

ER Diagram

Team 10

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Changes made to entities

1. We initially thought of making Crime a weak entity because we had made Locality a weak entity. However, we decided to keep location independent from Locality.
2. In Crime the team has used Locality as a value in the composite attribute Location. Since a weak entity named Locality exists, the Locality value has been renamed to area.
3. We are making Locality a weak entity because the Crimes and Criminals attribute is multivalued. Its value depends on the Crime IDs in the Crime relation and Criminal IDs in the Criminals relation, which are foreign keys referencing the Crime relation. The ternary identifying relationship involving the Locality, Crimes, and Criminals requires that the Criminals attribute be added to the Locality relation.
4. We feel that the Weapon usage entity is unnecessary. However, we are preserving the structure of the original document with addition of 2 attributes as explained below.
5. We have assumed that sex is not NULL as part of our constraints for attributes. The concerned authority will enter it in the Database.
6. In the weak entity, People Involved, the eyewitness attribute can be NULL. A crime may have no eyewitnesses.
7. We added an attribute Criminals(multi-valued) to the locality entity. Because locality is a weak entity it is participating in a relationship with strong entities crime and criminal. We removed a binary relationship between Crime and Locality. Since the original document has 2 relationships one is in between Crime, locality and the other is in between Crime, Criminal, and Locality. The ternary one is more efficient and gives a lot more information about the crime, so we considered it and removed the binary relationship. To correct the ternary relationship, we added Criminal_ID to the Locality entity.

Crime:

The team has made Crime ID a composite attribute of Primary Key and Foreign Key. We have removed this and made Crime ID a primary key. Crime is a strong entity. It requires a primary key which cannot be a foreign key or include a foreign key. This will lead to Crime becoming a weak entity.

Attribute	Data type	Constraints	Description
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Crime ID	Varchar (50)	Primary key	Contains values like C101, C102 etc.
Type of Crime	Enum	Not Null	Theft, assault, murder, kidnap, fraud, cybercrime
Location [Composite attribute: House number + Street name + area]	Varchar(30) for each field	Not Null (for all fields)	
No. Of Deaths	Integer	Not Null, Default: 0	
No. Of Injured people	Integer	Not Null, Default: 0	

Locality:

Name is changed to partial key since in a locality will be recognized by crime and criminal ID's.

Attribute	Data type	Constraints	Description
Name	Varchar (50)	Partial key	
Type of location	Enum	Not Null	Residential, Commercial, Industrial, Wasteland.
Crimes [Multi-valued attribute]	Varchar (50)	Can be Null	Contains the Crime ID of the crimes committed in this locality
Criminals [Multi-valued attribute]	Varchar (50)	Can be Null	Contains the Criminal ID of the crimes committed in this locality
No. of hospitals	Integer	Not Null	
No. of police stations	Integer	Not Null	
No. of fire stations	Integer	Not Null	

7. We added an attribute Criminal ID to the weapon usage entity. Because weapon usage is a weak entity it is participating in a relationship with strong entities crime and criminal. The ternary one is more efficient and gives a lot more information about the crime, so we considered it and to make it meaningful. To correct the ternary relationship we added Criminal_ID to the Weapon Usage entity. (Weak entity should have a foreign key along with a partial key for identifying). Crime ID and Criminal ID together as partial key needed to find about weapons.

Weapon Usage:

Attribute	Data type	Constraints	Description
Crime ID	Varchar (50)	Partial Key	This is linked to the “Crimes” entity through the Crime ID attribute
Criminal ID	Varchar (50)	Partial Key	This is linked to the “Criminals” entity through the Criminal ID attribute
No. of gunshots	Integer	Not Null, Default: 0	
No. of bombs	Integer	Not Null, Default: 0	
No. of knives	Varchar (25)	Not Null, Default: 0	
No. of Batarangs	Date and Time	Not Null, Default: 0	

Assumption: We are assuming that if a crime takes place then one of the four weapons mentioned in the table would have been used. Due to that fact that they have been used in the original table. If there is a weapon used not mentioned here, the table will not capture. That is a design choice in the original document.

