CSCI 5408
DATA MANAGEMENT AND WAREHOUSING

Group - 6
Team Assignment – 1
Sprint-1

Banner ID:
B00963832 – Heli Desai
B00980674 – Ovaiz Ali
B00976563 – Haoyu Wang
B00974443 – Yukta Gurnani
B00981275 – Raisa Putri

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Background Research

The initial phase of our project was dedicated to background research within the healthcare domain. Our focus was on understanding the integration of Distributed Database Systems technologies in healthcare. The team conducted a comprehensive review of various aspects within the healthcare industry, gathering information from credible sources Below is a tabular representation of our research findings:

Table 1:Table depicting the background research findings.

Topic	URL	Summary of Findings
Hospital	Halifax Infirmary	Explored facilities and services offered, highlighting the significance of advanced healthcare infrastructure.
Patient	Better Health	Discussed the importance of patient records and paperwork in hospital settings.
Medical History	National Cancer Institute	Reviewed how medical histories are documented and their critical role in patient care.
Prescription	Student Doctor	Analysed prescription writing practices, emphasizing accuracy and patient safety.
Prescription	NCBI	Further insights into the standard prescription processes and their implications.
Hospital Staff	Better Health	Investigated the roles and responsibilities of hospital staff in patient care.
Medical Waste	WHO	Highlighted the management and disposal practices for medical waste to ensure environmental safety.
Patient Meals	Johns Hopkins Medicine	Explored the nutritional care and meal services provided to patients.
Insurance	My Aetna Health Plans	Reviewed insurance card benefits and its role in accessing healthcare services.
HIMSS	HIMSS	Comprehensive insights on healthcare information technology, crucial for distributed database systems.
Health Tech Insider	Health Tech Insider	Focuses on the latest in health and medical technology, relevant for database system innovations.
IoT Equipped Intelligent Distributed Framework for Smart Healthcare Systems	Arxiv	Discusses an IoT-based distributed framework for healthcare, emphasizing secure and fast data availability through DDMS and blockchain.
Distributed Database Strategies in A Healthcare Record Systems	*https://proceeding.unikal.ac.id › article › download*	Deploys Multi-Master Replication model, presenting theoretical research on distributed database, thereby enabling the development of large systems in dispersed environment and wide use scope.
Strategies to Access Patient Clinical Data from Distributed Databases	*https://www.scitepress.org › Papers*	Makes comparison between applying a common data model and using Semantic Web principles by evaluating them according to parameters relevant to data

		integration, such as cost, data quality, interoperability, extendibility, consistency, and efficiency.
What is Distributed Healthcare?	https://orionhealth.com › global › what-is-distributed-h...	Focuses on how distributed healthcare can be harnessed to give personalized healthcare
A Secure Healthcare System: From Design to Implementation	https://www.sciencedirect.com › science › article › pii	Presents the design and development of a novel EHR system incorporating two formal development methodologies as software engineering perspective, together with database development approach.

Summary of Findings

To get knowledge of healthcare domain, we visited several websites such as HIMSS and Health Tech Insider. Through this, we gained insights about functioning of existing healthcare systems. On gaining domain knowledge, we started working on gathering requirements. We had dived deep into the phase of requirement gathering by reviewing many research papers and blogs. With this, we learned that how different technologies such as IOT, blockchain can be harnessed to ensure secure and fast data availability through DDMS. We even came across by the concept of multi-master replication. This model involves having multiple master nodes that are all able to accept write commands, and these write operations are replicated to all other masters.[1] Multi-master setups are useful for achieving higher availability and better write performance across geographically distributed systems.[1]

Further when referring the “Strategies to Access Patient Clinical Data from Distributed Databases” research paper, we got to know that despite the recognised gain of data sharing, database owners remain reluctant to grant access to the contents of their databases because of privacy and security issues, and because of the lack of a common strategy for data sharing. The paper eventually discusses about the two main approaches to solve this issue, i.e. applying a common data model, or using Semantic Web principles. The paper concludes by making comparison between two approaches by evaluating them according to parameters relevant to data integration, such as cost, data quality, interoperability, extendibility, consistency, and efficiency.

To understand how the product will impact lives of patients in a better way, we started looking for various internet sources and found a blog by Orion health. The blog “What is Distributed Healthcare?” elaborates the benefits of providing decentralised care services. The blog urges for the requirement of common data platform to get dynamic view of patient’s medical record. Also, it would help in crossing the boundary between primary, community and hospital-based care.

On understanding the requirements, we focused on how database development and software engineering go together. For this we studied the “A Secure Healthcare System: From Design to Implementation” research paper. This paper demonstrates the steps of development process based on database ER-model and normalizes the final design to 3NF.

