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HYBRID INTEGRATED CARE MODELING FRAMEWORK TO IMPROVE PATIENT OUTCOMES AND SYSTEM PERFORMANCE

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ABSTRACT

The healthcare sector faces rising demands from aging populations, complex patient needs, and workforce shortages, requiring innovative solutions for resource and service coordination. In response, Trondheim municipality and St. Olavs hospital are developing integrated planning tools within the Research Council of Norway funded HARMONI project. This transdisciplinary initiative aims to bridge the widening gap between service demand and capacity through planning tools that offer an overview of patient flows and resource capacities. The tools will support comprehensive planning, process adjustments, and capacity dimensioning, fostering collaboration to prevent patient queues and unnecessary transfers. We present three ongoing hybrid model case studies focusing on patient flow between primary and specialist health services. These cases provide opportunities to develop hybrid simulation verification and validation techniques.

1 INTRODUCTION

The healthcare sector faces increasing demands due to an aging population (Statistisk sentralbyrå 2018), complex patient needs, and workforce shortages. This necessitates innovative solutions for resource management and service coordination. Trondheim municipality and St. Olav's hospital are addressing these challenges by developing integrated planning tools, as part of the Research Council of Norway funded project HARMONI to provide comprehensive resource management for sustainable healthcare services.

The problem is the widening gap between service demand and capacity. Factors like the rising number of elderly individuals with multiple chronic conditions, coupled with the shift of complex care from hospitals to municipalities, strain existing resources (Helse- og omsorgsdepartementet 2023). This leads to fragmented care, increased readmissions, and potential patient harm. Our proposed solutions are prototype planning tools that provide an overview of patient flows and resource capacities. These tools will support integrated planning, management, and capacity dimensioning, enabling better collaboration and prevention of patient queues and unnecessary transfers across and within primary and specialized healthcare services.

HARMONI will develop product and process innovations to improve tactical-level cooperation and planning between hospitals and municipalities for patients with frailty. The product innovations include:

- Dashboards: Provide real-time overviews of key performance indicators e.g. patient flows, queues.
- Simulator: Offer dynamic predictions of future scenarios based on resource capacity assumptions.
- Optimization Algorithm: Proposing resource capacity adjustments at the tactical level.
- Database: Hosting "Helsesplattformen", a shared Patient Information System (PIS), aggregate data.

The process innovation establishes design for patient flow and processes, including guidelines for utilizing the tools, fostering interaction between hospitals and municipalities. It involves an integrated planning process across organizational units, to deliver sustainable patient flow and resource utilization.

HARMONI builds upon research in operations and supply chain management (OSCM), health service research (HSR), change management (CM) and operational research (OR), to improve health service tactical planning. The knowledge base from manufacturing industries, adapted for healthcare, will be combined with integrated care and organizational dynamics expertise. It emphasizes the importance of understanding how tactical planning can utilize data on patient flows and resource capacities to promote sustainable health services. The project will explore the unique context of value chains involving institutions at different service levels, to overcome sub-optimization and differing service perceptions.

Section 2 reviews healthcare related transdisciplinary, and Modeling & Simulation (M&S) research. Section 3 presents key hybrid modeling frameworks used in Section 5 to classify three models under development. Section 4 summarizes stakeholder engagement for the team's transdisciplinary research, focusing on M&S. Section 6 summarizes simulation verification and validation (V&V) methods, proposing a contribution to hybrid modeling V&V. Section 7 concludes the paper with suggestions for future work.

2 LITERATURE REVIEW

2.1 Health Services Research, Operations and Supply Chain Management and Action Research

To understand inter-service organizational patient flow within healthcare services, such as between hospitals and municipalities, OSCM has proven valuable, especially in aligning resource capacities with patient demand (Meijboom et al. 2011; Dobrzykowski 2019). Given that healthcare delivery is often complex, fragmented and divided among various specialists and caregivers (Aitken et al. 2021), understanding the mechanisms that affect patient flow across the service supply chain is key to resolve the problem of improving both resource capacity utilization and service quality. Action research (AR), within healthcare has shown that skepticism, professional and functional silos are repeatedly experienced as challenges in implementation of concepts of flow-based logics (Leite et al. 2022).

