Case Design Sheet

1. CASE DESCRIPTION

TITLE: Collaborative processes for the deployment of rural medical homes

	ACTORS	LOCATION
LEADER(S)	**Mines Saint-Etienne, CIS**	**Saint-Etienne, FR**
PARTNER 1	**ALTERMEDIS**	**Beauzac, FR**

TIME PERIOD OF THE PROJECT: Octobre 2023 -Septembre 2024

SHORT DESCRIPTION OF THE CASE:

To improve access to primary care in underserved areas, policies have promoted multidisciplinary medical homes (e.g., family health groups, patient-centered medical homes). Through the development of medical homes, the expected improvements in accessibility concern both the likelihood of accessing primary care and the frequency of healthcare utilization. This study analyzes the impact of collaborative organizational models within territorial medical home networks, on various performance dimensions and using a simulation-based approach. The goal is to develop a decision-aid tool to assist local managers in optimizing organizational design. We assess different collaboration scenarios, including intra-home teamwork among healthcare professionals and inter-home cooperation.

2. 5.0 ORGANISATIONAL CHANGES OF HEALTHCARE PROCESSES

2.1. Short description of initial context and needs of organisational changes

General Context

Health inequalities and access to care are major public health concerns. Access to healthcare is a multidimensional concept that includes a willingness-to-pay component, as well as a non-financial component related to the availability of healthcare services within a reasonable distance from patients' homes and accessibility via transportation. There is extensive evidence of disparities in health status among different social groups in all countries, regardless of whether they are low-, middle-, or high-income [1]. Significant inequalities in healthcare access have also been highlighted in most OECD countries, strongly influenced by spatial variations in healthcare service availability for different social groups [2]. These inequalities have substantial social and economic costs for individuals and societies and are the target of numerous public policies.

Access to primary care has been identified as a key lever for reducing socio-economic and spatial health inequalities. An analysis of the 2016 Commonwealth Fund International Health Policy Survey of Adults, conducted in 11 countries (Australia, Canada, France, Germany, Norway, the Netherlands, New Zealand,

Sweden, Switzerland, the United Kingdom, and the United States), highlights that low-income individuals are more likely to face multiple barriers to accessing care, particularly before reaching primary care facilities [3].

In France, the Ministry of Health and Prevention announced in June 2023 a €50 million action plan to improve access to primary care in underserved areas [4]. To attract new healthcare professionals to these regions and create multidisciplinary care teams around patients, the plan aims to establish 4,000 multidisciplinary medical homes (i.e., maison de santé pluridisciplinaire in French) by 2027. In other OECD countries, similar forms of organization (e.g., medical home in the US, family health groups in Canada, patient-centered medical home in the UK) have emerged since the 2000s, in response to the significant rise in chronic diseases and a medical demographic crisis [5].

Through the development of medical homes, the expected improvements in accessibility concern both the likelihood of accessing primary care and the frequency of healthcare utilization, which has been identified as a major component of primary care access inequalities [6]. These structures also aim to strengthen healthcare provision in medically underserved areas, attracting young doctors while promoting collaboration between different healthcare professionals.

While this territorial model appears interesting to address health inequalities and for the overall improvement of healthcare delivery, the deployment of medical homes suffers of organizational difficulties, notably due to the complexity to define the efficient and well-balanced organizational modes which could both guarantee a high healthcare efficiency for the local population and a consistent quality of life and profession for the healthcare practitionners. This complexity is linked on the once side to the flexibility of the model where the healthcare offer can include many variations, depending on the competencies of professionals involved and the way to organize their collaboration and on the other side to the lack of organization management skill for the decision-makers of the medical homes who are generally doctors. To answer these challenges, the study intends to analyze the impact of flexible organizational modes within medical home territorial networks on different dimensions of the performance, using a simulation-based approach which could later provide a decision-aid solution to help the local managers for this organizational design.