The background research conducted across various topics within the healthcare industry revealed several key insights:

Infrastructure and Services: Hospitals like the Halifax Infirmary are pivotal in providing comprehensive healthcare services, demonstrating the importance of robust healthcare infrastructure.

- Patient Care and Safety: Proper management of patient records, prescriptions, and medical histories is critical to ensuring high standards of patient care and safety.
- Operational Efficiency: The roles of hospital staff and the management of hospital operations, including medical waste disposal and patient meals, are crucial for the efficient functioning of healthcare facilities.
- Insurance: Understanding insurance benefits and how they facilitate access to healthcare services underscores the importance of financial planning in healthcare.

This research underscores the complexity of the healthcare industry and the importance of integrating advanced database systems to manage healthcare operations efficiently. The insights gathered from these sources will be instrumental in developing a comprehensive database model that addresses the nuanced needs of the healthcare sector.

Design Issues

In terms of managing historical data, yes, it is essential to address this requirement, particularly because the healthcare industry necessitates the retention of medical history along with corresponding dates. We have incorporated the Medical History entity for this purpose, and other entities requiring historical data have the necessary “date” attribute. This ensures that our Entity-Relationship Diagram (ERD) is comprehensive, capable of accommodating historical data seamlessly, and free from defects.

Upon reviewing our initial conceptual model, the following design issues have been identified:

1. Chasm Trap in Doctor Entity

    The "Treated_By 1:M Patient" relationship in the Doctor entity may lead to a chasm trap, as doctors can treat multiple patients, and patients can be treated by multiple doctors. This situation risks ambiguity and can complicate queries involving doctor-patient interactions.

2. Fan Trap in Surgery Entity:

    The Surgery entity presents a potential fan trap scenario, where one patient undergoes multiple surgeries involving multiple doctors. This complexity can result in redundancy or ambiguity in representing surgical procedures and medical staff involvement.

Solutions Proposed

To address these issues and improve the initial conceptual model, the following solutions are proposed:

1. Chasm Trap Resolution: Introduced a new relationship entity to clearly define doctor-patient interactions, eliminating ambiguities.
2. Fan Trap Resolution: Created a separate entity to represent groups of doctors involved in surgeries, ensuring data integrity, and avoiding redundancy.

Entity-Relationship Diagram (ERD)

Our ERD was meticulously developed to include over 20 entities, reflecting the intricate relationships within the healthcare domain. Each entity was designed with consideration for real-world healthcare processes, ensuring a comprehensive model that supports the diverse needs of healthcare data management.

