Course Project: Submission One

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INFO260: Data Management

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Purpose of Data Management

Analysing the Ambulance and Paramedic Dispatch System

The case presents the Emergency Medical Services (EMS), who provide fast and effective medical response to a wide array of medical emergencies in New Zealand. Despite the skills and capabilities of the EMS team, the dispatch process is currently inefficient. This can occasionally result in delays in responding to critical emergencies. The current dispatch capabilities can also lead to poor resource allocation, hampering the delivery efficiency. Hence, the EMS board members are interested in an ambulance dispatch system which is efficient and accurate. The EMS envision a dispatch system which enhances dispatch response times and the outcomes of patients by utilising data-driven insights. The EMS are also interested in an improved data management plant which can enhance dispatch efficiency, optimize ambulance allocation, and evaluate performance effectively.

Business requirements and data requirements of the system.

The EMS department has identified two main business requirements of the EMS system which are dispatching efficiency and dispatching accuracy. By meeting these requirements, the EMS will be able to significantly improve their service and help save lives in New Zealand.

- Dispatching efficiency
  The current dispatch process is inefficient and can sometimes result in delays. The EMS would like to improve this as it would mean that the EMS can respond to emergencies faster. The EMS department aims to do this by using data management to quickly identify the nearest available ambulance which has the appropriate medical facilities and paramedics.
- Dispatching Accuracy
  Accuracy in the dispatch process is very important for the EMS. This is because the EMS has limited resources, and so must allocate them effectively. The current dispatch system sometimes leads to suboptimal resource allocation, resulting in care which is inefficient. Dispatching accuracy can be improved by the data system prioritising incident based on medical conditions. This is so that the most appropriate ambulance and paramedics are sent to the scene.

Overall, the business requirements are very straightforward and logical. If implemented, should make a world of difference is the service provided to New Zealanders by the EMS.

The data requirements of the EMS system include:

- Efficient and effective capturing, storing, and analysing of critical incident data.
- Comprehensive analysis of the data
  - Identifying patterns
  - Assessing response times
  - Evaluating dispatch accuracy
- Establishing a data warehouse to effectively store/manage large amounts of both historical and real-time data.
- Implementing an Extract, Transform, Load (ETL) plan to extract data from different sources, convert it into a consistent format, and then transfer it into the data warehouse.

- A sophisticated data environment the supports:
    - Advanced analytics
    - Reporting
    - Data mining

The importance of effective data management for the Ambulance and Paramedic Dispatch System.

Effective data management is very important for the Ambulance and Paramedic Dispatch System for many reasons including:

- **Faster response times**
  The response times can be reduced by rapidly identifying the nearest ambulance which has the appropriate medical facilities and qualified paramedics.
- **Better dispatch accuracy**
  Dispatch accuracy can be improved by prioritizing incidents based on the given medical condition. Then, the most appropriate ambulance and paramedics can be sent to the incident as soon as possible.
- **Optimised resource allocation**
  By sending the most appropriate ambulances and paramedics to each incident, the limited resources of the EMS can be utilised optimally.
- **Storing and analysis of data to make data-driven decisions**
  By using effective data management, the EMS can effectively store important data and then analyse this data to gain insights. Then these insights can be used to make data-driven decisions that will benefit the EMS.
- **Better service**
  The EMS having effective data management means that they can respond to emergencies faster and with the right resources. This would greatly increase their quality of service in helping patients.
- **Increased trust and public image**
  By providing fast and accurate care, New Zealand citizens will trust the EMS more in delivering medical care and, in turn, the public image of the EMS will heighten.
- **Saving lives**
  Overall, effective data management is very important for the EMS as the stakes are incredibly high and there are potential lives on the line. By implementing effective data management and gaining the above benefits, the EMS can continue to help save more lives.

Database Design

The EMS database in its current state is not meeting the needs and requirements that the EMS department are interested in. The current database is a single table and, along with not meeting the requirements, also suffers from issues such as data redundancy, a lack of normalisation, and poor data integrity to name a few. Hence why it is imperative that a new database design is created.

To address the dispatching efficiency business requirement, the EMS aims to identify the nearest available ambulance (to the incident) which has the appropriate medical facilities and paramedics. To achieve this, we will need to know the location of the incident, the nature of the incident (to receive the appropriate medical facilities and paramedics), the location of the available ambulances and their vehicle type, and the available paramedics and their qualification.