Operational needs of organizational changes

The case study addressed in the study is developed in collaboration with Altermedis structure, which gathers 3 medical homes, situated with a good geographical proximity each in a distinct rural village of the same department. This paper addresses the following collaborative issues for the Altermedis case study:

- At internal level of single medical homes, the goal is to assess alternative opportunities to integrate new healthcare professionals, complementary to the medical doctors. The French healthcare system proposes currently two types of profiles, ‘Medical assistant’ and ‘Asalée nurses’, each with different skills who can take in charge part of the healthcare tasks generally executed by the doctors. Additionally, another opportunity is the recent deployment of teleconsultation which is also a pertinent lever to try and increase healthcare efficiency. The study aims at analyzing the impacts of these various organizational options within each single medical home.
- At the inter-organizational level, among the 3 medical homes of the network, the objective of the study is to analyze pertinent solutions to manage emergency patient flows. Normal patient flows are characterized by anticipatory schedules, when emergency flows are characterized by no anticipation, thus inducing perturbations in the healthcare delivery to normal flows. The networked organization bring the added-value to make possible a mutualization of patient flows among the 3 medical homes, with the

opportunity to position one dedicated doctor to manage the emergency flow, inducing a necessity of local travels among the various medical homes. The impact could be positive, allowing to reduce drastically the perturbation of the normal patient flows, thus increasing the overall healthcare efficiency.

2.2. Challenges on Resilience of Healthcare processes:

Resilience is quite important in this study from various points of view:

1. From the point of view of medical doctors and medical staff, the ambition of medical home in rural areas is to create new economic and organizational model to ensure the quality and resilience of medical profession in such geographical regions. Thus, from this point of view, the resilience is (i) organizational, by increasing the stability, efficiency and flexibility of healthcare processes, (ii) economic, to ensure a good economic revenue to the medical professions concerned, (iii) human to ensure a clear increase of quality of life for the medical staff and (iv) technological to ensure a constant capacity of change and innovation linked to technological evolutions.
2. From the point of view of regional healthcare institutions (ARS in France), the issue is to ensure the resilience of this organizational model at the level of large territories and to support its deployment and generalisation, with the objective to increase the overall territorial healthcare resilience.
3. From the point of view of the citizen, the first challenge is to increase the quality and resilience of primary care processes, thus with a clear societal dimension.

Digital technologies are involved in resilience for two main aspects. First, they represent a key lever to improve progressively and on the long run the healthcare processes. Digital supervising tools, together with artificial intelligence can be deployed efficiently to assist several tasks included in primary care processes, including notably administrative tasks or information tasks linked to prevention. Secondly, in thus study, digital technologies are used as a key support to help developing a new collaborative innovation capacity in medical homes, recognized as a new necessary corporate competence: simulation and digital twin techniques are used to develop a decision-support system, offering to the managers of medical home new change management capabilities. Through this simulation approach, we address directly the need of flexibility and adaptability of organization processes notably through the deployment of deeper levels of collaboration.

Resilience is also very linked to human factors: the organisation flexibility under study is very linked to sharing hours, schedule, medical resources among the various medical staff, in order to tr and improve the quality of professional life for all. Additionally, the quality of the organizational model is very important to increase the attractivity of these medical homes, ensuring enough recruitment which represent a real problem at national level.

Indicators

To evaluate the results from the simulation model, two categories of key performance indicators (KPI) have been established to measure the impact of care organization strategies on patient management. The following KPIs are considered:

- Total number of patients treated
- Workload, measured by resource utilization
- Surplus number of patients, occurring when the combined load of scheduled and unscheduled patients exceeds capacity, resulting in additional working hours or patients left without being seen

- Average number of overtime hours

2.3. Challenges on sustainability of Healthcare processes

The Sustainability challenges are not very important in this case study in terms of environmental impacts (they are in terms of human-impacts in next section). The only direct environmental effect is link to transport which is affected by the alternative organizational models under study. The organizational model can change the volume and distance of professional mobilities for the healthcare staff. However, since the factor was really minor in the decision-making and with a low level of environmental impact, it was not considered in the model and evaluation.