Initial ERD

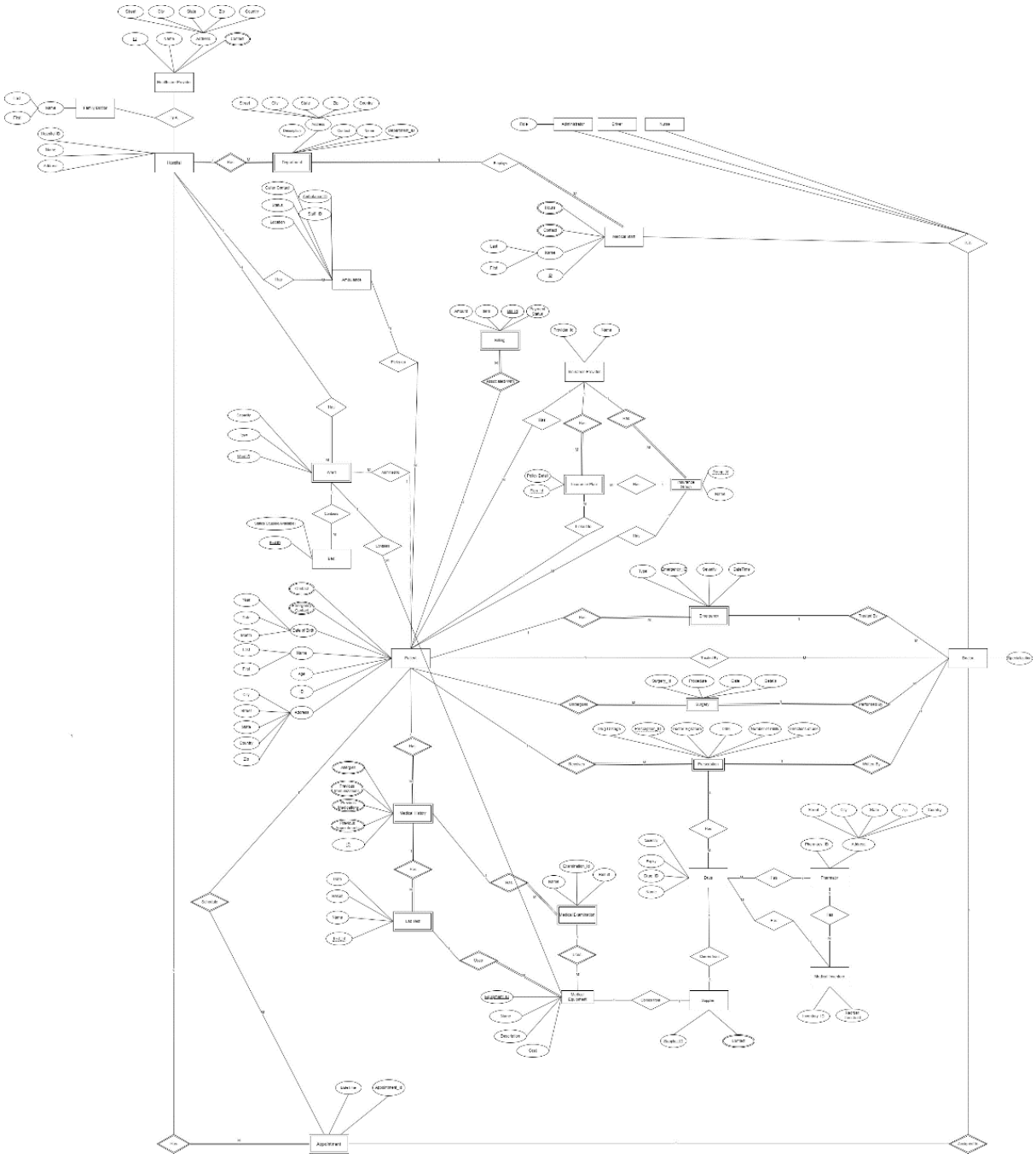

Figure 1: Figure representing the initial ERD.

Final ERD After Resolving Design Issue.