To address the dispatching accuracy business requirement, the EMS wants the system to prioritise incidents based on medical conditions so that the appropriate ambulance type and qualified reach the scene quickly. To do this, we can assign a dispatch priority to each incident based off the details provided in the call to the EMS. This way, incidents that have more severe medical conditions (as described in the phone call) receive a higher dispatch priority and, in turn, these incidents are prioritised in the dispatch process.

The data requirements as given by the EMS department will also need to be considered in the database design. However, many of the given data requirements are not relevant in the database design and will be addressed later on. The main data requirement for the database is that it stores the necessary and relevant data such as patient information, incident details, clinical impressions, etc.

It is also important that the database is designed well so that it is normalised, does not have data redundancy, has good data integrity, etc. so that the database is efficient and supports the EMS' needs effectively.

Designing the database schema

Initial tables:

- Patient
  There needs to be a patient table as each incident deals with one patient, and the EMS aims to care for patients. There can only be one patient for each incident, but a given patient can be the patient in many different incidents.
- Incident
  Incidents could be considered the core data point as an incident happening is what causes the EMS response.
- Clinical Assessment
  This is about storing clinical data gathered by the paramedic once they've arrived to the incident relating to the patient in the incident.
- Clinical Impression
  This is related to clinical assessment and is about the clinical impressions gathered by the paramedics about the patient. The impressions are in order from most to least prominent.
- Glasgow Coma Scale
  This also relates to clinical assessment and is about evaluating the consciousness of the patient.
- Dispatch Information
  This is relating to the business requirements and is about the information used to decide the dispatch to the incident.

- Dispatch
  This is about the dispatch (vehicle type, paramedics, etc.) to the incident.
- Ambulance
  This is about the ambulance that can be dispatched to the incident.
- Paramedic
  This is about the paramedics which can be dispatched to the incident.

These are the initial tables as more will be created once some more are normalised.

Attributes and primary keys for each table:

Patient

- PatientID
- Date of birth
- Gender

PatientID is needed to uniquely identify the patients and is the primary key.

Date of birth is used to identify the patient's age. Previously, there were three attributes – age, agetype, and agecategory – but having three attributes to represent age seemed redundant. Date of birth can achieve the same purpose in one attribute. Needed for general information about the patient (can be used later on in analysis and categorisation).

Gender is used to identify the patient's gender. Needed for general information about the patient (can be used later on in analysis and categorisation).

The database could possibly use the DOB and gender to assist in dispatch prioritisation and choosing the right ambulance/paramedics, but this is not a requirement and so will not be implemented as to keep the database simple.

Incident

- IncidentID
- Call_district
- DateOfCall
- DateOnset
- Location_type
- CAD_Time_PhonePickUp
- IsSTEMI
- IsOHCA
- CPRPerformed

IncidentID is needed to uniquely identify the incident and is the primary key.

Call_district is the district from which the call originates. Needed so that the dispatch can know where to go to.

DateOfCall is when the call is made. Needed for general incident information.

DateOnset is when the patient's symptoms started. Needed for general incident information and data storing.

Location_type is about the location type (urban/rural) of the incident location. Needed for general incident information and data storing.

CAD_Time_PhonePickUp is about when the EMS picked up the phone call. Needed for general incident information and data storing.

Clinical Assessment

- ClinicalAssessmentID
- IsSTEMI
- IsOHCA
- CPRPerformed

ClinicalAssessmentID is for uniquely identifying the clinical assessment table and is the primary key.

IsSTEMI**,** IsOHCA**,** and CPRPerformed are important clinical assessment measures which is why they are included as attributes.

Clinical Impression

- ClinicalImpressionID
- ImpressionOrder
- ClinicalImpression

ClinicalImpressionID is for uniquely identifying the clinical impression table and is the primary key.

ClinicalImpression and ImpressionOrder are used to list clinical impressions. The impression order is needed as it is important that the impressions are ordered from primary impression onwards.

Glasgow Coma Scale

- GCSID
- GCS_Initial
- GCS_Initial_Time
- GCS_Final
- GCS_Final_Time

GCSID is for uniquely identifying the GCS table and is the primary key.

GCS_Initial is the first GCS measure recorded when the paramedics arrive, GCS_Initial_Time is the time that this is recorded.

GCS_Final is the first GCS measure recorded when the paramedics arrive, GCS_Final_Time is the time that this is recorded.

Dispatch Information

- DispatchInformationID
- CAD_Response_Area
- CAD_Triage_Priority

DispatchInformationID is for uniquely identifying the Dispatch Information **t**able and is the primary key.