In OSCM, decoupling thinking is a strategic approach to simultaneously leverage the advantages of high resource utilization, responsiveness, and customization in the design of patient flow (Guven-Uslu et al. 2014). It involves separating and reorganizing activities so they can operate independently, thereby enhancing both efficiency in resource utilization and service quality through customization. In healthcare, this often relates to the decoupling of front-office and back-office activities (Wikner et al. 2017). A key strategic outcome is the identification of decoupling points within the service process as this may smooth patient flows, i.e., balance capacity and ensure timely treatment (Rahimna and Moghadasian 2010).

In HSR, integrated service models are designed to address the complexities of maintaining seamless patient flows for patients with frailty across service providers. These models are expected to enhance collaboration among healthcare professionals, utilize integrated PISs, and empower patients and their support networks (Wallis et al. 2018; WHO 2019). However, implementing these models is often impeded by a lack of awareness and training among healthcare providers, limited resources, resistance to change, policy and regulatory challenges, and insufficient engagement of patients and their informal caregivers (Baxter et al. 2018; Knight et al. 2023; Huang et al. 2025). Overcoming these barriers and demonstrating the effectiveness of integrated service models (Briggs et al. 2018) necessitates a multifaceted approach, fostering a culture that embraces change and establishes supportive policy frameworks. The HARMONI project represents such a broad and dynamic approach, both theoretically and methodologically.

2.2 Hybrid modeling (HM) and Simulation (HS)

HM/HS use has increased over the last 10 years (Anagnostou et al. 2024). The scope and complexity of the challenges HARMONI will address will benefit from the application of HM/HS. Hybrid Systems modeling (HSM) is the combined application of simulation with methods and techniques from other disciplines specifically Applied Computing, Computer Science, Engineering and OR more broadly (Mustafee et al. 2018). Mustafee et al. (2018) extended HS classifications to HSM to unify conceptual representations for mixing simulation approaches with other disciplines, including social sciences. Several authors

(Anagnostou et al. 2024; Mustafee et al. 2018; Tolk et al. 2021; Brailsford et al. 2019) have defined HS as combinations of System Dynamics (SD), Discrete Event Simulation (DES), and Agent Based Modeling (ABM). Abohamad et al. (2017) combined process mining with simulation to support conceptual modeling using event logs to discover process knowledge to develop an Emergency Department (ED) simulation model. This conceptual modeling aid complements stakeholder engagement to cocreate models, potentially increasing buy in, and the likelihood that stakeholders use the models to support decision making.

The growth of HM/HS to model complex real-world problems have led to improved documentation. Jones et al. (2022) developed a method to support the choice and combination of modeling approaches in HM. Mustafee et al. (2022) classified five empirical HMs with their conceptual framework. Tolk et al. (2021) stressed the importance of HM as it extends the M&S discipline by combining theories, methods, and tools from across disciplines and applying multidisciplinary, interdisciplinary, and transdisciplinary solutions to practice. They proposed a conceptual framework HARMONI may use to utilize discipline-specific methods, to align domain knowledge, hypotheses, and theories.

2.3 Stakeholder Engagement

Conceptual modeling is vital in all M&S studies, including HM/HS. Kotiadis et al. (2014) developed a framework to support participatory DES model development with stakeholders to develop a common conceptual model, through facilitated workshops. Healthcare simulation can benefit from stakeholder participation as multiple views and tacit system knowledge can be identified. Tako et al. (2015) further developed this approach by developing the multi-methodology PartiSim framework. PartiSim combines DES with soft systems methodology (SSM) to incorporate stakeholder involvement, through facilitated workshops, in the study lifecycle. The framework's prescribed activities and outputs include: study initiation, problem clarification, conceptual modeling, model coding, experimentation, and implementation.

PartiSim focused on DES but is suitable for other M&S studies. Powell et al. (2017) illustrated how soft OR methods including qualitative SD and SSM are essential in hybrid M&S study problem formulation. Further developments of participatory modeling include Harper et al. (2023) who noted the implementation challenges for M&S in health and social care, through a participative ED real-time simulation model. Some may consider PartiSim an instrumental approach to stakeholder engagement compared to AR (Rosmulder et al. 2011). As structural silos can be a barrier to real changes, especially in the HARMONI case where we shall produce simulation models across institutional borders, within and between specialist and primary health services (Leite et al. 2024). AR in healthcare simulation shows that one needs to: 1) onboard stakeholders with authority to make changes 2) not underestimate the implications of changes in practice for personnel - thus involve all, not just a group in simulation.