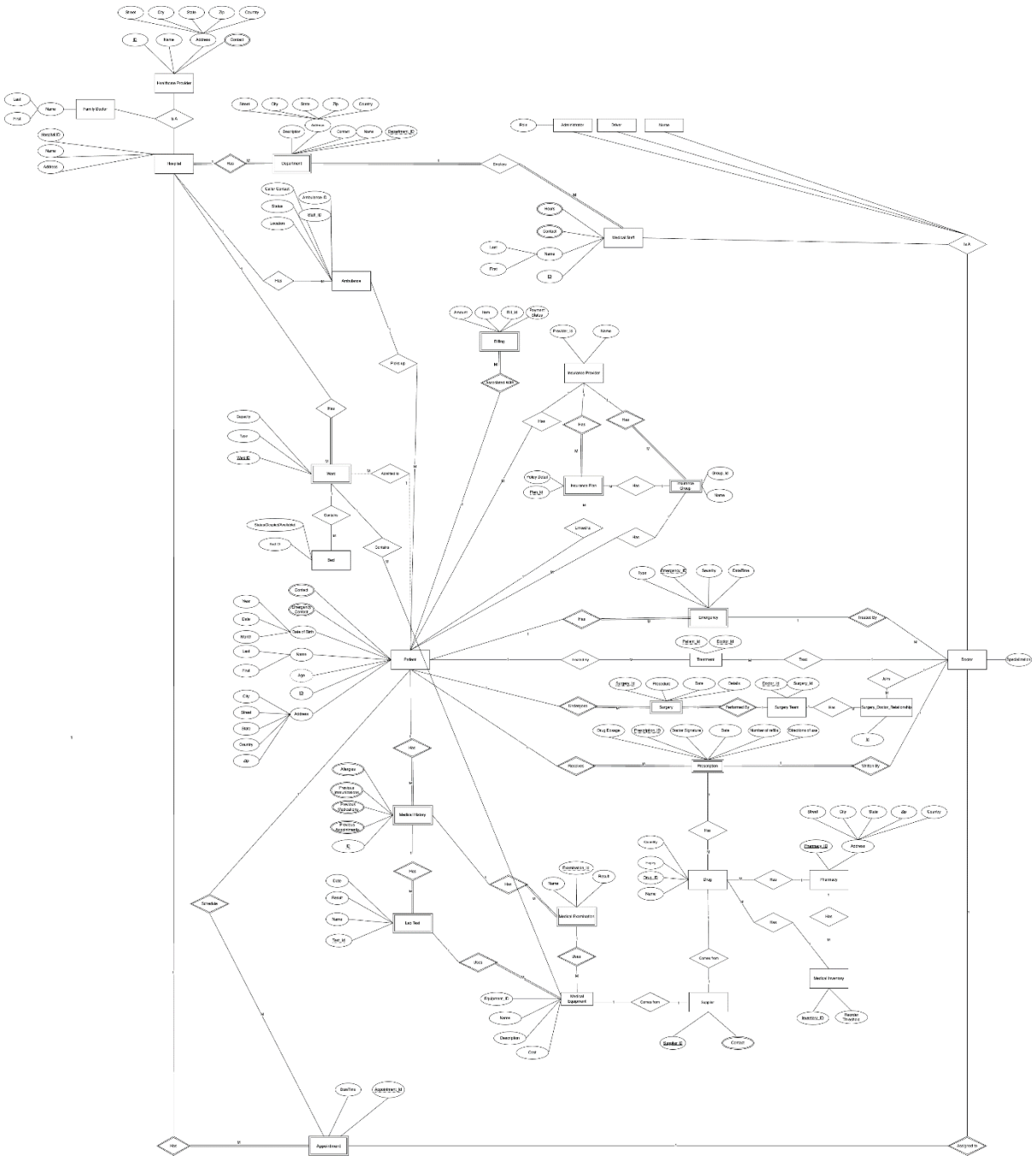

Figure 2: Final ERD

Minutes of the meeting

Table 2: minutes of the meeting from meeting 1

Item	Details
Date/Time	Monday, February 19, 2024, 1:00 PM
Duration	45 minutes
Location	Online (MS Teams)
Attendees	All team members
Agenda	• Presentation of background research on the healthcare system. • Discussion on entities and relationships for ERD • Decision on healthcare industry scope.
Action Items	• All members to add research, entities, and attributes to shared OneDrive document. • Raisa to update on head TA's guidance. • All members to add to ERD shared by Haoyu. • Schedule next meeting for collaborative ERD design problem-solving.
Discussions	• Reviewed each member's research on the healthcare system. • Discussed scope: general healthcare system vs. hospital specific. • Clarification sought from head TA Bharat.
Outcomes	• Majority voted for healthcare system as the project scope. • Agreed to further refine entities and relationships in the next meeting. • Next meeting scheduled for Wednesday, February 21, 2024, 1:30 PM

Table 3: minutes of the meeting from meeting 2

Item	Details
Date/Time	Wednesday, February 21, 2024, 1:30 PM
Duration	2 hours, 5 minutes, 27 seconds
Location	Online (MS Teams)
Attendees	All team members
Agenda	• Consolidate ER Diagram (ERD). • Discuss and solve design issues. • Assign tasks for research and documentation.
Action Items	• Haoyu Wang and Raisa Putri to consolidate ERD. • Yukta Rajkumar Gurnani to conduct background research and summary. • Ovaiz Ali to address design issues. • Heli Desai to consolidate minutes into report.
Discussions	• Detailed review of entities, attributes, and relationships. • Collaborative effort on Draw.io for ERD adjustments. • Evaluation of each entity's necessity and associated relationships.
Outcomes	• Unified ERD with agreed-upon entities, attributes, and relationships. • Clear division of work for subsequent tasks. • Identified and planned resolution for design issues.

Table 4: minutes of the meeting for meeting 3

Item	Details
Date/Time	Tuesday, February 27, 2024, 2:00 PM
Duration	1 hour
Location	Online (MS Teams)
Attendees	All team members
Agenda	• Finalize ERD. • Refine documentation for sprint 1 submission.
Discussions	• Detailed review of entities, attributes, and relationships after the design issues are resolved. • Collaborative effort on reviewing and refining the documentation
Outcomes	• Finalized submission

Conclusion

The culmination of our background research, analysis, and model development has provided us with a solid foundation to proceed with the implementation phase of our project. Our focus on integrating cutting-edge technologies within the healthcare industry not only aims to address current challenges but also to anticipate future needs, ensuring that our database system remains robust, scalable, and aligned with the evolving landscape of healthcare services.

