Digital twins report: Future recommendations

9.1 Technical recommendations

9.1.1 Optimisation with DES

AI integration to DES is an ongoing area of research. A number of AI software add-ins have become available, which makes the inclusion of certain AI methodologies easier to implement to facilitate the real-time evaluations of various ‘what-if’ scenarios in abattoir inspection processes. Such AI methodologies could allow simulation of potential cost-benefit analysis of proposed interventions to abattoir inspection processes prior to investing in actual infrastructure or technology. This can be achieved by rapidly evaluating the input parameters to find the best layout, configuration of machines for production scheduling, utilisation of employees for workforce planning etc. while considering specific abattoir settings. As a next step, an optimisation algorithm could be integrated to this generic abattoir simulation model to optimise resource allocation in specific abattoirs.

9.1.2 DES Digital Twin

Digital Twin is most commonly defined as a virtual representation of a physical asset, system or process used to detect, prevent, predict, optimize and deliver business value through real time analytics. A further study is thus required to develop the proposed DES digital twin with better data inputs for understanding both what is currently happening and what may happen in future technology-augmented inspection processes. Advancing the current model will provide the FSA with a tool for running risk-free simulation before introducing any actual changes to the inspection processes. To this end, the FSA and abattoir management can ensure consistent delivery against safety, quality, cost and other productivity objectives (footnote 1). This would require further validation of the proposed model to determine its viability through a series of use cases where the current state will be modelled and the future case be simulated, thereby providing an excellent starting point for the development of a comprehensive DES digital twin of abattoir inspections.

9.1.3 Hybrid Model (PhysiNet) Digital Twin

Discrete event simulation models require expert knowledge and advanced modelling techniques but can be used almost immediately after being developed. However, compared to AI-based models, DES models may be less accurate because they tend to be over-simplified as key system non-linearities may be ignored to reduce modelling complexity. Moreover, parameters in DES models may sometimes be estimated or inaccurately determined. These factors decrease the fidelity of DES-based digital twins and to improve the accuracy of such model predictions, engineers often have to redevelop the model by comparing the prediction and measurement to other modelling approaches such as AI-based models (Figure 10).

Figure 10: PhysiNet model

Another approach to building relevant digital twins for the FSA is using AI-based methods (footnote 2). However, such models require a reasonable amount of data, which is challenging to obtain for new systems or processes such as the proposed model that has been developed with limited data. Nonetheless, there are future opportunities to further investigate the established theoretical hybrid model (PhysiNet) (footnote 3)] (Figure 10) by combining discrete event simulation and the AI-based models to capture the whole life cycle of abattoir inspection systems (i.e. from the beginning with insufficient data to the point where sufficient data is generated from connected devices). As more data is generated from the actual deployment of connected digital devices, such hybrid models could significantly improve inspection processes by providing near accurate simulations and predictions of inspection process requirements and performance parameters.

9.2 Managerial Recommendations

9.2.1 Socio-technical balance

- the nature of meat inspections implies that any viable change initiative such as the newly proposed operational transformation framework must be based on a well-defined “socio-technical proposition”.
- the central idea here is that the work systems of MHIs, OVs and field operators comprises both a social system (including the staff, working practices, job roles, culture and goals) and a technical system (the tools and technologies that support and enable work processes).
- these elements together establish a single system of operating protocols and the technical and social elements have to be jointly designed (or redesigned) and congruent for the efficient delivery of inspection operations.
- to meet the FSA transformational goals, a crucial extension of this work is to understand and simulate how people (MHI, OVs and other field and back-office operators) and systems can be modelled to work together under both nominal and uncertain conditions, building on digital twin constructs.
- a logical next step in advancing this project is to engage with operators in the field through focus groups, Gemba walks and other ethnographic research methods to understand granular details of day-to-day inspection operations such as the key human-technology interphases (e.g., tasks description, timing, reporting and data requirements) that underpin

the delivery of inspection protocols at each critical control point, the task bottlenecks, failure modes and recovery strategies.
- this will facilitate the development and training of simulations of optimal human-technology augmented operations as well as models for detecting and countering the adverse effects of communications bottlenecks and disruptions.
- another focus of this proposed activity would be to identify the requisite training, upskilling and capacity development needs along with cost-benefit assessment that the FSA could use to prioritise the various socio-technical transitions required to prepare different categories of staff for transitions in alignment with the operational transformation strategy.
- such simulations could also be expanded using primary data to model not only individual behaviours but also the processes and data that capture the interactions and interdependencies of different FSA staff (field, front-office and back-office) that support inspections.

9.2.2 Capacity Planning

- the recent pandemic and resulting staff shortages led to major capacity planning challenges for both the FSA and the industry, which had to be developed and executed in real time as the events unfolded. With sudden staffing issues arising in pig processing plants, coupled with related export delays and a surge in demand ahead of Christmas, the agency had to deal with a weekly backlog of at least 40,000 pigs on farms across the UK.
- scenario planning around capacity issues is therefore crucial, but requires a detailed understanding of the capacity constraints, bottlenecks and opportunities across the various field operations run by the FSA in order to inform future capacity planning for service resilience to sudden disruptions.
- this would require detailed mapping of the communications protocols among FSA teams and the development of a detailed capacity requirement blueprint for different inspection tasks (for example, abattoirs, export certification etc.) to feed into a digital twin model for capacity planning that is as agile as it is reliable, to inform evidence based decision making.
- this would facilitate the running of strategic and operational scenarios based on real-life capacity parameters within a configurable virtual environment where problems and effective response can be simulated, and response strategies developed prior to facing real challenges.

9.2.3 Transformational change feasibility and viability assessments

- the nature of meat inspections is rapidly changing, with several new propositions currently undergoing feasibility and viability assessments.
- one such feasibility initiative which could potentially change the way meat inspections are conducted is the idea of mobile slaughter units (MSUs) and the assessment of their fitness for purpose, including how they should be financed, the viability of docking stations at retail outlets, the potential value streams to stakeholders, and the implications for FSA MHI and OVs evolving role within such scenarios.
- another of such feasibility assessments includes developing bespoke regulatory frameworks under the new operational transformation strategy for different animal stunning protocols (for example, Shechita and halal) as well as modelling the outcomes of technology enabled regulation of different stunning approaches to demonstrate/validate welfare monitoring to customers (for gas and electric stunning approaches) and transform welfare reporting measures using technologies.
- these and other transformational initiatives can be modelled using digital twins to develop sufficient evidence base in a virtual environment that is fine-tuned with real-world parameters prior to developing regulatory or operational frameworks for the FSA and FBOs .

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