2.4 Healthcare Hybrid Modeling and Simulation

Healthcare M&S studies are numerous, what follows is selected HARMONI related literature. The International Society for Pharmacoeconomics and Outcomes Research published seven articles about best practice in health care mathematical modeling in Medical Decision Making and Value in Health (Caro et al. 2012). Hulshof et al. (2017) proposed a taxonomy to identify and classify health care planning and control decisions and to map these to Operational Research and Management Science (OR/MS) methods.

Healthcare presents opportunities for OR/MS to support system improvement. Despite many reported models, the evidence of model recommendation implementation is slim (Harper et al. 2023). Brailsford et al. (2019) reviewed the HS literature and of 139 papers healthcare accounted for 22%. Subsequently, Kar et al. (2024) conducted a healthcare HS review. Reviews from an OSCM (Ali et al. 2022) and logistics perspectives (Roy et al. 2021) identified topics including sustainability, risk and resilience, climate change, circular economy, and knowledge management. Larrain et al. (2021) reviewed integrated care simulation models, defining aspects of complexity, "What if?" and "How to?" system optimization scenarios.

Health systems can be complex, therefore Bell et al. (2016) proposed a HM to investigate system wide non-elective healthcare. They argued their HM supported diverse stakeholder perspectives and promoted system understanding. Harper et al. (2019) developed a HM for short-term decision support in urgent and emergency healthcare to reduce overcrowding. The HM integrated real-time information from NHSquicker, a digital platform that provides real-time information, to proactively divert patients if necessary. Mustafee et al. (2021) investigated how NHSquicker and M&S could improve the NHS four-hour standard, which requires that 95% of patients presenting to urgent or emergency care centers should be assessed, treated and admitted, transferred or discharged within four hours. Recently HM real time simulation and digital twins have been developed in support healthcare decision making (Mustafee et al. 2023; Mustafee et al. 2024).

Elbattah et al. (2016) combined DES and predictive modeling to model discharge planning for elderly hip fracture patients. They used predictive models to predict inpatient length of stay and discharge destination for the simulation model. The simulation model provided demand predictions for healthcare resources. Penny et al. (2023) created a hybrid ABM and DES to capture the complex interactions between the UK health and social care services, for dementia telecare. Finally, Zulkepli et al. (2012) proposed an integrated care DES/SD framework, to support operational and strategic planning.

2.5 Contribution to the Hybrid Modeling Literature

This paper's contributions are:

1. Present initial conceptualizations for models co-created with healthcare actors, to increase the likelihood of implementation as decision support tools (Brailsford et al. 2019; Harper et al. 2023).
2. Proposing that modeling and models can be used as pedagogical tools to support integrated health care, promote systems thinking and improved care delivery (Tako et al. 2015; Harper et al. 2023).
3. Exploring integration of models (output) into a regional Decision Support Systems, Helseplattformen (EPIC) (Mustafee et al. 2023; Mustafee et al. 2024).
4. Developing case models for specific purposes which may be integrated to address system level performance (Zulkepli et al. 2012; Larrrain et al. 2021).
5. Present initial reflections on HM V&V challenges (Brailsford et al. 2019; Tolk et al. 2021; Mustafee et al. 2022).

3 HYBRID MODELING FRAMEWORK

The HARMONI project extends Zulkepli et al. (2012) Integrated Care Hybrid Simulation modeling framework by leveraging the transdisciplinary framework proposed by Tolk et al. (2021), see Figure 1. Zulkepli et al. (2012) focused on combinations of DES and SD to model large complex systems. Our work extends this to include ABM and optimization modeling, and HSR, CM and OSCM approaches.