CAD_Triage_Priority is to prioritise the incidents by severity based on the phone call (which gives CAD_Triage_Priority) and meet the dispatch accuracy business requirement of sorting incidents by the medical condition severity.

CAD_Response_Area is the location of the incident. This is needed so that the closest appropriate ambulance with the qualified paramedics can be identified.

There is also CAD_Service_Area which is separated into a different table as to comply with normalisation.

Service Area

- CAD_Response_area
- CAD_Service_area

CAD_Response_area is for uniquely identifying the Service Area table and is the primary key. This is because service area can be identified by the response area.

CAD_Service_area is the area type (urban/rural/remote). Is needed for the EMS to respond accordingly.

Dispatch

- DispatchID
- CAD_Time_Assigned
- CAD_Time_ArrivedAtScene
- CAD_Time_Depart_Scene
- CAD_Time_Arrive_Destination
- FinalDestination

DispatchID is for uniquely identifying the dispatch table and is the primary key.

CAD_Time_Assigned, CAD_Time_ArrivedAtScene, CAD_Time_Depart_Scene, CAD_Time_Arrive_Destination are the relevant times throughout the dispatch process.

FinalDestination is the final destination that the dispatch takes the patient to.

There is also FinalDestination_IsPCIHospital which is whether a hospital has a cardiac treatment facility or not. This is given a new table to comply with normalisation.

Cardiac Treatment Facility

- FinalDestination
- FinalDestination_IsPCIHospital

FinalDestination is for uniquely identifying the Cardiac Treatment Facility table and is the primary key. This is because FinalDestination_IsPCIHospital can be identified by the final destination.

Ambulance

- AmbulanceID
- VehicleType
- AmbulanceLocation
- AmbulanceAvailability

AmbulanceID is for uniquely identifying the ambulance table and is the primary key.

VehicleType is the type of vehicle the ambulance is and the medical capabilities it provides. The database aims to dispatch the adequate vehicle to the appropriate incident given the incident’s medical severity.

AmbulanceLocation is used to know the location of the ambulance so that ambulances that are closer can be assigned to the incident.

AmbulanceAvailability is used to know if an ambulance is available, so can be dispatched to an incident.

Paramedic

- ParamedicID
- ParamedicQualification
- ParamedicAvailability

ParamedicID is for uniquely identifying the ambulance table and is the primary key.

ParamedicQualification is used to get the qualification of the paramedic. This way, the paramedics with the suitable qualifications can be dispatched to the incident (fitting with the requirements).

ParamedicAvailability is used to know if a paramedic is available to be dispatched or not.

Relationships:

There can be one patient per incident, but a patient may be involved in many different incidents. Hence, there is a one-to-many relationship between Patient and Incident. It is mandatory for both sides as for a patient to exist, they must have been associated with an incident, and for an incident to exist, there must be a patient.

There is a one-to-one relationship between incident and dispatch information as an incident can have one instance of dispatch information and vice versa. It is mandatory for both sides as an incident needs to be associated with dispatch information and dispatch information cannot exist without an incident.

There is a one-to-one relationship between dispatch information and service area as the dispatch information table is only associated with one service area table. It is mandatory for both sides as dispatch information needs to be associated with service area and vice versa.

There is a one-to-one relationship between dispatch information and dispatch as dispatch information only requires one dispatch and vice versa. It is mandatory for both sides as dispatch information needs to be associated with dispatch and vice versa.

There is a one-to-one relationship between dispatch and ambulance as the dispatch only needs one ambulance. It is mandatory for dispatch to require an ambulance as it needs one to assist in patient care, but an ambulance does not have to be associated with a dispatch (optional).

There is a one-to-many relationship between dispatch and paramedic as the dispatch needs one or many paramedics to dispatch to the incident. It is mandatory for dispatch to require paramedics as it needs them to aid in dispatch, but a paramedic does not have to be associated with a dispatch (optional).

There is a one-to-one relationship between dispatch and cardiac treatment facility as dispatch is only associated with one instance of cardiac treatment facility being true or false. It is mandatory for both sides as dispatch needs to be associated with Cardiac Treatment Facility and vice versa.