8. Here Crime ID will act as a partial key to get the data about people involved.

People Involved:

Attribute	Data type	Constraints	Description
Crime ID	Varchar (50)	Partial Key	This is linked to the “Crimes” entity through the Crime ID attribute
Victims [Multi-valued attribute]	Varchar (50)	Not Null	Contains the Citizen ID of the victims (the dead and injured people)
Eyewitnesses [Multi-valued attribute]	Varchar (50)	Not Null	Contains the Citizen ID of the eyewitnesses
Criminals [Multi-valued attribute]	Varchar (50)	Not Null	Contains the Criminal ID of the criminals (regardless of their health/living status)

9. Here Crime ID will act as a partial key to get data about Emergency services.

Emergency services at the crime scene

Attribute	Data type	Constraints	Description
Crime ID	Varchar (50)	Partial Key	This is linked to the “Crimes” entity through the Crime ID attribute
Police	Binary (yes/no)	Not Null	
Ambulance	Binary (yes/no)	Not Null	
Firefighters	Binary (yes/no)	Not Null	
Batman	Binary (yes/no)	Not Null	

Law enforcement agency (Police + Lawyer)

The team has assumed that Law enforcement included Police and Lawyer. However, they had Law officer as an attribute. This had been modified to include either Police officers or Law officer.

Attribute	Data type	Constraints	Description
Photo ID	Multimedia	Not Null	
Law/Police officer ID	Varchar (50)	Primary key	Contains values like LE101, LE102 etc.
Name [Composite attribute: First name + Middle name + Last name]	Varchar (30) for each field	First name and Last name: Not Null Middle name: Can be null	
Sex	Varchar (25)	Can be Null	
Date of Birth	Date and Time	Not Null	
Occupation	Binary (Lawyer/Police)	Can be Null	Has to be either a lawyer or a police

Original Table

	Relationship type	Participating entities	Cardinality ratio	Degree
1.	Criminals commit a crime	Criminals, Crime	N:1	2

2.	A Criminal commits crime(s)	Criminals, Crime	1:N	2
3.	Crimes are committed in a locality	Crime, Locality	N:1	2
4.	A crime is committed in different localities	Crime, Locality	1:N	2
5.	A crime can involve multiple people present at the crime scene.	Crime, People Involved	1:N	2
6.	The person present in at least one crime scene can be involved in multiple crimes.	People Involved, Crime	1:N	2
7.	Each Crime can be reported by multiple Emergency services.	Crime, People Involved	1:N	2
8.	Crime is committed by Criminals at a location.	Crime, Criminals, Locality	1:N:1	3
9.	Crime is committed by Criminals using different weapons.	Crime, Criminals, Weapons	1:N:M	3
10.	Emergency services arrive at a location when a crime takes place .	Emergency services at a crime scene, Locality, Crime	N:1:1	3
11.	Criminals use weapons in a crime to harm citizens	Criminals, Weapon usage, Crime, People Involved	N:M:1:P	4
12.	A lawyer is assigned to criminals	Law enforcement, Criminals	1:N	2
13.	A police officer arrests the criminals of a crime	Law enforcement, Criminals, Crime	1:N:1	3

Changes made to Relationships

	Relationship Name	Participating entities	Cardinality	Min/Max	Reason
1.	Commits Degree:2	Criminals, Crime	M: N	Criminal: (1, N) Crime: (1, N)	A Criminal can commit multiple Crimes. A Crime can be committed by multiple Criminals.
2.	Involve Degree:2	Crime, People Involved	M: N	Crime: (1, N). People Involved: (1, N).	A Crime can involve multiple People. A person can be involved in multiple Crimes.

3.	Reported Degree:2	Crime, Emergency Services at a crime scene	M: N	Crime: (1, N). Emergency Services at a crime scene: (0, N).	A Crime can be reported by multiple Emergency Services. An Emergency Service can report 0 or multiple Crimes. All events that emergency services respond to are not crimes (eg: natural disaster)
4.	Crime_Info Degree:3	Crime, Criminals, Locality	M: N: P	Crime: (1, N). Criminal: (1, N). Locality: (0, N).	A Crime can involve multiple Criminals. A Crime can take place at one or more Locations. A Criminal can commit multiple Crimes. A Location can be the scene for multiple Crimes.
5.	Weapon_Used Degree:3	Crime, Criminals, Weapon Usage	M: N: P	Crime : (0, N). Criminal: (0, N). Weapon Usage: (0, N).	A Crime can be committed by multiple Criminals. A Crime can involve multiple Weapons. A Criminal can commit multiple Crimes. A Weapon can be used in multiple Crimes.
6.	Response_From Degree:3	Emergency services at a crime scene, Locality, Crime	M: N: P	Crime (for Emergency Services at a crime scene): (1, N). Crime (for Locality): (1, N).	A Crime can occur at one or more Localities. A Crime can involve multiple Emergency Services. A Locality can have multiple Crimes. An Emergency Service can respond to multiple Crimes.
				Emergency Services at a crime scene: (0, N). Locality: (0, N).	