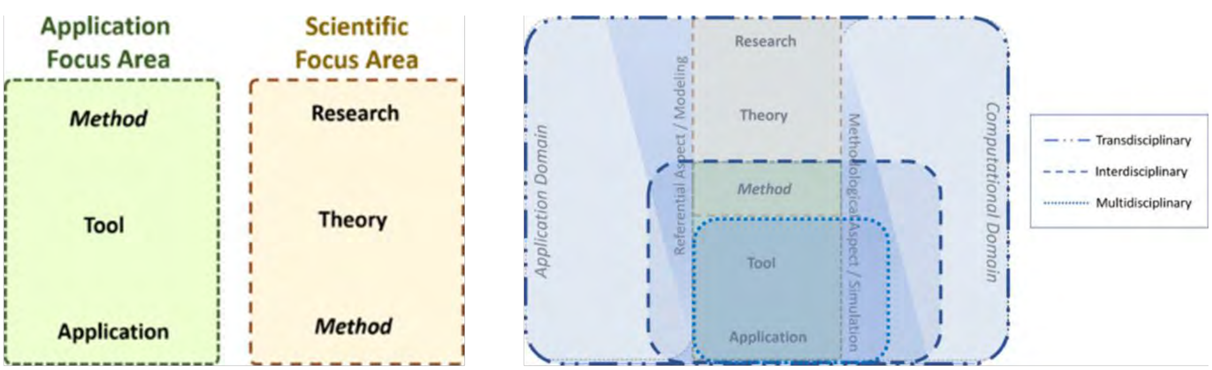

Figure 1: Hybrid modeling framework supporting multi, inter and transdisciplinary research engagement (reproduced from Tolk et al 2021).

The HARMONI project is an exemplary case of transdisciplinary collaboration in M&S within healthcare (Archibald et al. 2023; Erdemir et al. 2020). HARMONI will use M&S to develop a "dashboard" and a "control tower," (Dreyer et al. 2009) providing comprehensive tools for monitoring and managing patient flows across service providers. Additionally, M&S will be used as a pedagogical tool for co-creating an understanding of patient flow challenges and exploring potential solutions. Through this collaborative approach, the transdisciplinary research team and stakeholders work together to enhance understanding of the challenges and solutions for seamless patient transitions across the healthcare continuum.

The selected example case studies we present in Section 5, will be classified using Mustafee et al. (2022) Hybrid Modelling Framework, see Figure 2. Due to the academic disciplines involved in the HARMONI project, the subject area and potential cases we may investigate, this framework offers a flexible structure to classify the models the team creates during the project. The HARMONI project's unique collaboration offers opportunities to investigate the interfaces and connections between health systems to glean additional insight that a single discipline may miss. Our proactive use of qualitative and quantitative approaches enables us to not only develop various models, but to follow the use of (implementation) these decision support models in practice and for training purposes. Through the use of the frameworks presented models can be classified to support transdisciplinary model development, effective documentation, and specific HM V&V methods/techniques.

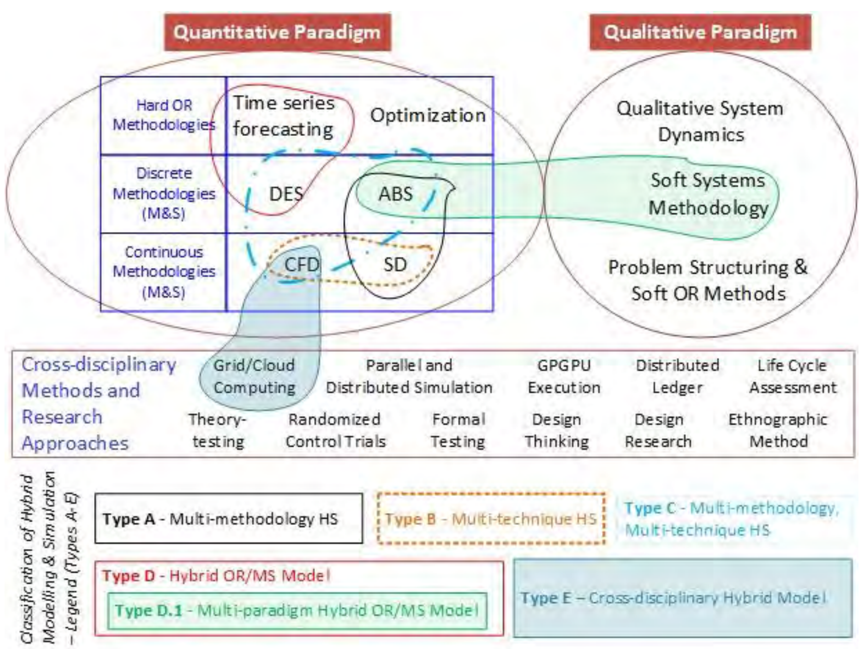

Figure 2: Hybrid Modelling framework (reproduced from Mustafee et al. 2022).