2.4. Human-Centred Approach for the Healthcare processes:

By looking for organizational solutions to improve the overall efficiency and quality of healthcare territorial processes, this study includes human aspects from several complementary points of view:

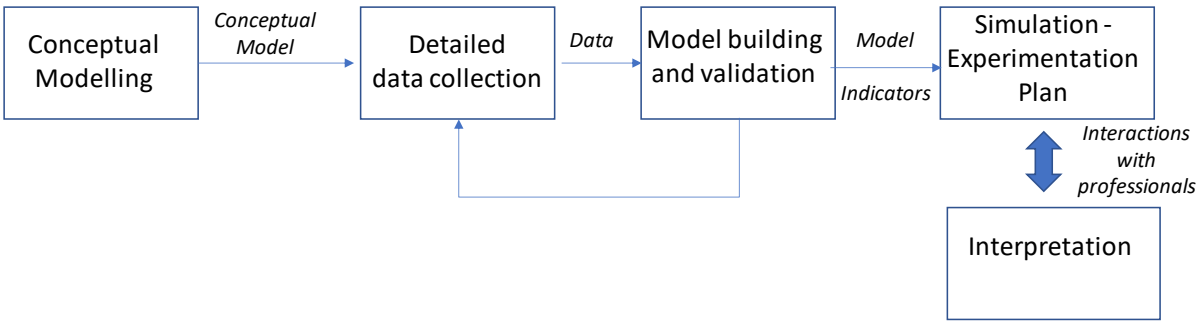
- Concerning the Innovation process in itself, the human actors from the medical professions are directly involved in the study through a collaborative innovation mode. A first step of information capture and conceptual modelling is dedicated to understand very concretely the current situation, organizational diagnosis and human expectations. Then interaction steps are spread along the innovation project to look for organizational solutions which could be aligned with the human needs and expectations.
- Concerning the results of the innovation process, that is to say the new proposal of organizational modes, they are evaluated according to added-value for two human points of view: the citizens and patients (Quality of service delivered) and the medical staff (elements of quality of professional life).

Some human-oriented indicators are included in the simulation method, helping to support decision-making of the selection of efficient organizational solutions.

3. METHOD AND SOLUTIONS

3.1. Method

An applied research methodology has been structured to study the potential of collaboration in these healthcare networks. The research protocol is based on the use of organizational simulation, in order do virtualize and assess the organizational mechanisms under study. The research protocol is structured according the steps described in the figure below.



"Conceptual modelling" is a first step oriented towards organizational modelling. Through an overall conceptual model, the key knowledge describing healthcare processes is capture, structured and represented in a formal process model, providing a rather general model to be refined in next steps. In this first steps, the organizational issues and challenges are also captured among the professionals (Doctors in Medical Homes). Based on this conceptual model, detailed steps of organizational modelling are engaged with "Detailed data collection" and "Model building and validation". A detailed model is built, based on a formalism and technical platform of event driven simulation, making possible to generate pertinent organizational indicators to address the organizational challenges and issues fixed previously. The last two steps, also interactive consists in generating consistent experimentation plans through simulation, to generate the necessary indicators supporting the comparative analysis of the collaborative organizational mechanisms under study. The interpretation of the results requires interactions with the professionals, to generate consistent recommendations for the future.

To analyze and assess various organizational models, we considered the four types of consultation represented in the figure below as alternative solution in each medical home (e.g., standard consultation with a doctor, a dual consultation with a medical assistant, a dual consultation with an Asalée nurse, and teleconsultation). As each medical home is an independent entity, the full model includes three independent sub-models for each medical home.

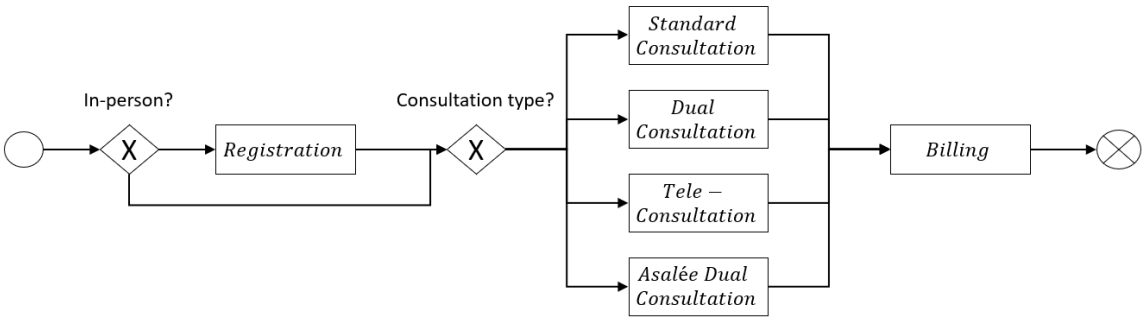


Figure : model for a single medical home, considering the four types of consultation.