Screenshots

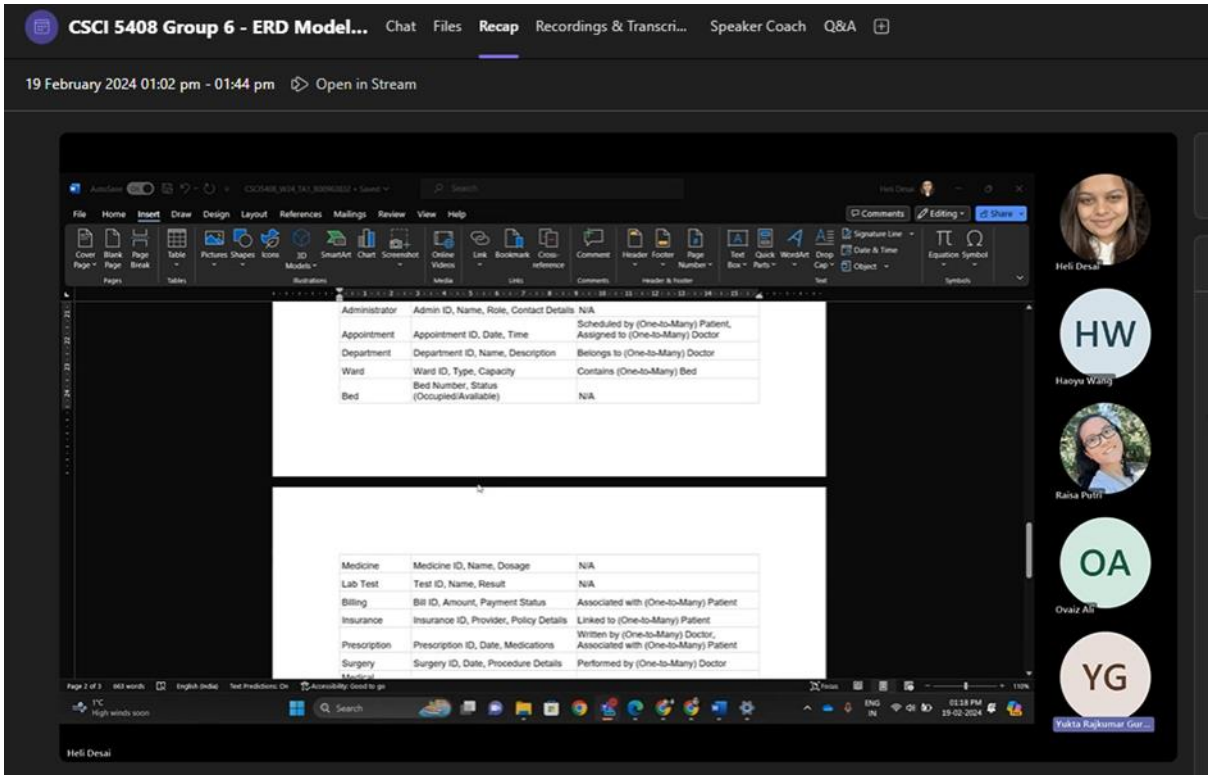

Figure 3: Screenshot of meeting 1

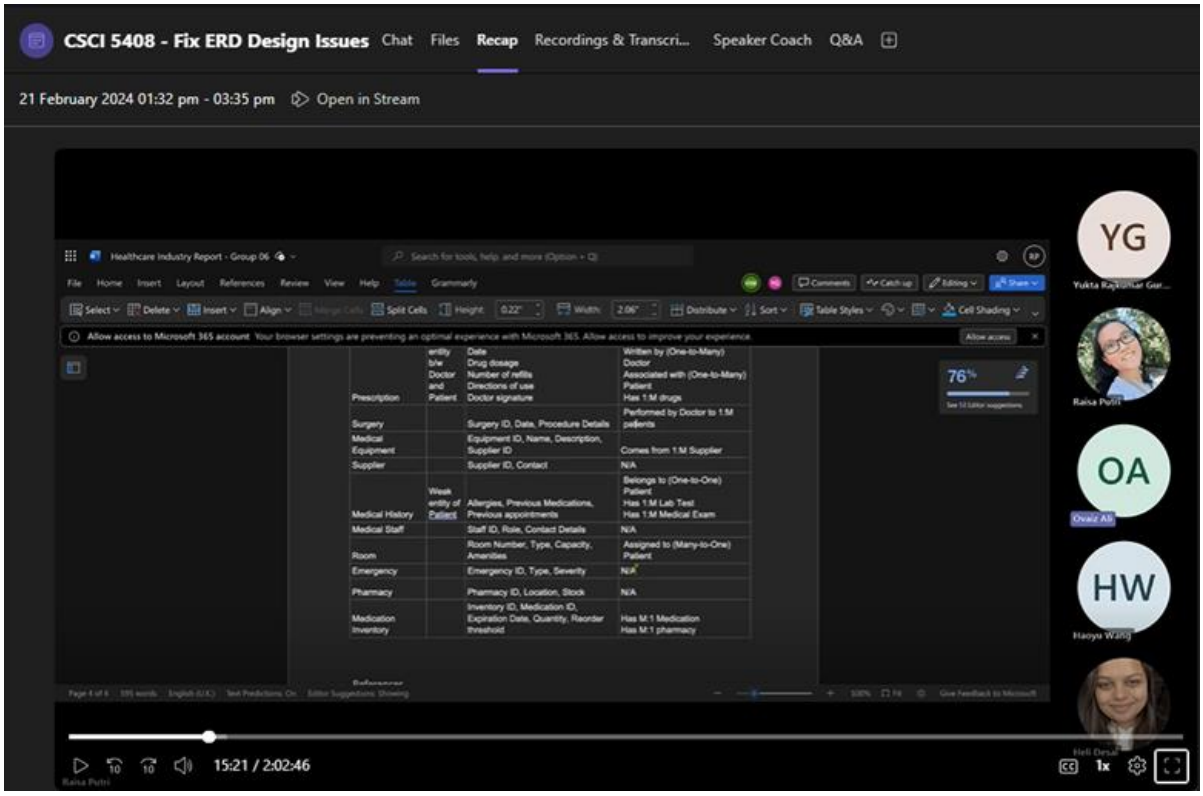

Figure 4: Screenshot of meeting 2