4 STAKEHOLDER ENGAGMENT AND SCENARIO ELICITATION

In June 2024, a workshop was held where primary and specialist health care organizations engaged with structured AR (Rosmulder et al. 2011) activities around the health system journey of a hypothetical fracture patient. The participants represented the Hospital, the Health and Welfare Office (HWO), Home services, the Out-of-GP-hours medical service, Health Centers (similar to US step-down), Rehabilitation Centers, and Nursing homes. For an overview of the Norwegian Health System see Norwegian Directorate of Health et al. (2023), Saunes et al. (2024) and Tikkanen et al. (2020). An aim of the workshop was to identify the "as-is" patient flow rather than what "ought-to-be". Following the "as-is" discussions we shifted to the "what-if" to identify if and how the system could be improved. The workshop inspired case 1 (Section 5.1).

Following the workshop, individual and focus group interviews were conducted with 15 individuals from the Hospital, the HWO, a Health Centre, and Nursing homes. Following reflections by the HARMONI team, the Health Centre was identified as a focus area as a large proportion of elderly people with frailty admitted to hospital are discharged here. This led to the development of case 2 (Section 5.2).

The HWO supports planning and control between specialist and primary care services. In Norway care services are funded through different mechanisms, with the four regional health authorities and the 357 Municipalities responsible for specialist and primary care respectively. The municipalities have authority to define the amount and type of primary care supplied. All health care services are almost free of charge, with limited co-payments (Saunes et al. 2024). Elderly people with frailty often present with complex needs that require multiple services. Various targets and penalties are associated with the interface between services, therefore effective timely communication is crucial, hence the team selected the HWO interactions as a key area to investigate which led to case 3 (Section 5.3).

A second workshop held in March 2025 engaged participants and organizations who attended the June 2024 workshop. During the workshop we presented initial qualitative findings and modeling insight, from Case 2 to seek validation of the "as-is" situation, and we engaged with participants to elicit "what-if" scenarios for further qualitative and quantitative analysis.

Ongoing reflections by the team to identify potential areas to model, and to incorporate into models under development is crucial. We could utilize PartiSim and participatory modeling approaches (Section 2.4) to develop models and to integrate them into stakeholders' organizations. By integration we mean to implement support decision making, e.g. implementing dashboards in Helseplattformen, and equally importantly as a training and educational tool to improve system understanding and operation.

5 HYBRID MODEL CASE STUDIES

To illustrate the proposed participatory HM approach, we present three ongoing case studies with primary healthcare and specialist healthcare partners. These initial conceptual models from works in progress, illustrate proposed HMs to capture the necessary complexity and scope of the investigated systems. For each case, we present its current conceptual model considering the presented HM frameworks (Section 3).

Each of the presented case studies will be initially developed in AnyLogic, to address specific needs, over different time frames to capture different modeling objectives, see each case subsection.

The hybrid aspects of each case are classified to illustrate which types of HM may be developed and potential V&V opportunities they afford. Classification challenges when additional academic disciplines are involved are anticipated. Through ongoing model development, classification using existing frameworks may solidify or suggestions to extent existing frameworks may be identified.

5.1 Case 1: HARMONI System Level

One major aim of the HARMONI project is to better understand the patient flow within and between primary and specialist health services of elderly people with frailty to provide evidence-based decision support. The proposed high level HARMONI model presented in Figure 3 is a hybrid ABM-SD-DES model. The people are agents, consisting of demographic information, health status, e.g. what condition(s) they have, their current frailty level as captured by the clinical frailty score (CFS) (Rockwood and Theou 2020; Burrell et al. 2024), the CFS for each person is modeled as a simple SD disease progression model. The different care providers are a collection of agents, each containing a DES model of the service(s) they deliver. At present these are high level DES models representing the available capacity and the patient's length of stay (LOS). We can replace one or more of the provider models with higher-fidelity models if needed. For more detailed models see Case 2 (Section 5.2) and Case 3 (Section 5.3).