We conducted 4 experiments and an extra validation experiment (i.e., base scenario). In the base configuration, one Asalee nurse is working 1.5 working day in medical home n°1, and is having independent consultation on her side.

In experiment 1, we explore the performance of also allowing the Asalee nurse to work in close collaboration with doctors, by having duo-consultation with them. Similarly, the same logic is experimented in experiment 2, where the availability of the Asalee nurse is extended to three full working day at medical home n°1. In experiment 1 and 2, we also model the independent flow of consultation the Asalee nurse is having on her own, in order to take into account its impact on her availability for duo-consultations.

The management of emergency consultations is often cited by doctors as one of the main causes of schedule disruption. Emergency appointments interfere with daily planning, creating a workload overload and overtime. To investigate potential organizational improvements, two additional experiments are being tested. In experiment 3, one doctor is dedicated to handling emergency consultations and travels between medical homes, thus allowing other doctors to focus on planned consultations. Similarly, in scenario 4, two doctors are dedicated to the unscheduled flow.

3.2. Concrete organisational solution implemented

The alternative organizational solutions have been assessed through simulation to generate a set of recommendations for the local decision-makers.

Table 1 summarizes the results of experiments 1 and 2, related to the organization of medical home 1 (MH1), comparing them to the baseline scenario. Overall, there is only a slight difference in the KPIs among the three evaluated scenarios. In the first scenario, the Asalée nurse handled on average 164 duo consultations, and 550 in the second scenario, over a six-month period. Although these numbers are not very high, this can be explained by the fact that the nurse already has her own consultations to manage. Additionally, duo consultations are relatively long, which limits the number of patients she can take care of. Based on these results, there is no significant difference in indicators such as the number of patients handled, the average waiting time, the number of surplus patients, and the number of overtime hours. However, a decrease in the physicians' utilization rate is observed. In summary, while the use of the Asalée nurse does not allow for the treatment of a significantly higher number of patients, it does help to reduce the workload of physicians.

Table 1: Results of experiments 1 and 2.

Metrics	Base scenario	Exp. 1	Exp. 2
	MH1	MH1	MH1
Resources:			
- Number of overtime hours	640.1 (51.3)	669.72 (37.03)	657.64 (33.08)
- Average physician workload (hours)	2729.2 (105.8)	2729.2 (105.8)	2277.1 (24.8)
- Asalée nurse workload	-	85.8 (6.4)	330.4 (4.3)
Patients:			
- Number of patients treated	8045.6 (61.4)	8062.76 (83.31)	8054.92 (70.76)
- Number of surplus patients	190.2 (36.4)	194.38 (33.83)	204.24 (32.87)
- Average waiting time (minutes)	8.5 (0.46)	9.15 (0.38)	9.50 (0.31)
- Number of duo consultations with Asalée	-	164.72 (5.37)	550.76 (5.34)

Note: The average over replication runs is indicated for each key performance indicator, with standard deviation in parentheses. Medical Home #1 (MH1).

Table 2 presents the results of Experiments 3 and 4 related to the implementation of a specific process for emergencies. Unlike experiments 1 and 2, experiments 3 and 4 assess forms of inter-medical homes

cooperation. In experiment 3, the objective is to ensure that a doctor is always available to handle emergencies by moving between different sites. However, this responsibility will not fall on a single doctor but will instead be shared among the seven doctors from the medical homes, who will take shifts each day. Thus, the doctor in charge of emergencies on a given day will be responsible for treating all urgent patients across all sites, requiring travel.