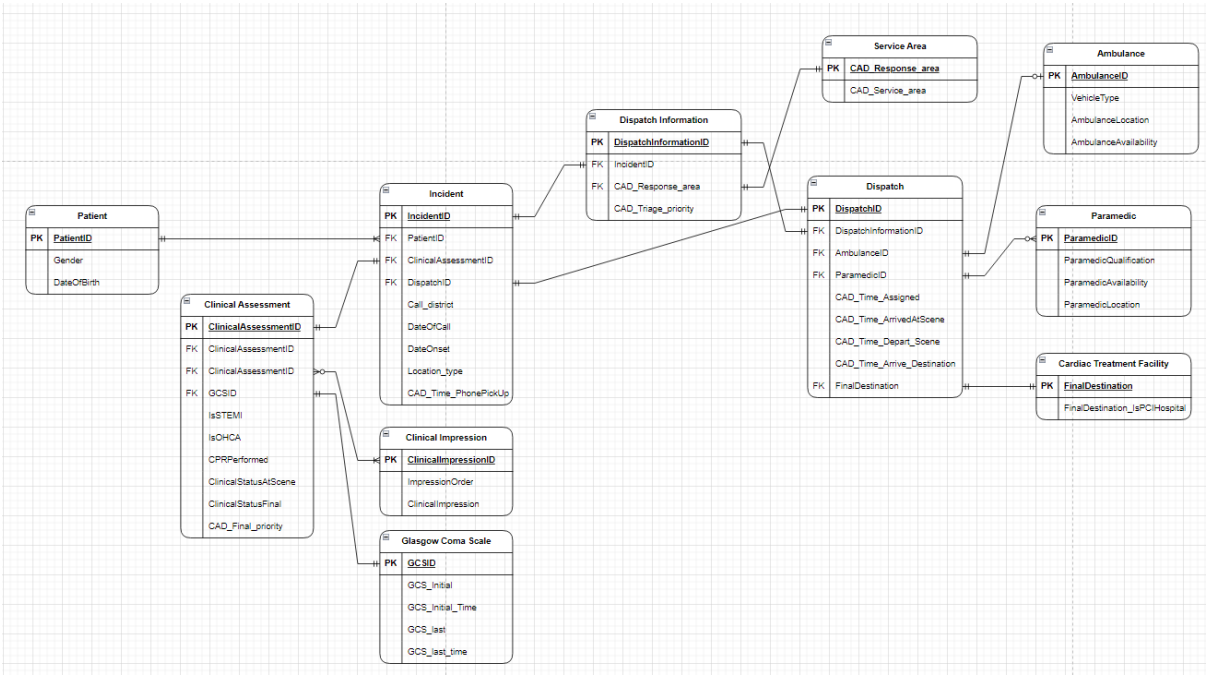
There is a one-to-one relationship between clinical assessment and incident as each incident can only be associated with one clinical assessment. It is mandatory for both sides as an incident needs to have a clinical assessment record and a clinical assessment cannot exist without a incident.

There is a one-to-many relationship between clinical assessment and clinical impression as each incident can be associated with many clinical assessments. It is mandatory for both sides as a clinical assessment needs clinical impressions, and a clinical impression can not exist without a clinical assessment.

There is a one-to-one relationship between clinical assessment and Glasgow coma scale as each clinical assessment can only be associated with one instance of Glasgow Coma Scale (being both the initial and final times). It is mandatory for both sides as a clinical assessment needs to have the GCS measures and times, and the Glasgow Coma Scale measures cannot exist without a clinical assessment.

There is a one-to-one relationship between incident and dispatch as each incident require a dispatch of ambulance and paramedics and there is only one dispatch per incident. It is mandatory for both sides as an incident needs dispatch and dispatch does not exist in the first place without an incident.

ER Diagram representing the database schema:



Database Summary:

The database meets the data requirements by capturing and storing a wide array of necessary information including patient details, incident details, important times, etc. The database is also free of data redundancy, is normalised, and has maintains data integrity.

The database also adequately meets the business needs of the EMS board.

Dispatching Efficiency:

Using the dispatch information, which consists of relevant attributes such as triage priority and the location of the incident, the appropriate dispatch can be allocated by allocating the most appropriate ambulance type (both in terms of the ambulance location and facilities) and paramedics to the incident based on the CAD triage priority. This way, the suitable ambulance with the correct paramedics can be dispatched to the incident promptly.

Dispatching Accuracy:

The designed database system prioritises incidents by their triage priority (the priority allocated to the incident from the phone call from the patient to the EMS) in the dispatch information table, which results in the dispatch table (which has relationships with the ambulance and paramedics tables) sending prompt and accurate services to the incident. This results in incidents with a higher triage priority receiving care first (and with the efficient dispatching as described in the dispatching efficiency business requirement).

Overall, the new and improved database now is efficient and effective and meets the business and data requirements of the EMS board and more. It provides an excellent foundation and should fulfil the further needs of the EMS board such as implementing the database schema into SQL to run queries on.