We classify this model as a transdisciplinary hybrid model (Tolk et al. 2021) as multiple applications domains, methods, crossing multiple application and scientific focus areas are present. The model is challenging to classify using Mustafee et al. (2022) as it is potentially multiple classes at once. It is a Type D Hybrid OR/MS model as each provider agent contains a DES, an agent the patient, an SD model the patient's CFS score, and potentially an optimization model to plan for capacities. Currently it is a Type C Multi-methodology Multi-technique HS, as we have not considered how to implement the optimization model. It's a Type E Cross-disciplinary Hybrid model as we incorporate aspects of Action Research, OSCM and HSR. One could consider the model as a Type A Multi-methodology HS. This model captures strategic to operational level decisions and runs for up to 5 years. Key performance indicators (KPIs) include resource utilization, queue lengths, waiting times, functional level, targets (un)met.

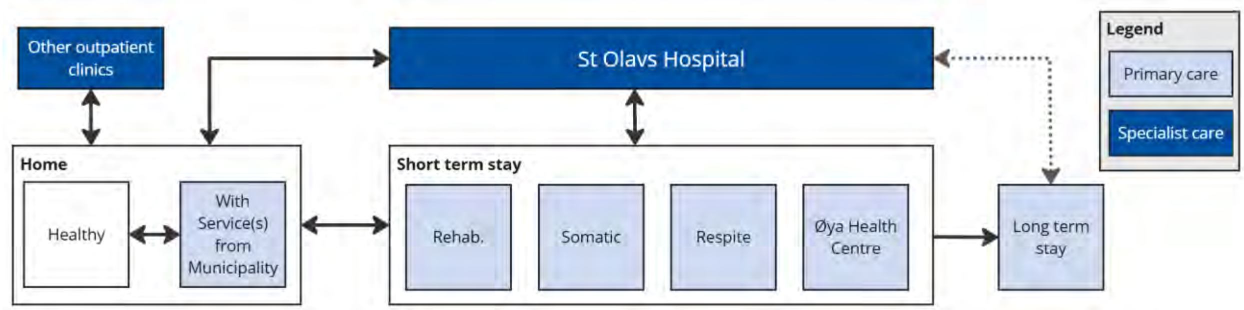

Figure 3: HARMONI system level conceptual model.

5.2 Case 2: Øya Health Center

Health Centers in Norway offer services for patients who do not require hospital admission, but rather short-term stay in a care home for e.g., medical observation, rehabilitation or immediate day help. Hagen developed a detailed DES model of the patient flow within the Health Center to model its operation, see Figure 4. The patients who use the Health Center are simplified agents. Hagen will incorporate optimization into the model to better align resources, staff and beds with demand, patient inflow.

We classify this model as an Interdisciplinary hybrid simulation (Tolk et al. 2021). The application area focuses on the operation of the Health Center and wider health system we currently treat as exogenous to the model. Using Mustafee et al. (2022) we classify this model as a Type D Hybrid OR/MS Model as it combines ABS and DES, and a Type C Multi-methodology, Multi-technique HS, as it also utilizes an optimization model. This model captures tactical and operational level decisions and runs for 365 days. KPIs include LOS, waiting time, wait list length, and readmission counts.

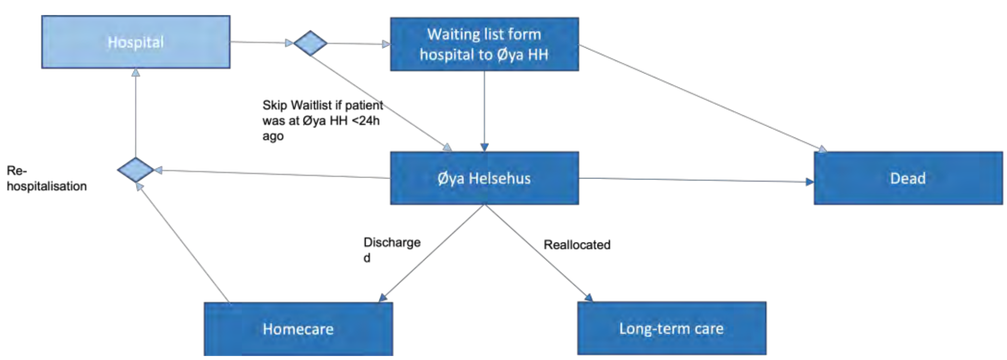

Figure 4: Øya Health Centre conceptual model.