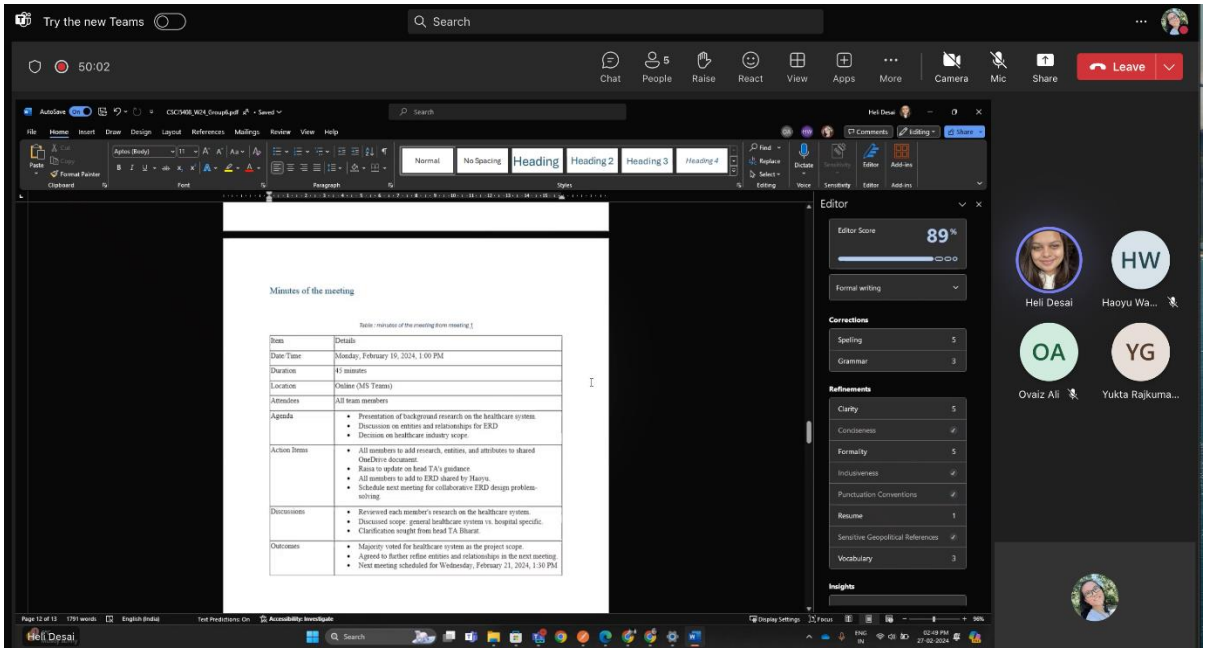

Figure 5: Screenshot of meeting 3

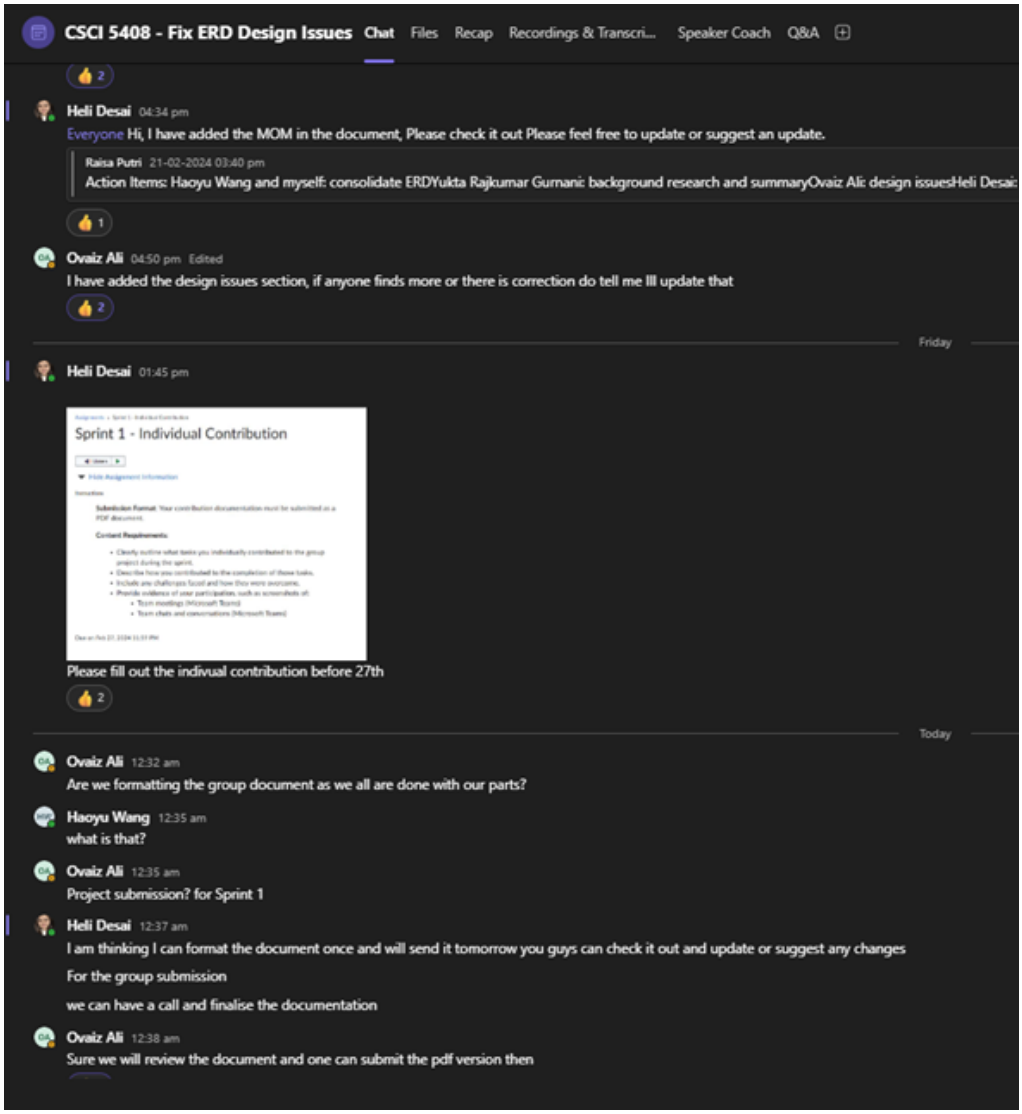

Figure 6: Team chat

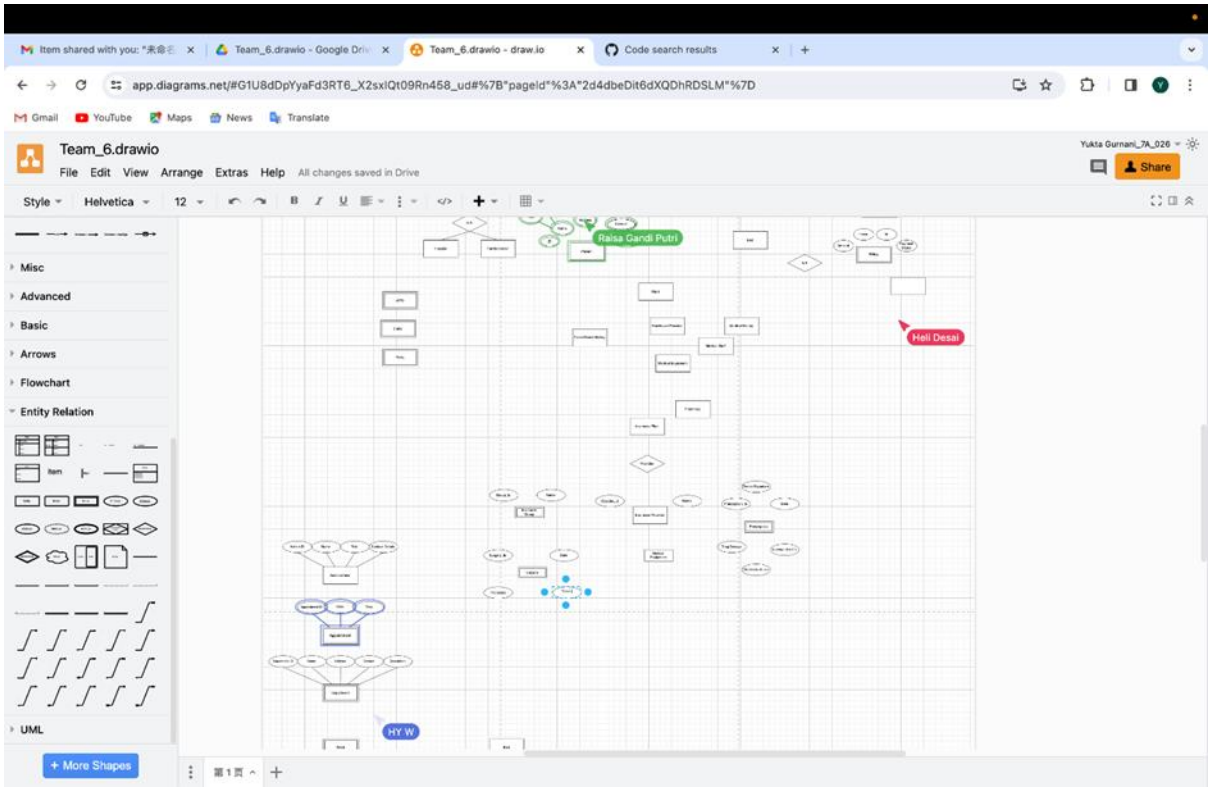

