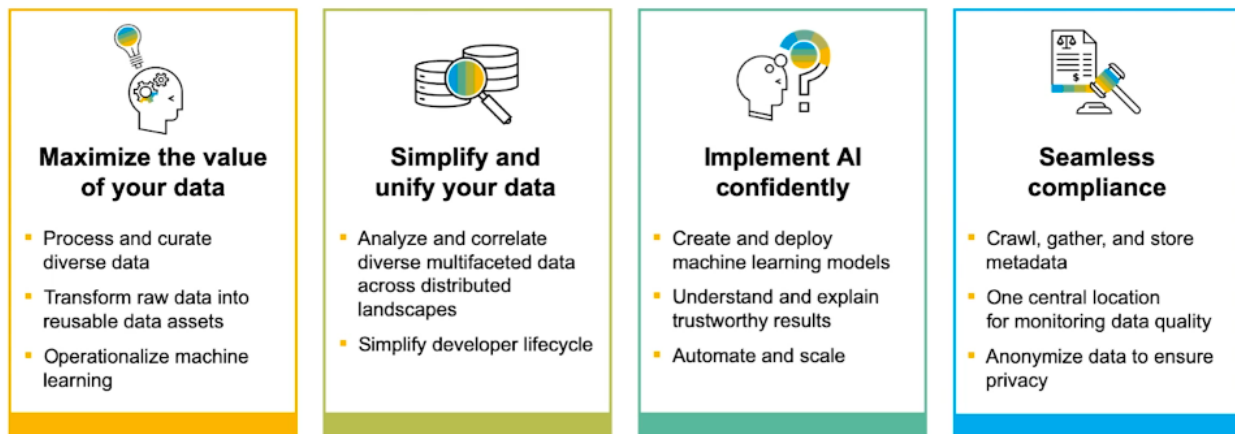
**Lack of
enterprise
readiness**



**Limited tools =
High effort**
to productize complex data
science scenarios across data
landscapes

Appendix 5. SAP SE, 2019. Retrieved from <https://open.sap.com/courses/di1>

Requirements and challenges of machine learning



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Appendix 6. SAP SE, 2019. Retrieved from <https://open.sap.com/courses/di1>

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	Stakeholder Analysis			
	Stakeholders	Concerns	Motivations	Priority
1	Society	A general public health concern in regard to food quality should be growing rapidly in 2020.	Raised standards for food safety and guaranteed quality control	high
2	Governments	We assume that in the upcoming years governments will be pushed by societies to take measures and more control over food production.	Government is already looking for solution to improve food production and we'll give it to them .	high
3	Healthcare sector	Unpredictable diseases and food poisonings often leading to patient's death.	Tech-enabled traceability and foodborne outbreak response in shorter time.	high
4	FDA and other controlling bodies	Questioning current safety standards and need for improved regulation.	The ability to use new data analysis tools and predictive analytics will help FDA and stakeholders better identify and mitigate potential food safety risks and advance the preventive controls.	high
5	NGOs: WHO (World Health Organization)	Unpredictable diseases quickly reaching pandemic level across the globe.	Fostering international collaboration and harmonization of legal base for safer practices.	high
6	Major meat producers focused on price	The business will be less profitable and cause customer loss as new technology will disclose bad practices.	Growing demand for good company reputation and consumer trust.	high
7	Shareholders	The business will be less profitable -> loss of share price.	Sustainable businesses in trend to invest in.	medium
8	Sustainable meat producers focused on animal welfare	The price of production will skyrocket.	Transparent technology will prove the sustainable practices and provide market advantage.	high
9	Infrastructure: slaughterhouses and transportation organizations	The business will be less profitable and cause customer loss as new technology will disclose bad practices.	Simpler, more effective, and modern approaches and processes	high

Appendix 7a.

10	Consumers	The end products will be too expensive; another "greenwashing" label.	The product is healthy and safe, I know where it comes from, and it's more ethically produced	high
11	Infrastructure employees	Control and surveillance will penalize me for bad performance and make my work even harder for low wages.	New industry standards require more careful approach, and transparent practices ensure higher wages and work safety.	high
12	Meat vendors (supermarkets, shops)	End products will be more expensive.	Guaranteed high-quality meat and effective tracing system improves customer satisfaction and reduces callback costs by failures.	high
13	B2B customers like McDonalds	End products will be more expensive.	Attract more customers by promise to use sustainable sources.	high
14	Farmers working for major meat producers	The price of production will skyrocket.	Transparency will eliminate commonly spread price wars imposed by major meat producers.	high
15	Farmed animals	Technology will be adopted only by sustainable producers leaving billions of animals to suffer further on factory farms.	Improvement of meat quality and safety will result into global technology adaptation and more ethical solution to one of the most difficult moral issues of our times.	high
16	Animal activists	Radical activists deny "humane" slaughter and insist on radical solutions (veganism).	They are a great source of research on animal welfare issues and some will gladly collaborate on improvement initiatives. "Influencers" for concerned consumers.	medium
17	Innovative, hi-tech companies	Their ideas to be too innovative and unprofitable.	Chance to introduce a know-how on a worldwide level with enormous impact.	high

Appendix 7b.

Sources of signals, trends and drivers

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