5.3 Case 3: Home Care Services, Hospital, Health Center and Health and Welfare Office

The home care services, hospital, health center and HWO model Figure 5, captures in greater detail, a persons' interactions with the home care services the hospital and the health center, compared with case 1. We plan to explicitly model the HWO which acts as a coordinator for municipality services, assessing a person's eligibility to receive a service based on care needs. This model includes patient flow (solid lines) and information flow (dashed lines) in terms of applications for support and their processing at the HWO. The processing of these requests influences patient flow indicated by the valves between the providers. The A and E circles represent "arrivals" from outside the system, e.g., ageing or migrating into the population, or "exits" e.g., migrating or passing away, respectively. The population is modeled as agents, with additional information related to paths within a care provider and home services received and requested. We add a new "requests" entity to the system representing HWO applications for different services. We represent the case workers who assess the cases as agents with various levels of experience, who may need to work in teams to assess certain applications. These "case worker" agents interact with a DES model of the application processing procedures; they can fatigue and leave the HWO. Due to the complexity of processes and interactions at HWO, we selected ABM to better capture the identified nuances.

We classify case 3, like case 1, as a transdisciplinary hybrid model (Tolk et al. 2021). The HARMONI teams ongoing AR (Rosmulder et al. 2011) identified the hospital, home services, health centers and the HWO as key actors and as key decoupling points from an OSCM perspective. The model is challenging to classify using Mustafee et al. (2022) and like case 1, in addition the modeling of information flow adds another dimension, we tentatively view it as a Type A Multi-methodology HS. This model will capture strategic to operational level decisions and run for several years. KPIs may include delays due to application processing, LOS, patient outputs, resource utilization, waiting times etc.

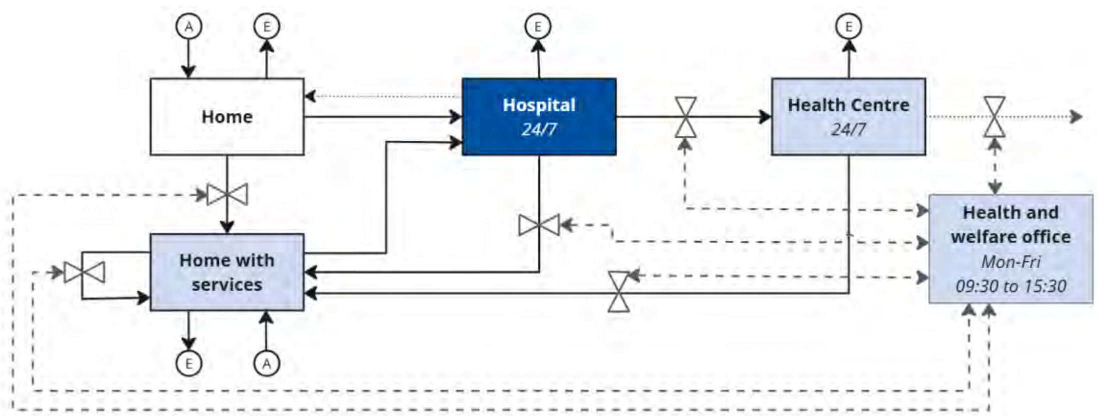

Figure 5: Home care, Hospital, Health Centre and Health and Welfare Office Patient and information flow conceptual model.

6 HYBRID MODEL VERIFICATION AND VALIDATION

Existing simulation paradigms V&V are well established (Brailsford et al. 2019; Sargent 2020), see Table 1 for selected examples derived by the authors from DES, ABM, SD, and optimization modeling, yet V&V approaches for different hybrid models and the interfaces between submodels are limited.