Analyzing the simulation results for this scenario, the first observation is that the surplus indicator for emergencies is very high. The doctor manages to treat an average of 1603.9 emergency cases, but an average of 645.8 cases remain as surplus, representing 29% of the total demand. This shows that the initial assumption about handling the surplus is no longer valid. In fact, the number of patients in surplus is too high for a single doctor to handle through overtime. The main conclusion is that a single doctor cannot manage the emergency flow. The doctor's utilization rate is 88%, and the average waiting time for an emergency consultation, including travel, reaches 100.2 minutes.

In experiment 4, we continue to focus on emergency flow management, this time by mobilizing two emergency doctors. This experiment builds upon experiment 3, which revealed that a single doctor cannot efficiently handle all emergency consultations. We therefore explored the possibility of improving the process for unscheduled consultations by distributing this responsibility between two doctors, with a rotating schedule among the seven available doctors.

In this experiment, an average of 2238.8 patients are treated, compared to 2168.6 in the baseline scenario, with a negligible average overflow of 8.44 patients. This slight increase in the number of emergency patients treated is accompanied by a slight decrease in the number of scheduled patients treated, leading to a slight decline in the total number of patients handled. This indicates that the emergency flow is fully absorbed but slightly affects the overall patient flow. In this scenario, the average workload per doctor is 0.61, and the average waiting time decreases significantly compared to the previous scenario, reaching approximately 28.3 minutes.

A notable improvement in the efficiency of the organizational model concerns the number of overtime hours worked, specifically for medical home No. 1, which reduces the time doctors work beyond theoretical hours by half. With this reallocation of resources, we observe a trade-off between absorbing the urgent patient flow and conducting scheduled consultations. Indeed, there is a slight decline in performance for scheduled consultations, with an increase in overflow and a decrease in the total number of patients treated.

Table 2: Results of experiments 3 and 4

Metric	Base scenario			Experiment 3		
	MH1	MH2	MH3	MH1	MH2	MH3
Resources:						
- Number of overtime hours	640.1 (51.3)	27.1 (3.4)	4.5 (1.8)	296.8 (28.8)	25.72 (3.41)	0.08 (0.2)
- Average physician workload (hours)	2349.3 (20.2)	1111.1 (14.4)	753.5 (11.1)	0.61	0.30	0.60
Patients:						
- Number of scheduled patients treated	6745.2 (70.2)	2849.8 (52.9)	1464.2 (24.1)	6642.5 (71.1)	2949.2 (51.2)	637.5 (18.4)
- Number of unscheduled patients treated	1319.4 (32.5)	560.8 (18.8)	288.3 (14.8)	799.2 (20.7)	485.5 (18.4)	319.2 (15.8)
- Number of surplus patients	190.2 (36.4)	1272.1 (28.1)	151.9 (20.8)	244.1 (42.6)	37.4 (10.1)	951.6 (33.1)
- Average waiting time (minutes)	8.5	10.1	0.2	19.1	10.1	0.01
Specific process for emergencies:						
- Average waiting time (minutes)		-			100.2 (0.7)	
- Number of surplus patients		-			645.8 (28.9)	
- Average workload of the dedicated physician		-			0.88 (0.00)	
Total number of scheduled patients		11059.4 (82.1)			10229.2 (93.5)	
Total number of unscheduled patients		2168.6 (40.4)			1603.9 (12.3)	
Total number of patients treated		13228.0 (98.1)			11833.2 (90.1)	

3.3. Key Skills And Competences Necessary

Several issues concerning skills and competencies can be underlined:

- The innovation project is based on developing new capacities of collaboration among several healthcare competencies within medical homes, notably the collaboration between doctors and 'Medical assistant' and 'Asalée nurses'. The study helps deciding the better organization, however collaborative skills remains to be developed by the human actors.

- Additionally, the study also brings medical homes top develop a new innovation capacity, based on the use of organizational digital twins as assistant for the overall innovation process. There is a real potential of long term use of such organizational decision-making supports, however this also requires developing new internal skills for the use and update of digital twins, and internal skills of collaboration with research organisms able to provide assistance for innovation.