7.	Arrests Degree:3	Law enforcement, Criminals, Crime	M:N: P	Crime (for Criminals): (1, N). Crime (for Law enforcement): (1, N). Law enforcement: (0, N). Criminal: (1, N).	A Police Officer can arrest multiple Criminals. A Criminal can be arrested for multiple Crimes. A Crime can involve multiple Criminals. Multiple Police Officers can be involved in the arrests related to a single Crime.
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Changes made in Relationships

- 1.The binary relationship Crime Locality is deleted as explained above to incorporate more information about the crime committed.
2. The quaternary relationship involving Criminals, Weapon usage, Crime, and People Involved is removed as there are already relationships with Crime and People Involved and Crime, Criminal, Locality. People Involved as a whole is related to a crime and not specifically to a criminal. This relationship provide no additional information that is not already included.
- 3.The binary relationship including Law enforcement, Criminals is removed. The ternary relationship with Law enforcement, Criminals, Crime is preserved. If a law enforcement officer need information about a crime, they need to not only know about the Criminals involved but also the Crime committed.

Deletions made

1. The second relationship involving Crime and Criminal is removed. The relationship can be captured with the Commits relationship. A second relationship describing the same is redundant and unnecessary.
2. The relationship between Crime and Locality is completely deleted and not incorporated in any way as it provides no additional information.
3. The relationship between Crime and People Involved is renamed to Involve. This is a single relationship between the entities participating with the necessary constraints providing information about the people involved in a crime. Relationship 6 and 7 are redundant. They are merged into one.
4. The original document specified a relationship described as follows: ‘Each Crime can be **reported** by multiple Emergency services.’, including the entities Crime and People Involved. This is incorrect according to the definition of the relationship the team has defined. We modified the entities involved to Crime and Emergency Services at a crime scene. The relationship is named Reported.

How easy is it to model the mini-world with these requirements?

Designing the ER diagram with the given entities and relationships was moderately complex. The following issues occurred while trying to incorporate identities and relationships in our ER diagram:

Attributes in entities: Entities like Crime, Locality, and Weapon Usage were not clearly defined with lots of redundancies in attributes in entities such as People Involved. Entities like Locality were left incomplete with no foresight of the relationships the entity was involved in. Attributes in People Involved are unnecessary. A simple Type of person involved suffices. Similar issues are faced in Weapon Usage.

Simple and intuitive binary relationships: Most interactions between entities are straightforward and easy to represent. Few binary relationships are redundant and do not provide additional information about the relationship with regards to the entities involved. Since ternary relationships with the entities have already been included. Similar issue was faced with the quaternary relationship defined.

Appropriate use of weak entities: The model effectively uses weak entities where necessary, with clear foreign key references (in some cases) that enhance the model's accuracy. But they didn't mention some required attributes, including few foreign keys in weak entities. Few weak entities are in ternary relationships having relation with only one strong entity, to preserve the relationship we added attributes to the weak entities to validate the relationship given.

Scalability: The model, after few modifications, allows for easy extension by adding new entity types like Investigators, Incidents, etc., ensuring it can grow without major redesigns. We didn't add any entity or relationship because it will change the database.

Since they didn't mention some attributes in entities which are required and also there are some redundant relationships which are not required we added some attributes and removed the unnecessary relationships.

Limited flexibility for client-investigator interaction: The model restricted the flexibility of assigning multiple crimes to one investigator or vice versa, which could pose a problem in more complex scenarios. It is a basic thing in any police department.

Note:

1. To represent partial participation of an entity in a relationship, we used arrows to connect entity and relationship. Please ignore this and consider them to be normal lines without arrows.