V&V reporting is diverse and model dependent. Monks et al. (2018) developed the Strengthening the reporting of empirical simulation studies (STRESS) guidelines which provides structured guidance on how to report DES, ABM and SD development, yet they do not describe V&V. We propose a checklist like Table 1 can be developed/incorporated into reporting guidelines and more specifically linked to current hybrid modeling frameworks, e.g. as Monks et al. (2018) have guidelines for ABM model documentation we could suggest a V&V checklist for a Type C Hybrid Model consisting of an ABM and DES. That for each of the current classifications of HM A-E in Mustafee et al. (2022), new or tailored V&V tests are clearly defined and added to Table 1.

The HARMONI project grants the team the unique opportunity to develop HMs, introduced in Section 5, and new V&V techniques, specifically in relation to the interfaces between the submodels. We will use existing V&V approaches, see Table 1, to evaluate the individual submodels of a HM where appropriate, and the team will reflect, develop, and document V&V approaches for each model during the project.

Table 1: A selective summary of simulation verification (1-10) and validation (11-23) tasks, derived from (Sterman 2000; Pidd 2004; Banks 2014; Robinson 2014; Law 2015; Monks et al. 2018)

Verification and Validation Tasks
1 Compare conceptual and simulation models.
2 Are system "real" input parameters represented correctly?
3 Is logical model structure represented correctly?
4 Engage people familiar with the system. Experts. Structured walk through.
5 Get another simulation expert to check the simulation model.
6 Create flow diagram which includes logical system actions & follows model logic.
7 Examine model output for reasonableness under a variety of input settings.
8 If the model uses animation, use to verify the model logic.
9 Debugging (interactive run controller) step through model, trace individual entities.
10 Graphical interface and documentation for verification and validation.
11 Attempts to confirm a model is an accurate representation of the real system.
12 Calibration. Use difference between model and the real system, to improve the model.
13 Subjective tests: system stakeholders, judge the model & its output(s) & judge if model is accurate enough. Use SSM and DOE. Turing Test(s), Structural assumptions. Face validity.
14 Objective tests. Statistical test(s) compare aspect(s) of the system with the model output data. If purpose changes, revalidate in terms of relevant response(s).
15 Iterative process. Comparing model/system and revising the conceptual/operational models to accommodate perceived model deficiencies until model deemed accurate.
16 Involve model users in model construction (conceptualization to implementation), to build an adequate degree of realism into the model (reasonable assumptions & data).
17 Sensitivity analysis (check face validity). Model users asked if it behaves in the expected way when they change an input variable(s). Extreme value tests?
18 Data assumptions: collected reliable data. Data reliability: statistical data homogeneity tests. Goodness-of-fit test(s): chi-square, Kolmogorov–Smirnov, t-Tests, distribution-free tests, bootstrapping, graphical methods, confidence intervals, % difference, correlation coefficient, regression analysis, Kruskal-Wallis, Mann-Whitney, time series methods, correlated inspection approach, Welch, P-P plots.
19 Can the model predict the future behavior of the system (inputs: data=real)? Models should be accurate enough to make good predictions, for a range of input data sets.
21 Input-Output Validation: Use Historical Input Data, alternative to generating input data, to drive the model and compare model output with system data. Black box.
22 Validate against another (simulation/analytical) model.
23 Subjective tests: Modeler experience and intuition about complex systems.

7 CONCLUSION AND FUTURE WORK

A key strength of the HARMONI project lies in its multidisciplinary academic team, including expertise in health services research, change management, operations and supply chain management, and operational research. This team works in close collaboration with primary and specialist healthcare organizations, who are actively engaged in the project. The team will construct the models presented conceptually, devise scenario based and optimization experiments, document the challenges and advantages of codeveloping these models with engaged healthcare stakeholders.

We aim to develop various models and tools designed for different purposes and levels of detail to improve the delivery of integrated healthcare both within individual organizations and across the health system. Our goal is for these models to benefit patients, the healthcare system, and society. By leveraging rich qualitative information from engaged stakeholders, we can effectively co-create improved models, validate existing ones, and implement these models in practice to support better decision-making.

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