3.4. Result and Feedback

To evaluate the results from the simulation model, two categories of key performance indicators (KPI) have been established to measure the impact of care organization strategies on patient management. These indicators include: patient satisfaction, which assesses the quality of care and waiting times; and medical staff satisfaction, which reflects the well-being and working conditions of healthcare providers. The following KPIs are considered:

- Waiting time from admission to consultation with a doctor (in minutes)
- Total number of patients treated
- Workload, measured by resource utilization
- Surplus number of patients, occurring when the combined load of scheduled and unscheduled patients exceeds capacity, resulting in additional working hours or patients left without being seen
- Average number of overtime hours

However, in the current state of maturity of the study, we mainly delivered recommendations. A deeper study, enlarged to other additional possibilities of organizational improvement still requires to be developed. A long term research collaboration between Altermedis and the research laboratory is under discussion.

4. CONCLUSION AND RECOMMENDATIONS

This study has explored the organizational dynamics of rural medical homes through a simulation-based approach, aiming to provide local healthcare managers with actionable insights for improving service delivery and resource allocation. Our analysis has demonstrated that while the establishment of medical homes creates a structural opportunity for enhanced access to care, the real benefits in terms of efficiency, patient satisfaction, and workload balance rely heavily on the design of collaboration mechanisms — both internally among professionals and externally between medical homes.

At the internal level, the integration of complementary healthcare roles, such as Asalée nurses and medical assistants, was shown to relieve doctors' workloads without significantly expanding the number of patients treated. Although the introduction of duo consultations did not lead to major improvements in patient flow, it did create a more sustainable distribution of tasks, potentially enhancing job satisfaction and reducing burnout among physicians.

At the inter-organizational level, the results highlight the clear potential of networked collaboration, particularly for handling emergency consultations, which often disrupt scheduled care. Scenarios involving dedicated doctors for emergency flows demonstrated a significant reduction in overtime hours worked when at least two physicians shared this role, although this required trade-offs in scheduled patient handling.

From a broader perspective, the study underscores the value of discrete-event simulation and digital twin technologies as decision-support tools in healthcare planning. These approaches enable managers to preemptively assess the operational impact of organizational changes in a risk-free virtual environment, making them highly relevant for complex and evolving care ecosystems like rural medical homes.

Future research should focus on expanding this simulation framework to include socio-demographic factors, patient outcomes, and financial performance, further supporting data-driven decision-making for policymakers and healthcare providers. Additionally, incorporating real-time data through digital twin systems offers promising avenues for adaptive, ongoing optimization of primary care delivery.

5. PUBLICATIONS

Marius Huguet, Xavier Boucher, Vincent Augusto, Nour Mezni and Chloé Gouttefangeas, Collaborative processes for the deployment of rural medical homes: simulation study, proceedings of PRO-VE'2025, 26th IFIP WG 5.5 Working Conference on Virtual Enterprises, Porto, Portugal, 27-29 October 2025.

6. REFERENCES

1. Beckfield J, Olafsdottir S. Health Inequalities in Global Context. *Am Behav Sci*. 2013;57(8):1014-1039. doi:10.1177/0002764213487343
2. Doorslaer E Van, Masseria C, OECD Health Equity Research. Inequalities in access to medical care by income. *Can Med Assoc J*. 2006;174(2):177-183. doi:10.1503/cmaj.050584
3. Corscadden L, Levesque JF, Lewis V, Strumpf E, Breton M, Russell G. Factors associated with multiple barriers to access to primary care: An international analysis. *Int J Equity Health*. 2018;17(1). doi:10.1186/s12939-018-0740-1
4. Ministère de la Santé et de la Prévention. *Plan d'action 4 000 Maisons de Santé Pluriprofessionnelles. Https://Sante.Gouv.Fr/IMG/Pdf/Dp_msp.Pdf [Accessed Feb 2025]*.; 2023.
5. Arend J, Tsang-Quinn J, Levine C, Thomas D. The Patient-Centered Medical Home: History, Components, and Review of the Evidence. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine*. 2012;79(4):433-450. doi:10.1002/msj.21326
6. Lueckmann SL, Hoebel J, Roick J, et al. Socioeconomic inequalities in primary-care and specialist physician visits: a systematic review. *Int J Equity Health*. 2021;20(1). doi:10.1186/s12939-020-01375-1