Figure 7: Collaborative ERD creation by the team on draw.io

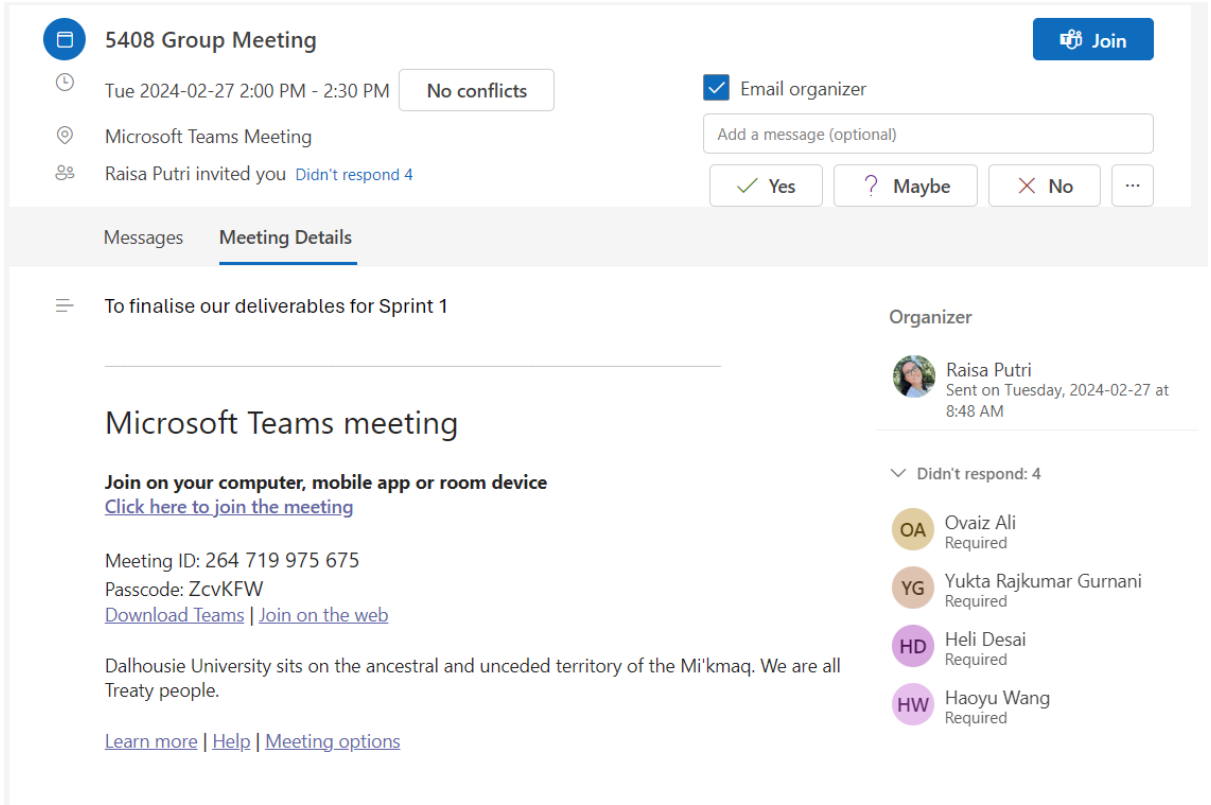

Figure 8: Meeting for documentation.

References

[1] "[Answered] What is Redis replication with multi-master?" Accessed: Feb. 26, 2024. [Online]. Available: https://www.dragonflydb.io/faq/redis-replication-multi-master