Database Design and Creation - Assignment 1

Part A – Topic Description

1. System Specification Document

Philpott's Farm is a local, small-scale farm situated within the county of Bath. The farm is renowned for the excellent quality of crop production and cow farming. However, the farm owner and manager believe a database and digital framework of the farm may be effective in improving the farms production levels. Following an inquest, a database and digital framework of the farm organisational system has been created with the intention to improve the farm's efficiency and therefore optimise production levels. The following report contains a conceptual Entity-Relationship Diagram (ERD), as well as, substantial additional information needed to allow detailed description, construction, analysis and evaluation of the proposed farm system. Over the past 15 years, it is noted that computer software systems are becoming increasingly more important to improving an organisations efficiency through effectively organising, analysing and monitoring farm systems (Kaloxylos et al.,). Computer software systems, by performing such tasks as an Entity-Relationship Diagram (ERD), have been observed to not only benefit the current efficiency and safety of a farm system, but also greatly increase the viability of the farms sustainable economic, social and environmental growth. Therefore, improving efficiency is key to optimising an organisations productivity. Farms with a similar organisational structure can adapt this initial conceptual framework to then implement it in a way which would be relevant to their individual farming system.

The detailed analysis of a farm's systematic framework is essential in providing support to the farm owner and manager, together with all employees working within the organisation. Analysing the farm's organisational framework is designed to increase in the information sharing of how the farm is operated, including the management of livestock and agricultural based crop cultivation for potential administrative organisations, as well as, the farm owner and their employees. Farm management can be defined as the process of achieving the optimal functionality of the resources within a system (J.Dillon, D.McConnel. 1997).

In addition to providing a clear and detailed structure of the business, the most significant objective of the organisations conceptual framework is to optimise how the farm is operated. Optimisation of the farm can be considered as efficiently utilising the farms available resources, with the objective of meeting the farm owners physical, environmental and socio-economic aspirations. One of the critical aspirations outlined by the farm owner is to have an organisation which provides equal opportunity to both genders. This can be assessed using the ERD to calculate the total many female employees in relation to male. It has been decided that the organisation must contain a female workforce of at least 33% of total employees.

A significant importance of analysing the farm's organisational framework is to improve the communication of farm information as it will greatly benefit the farms efficiency in livestock and crop production. Recording information regarding the livestock is particularly critical to a farm, this is as structure and controlled management is vital to reduce spreading of potential infectious diseases which can sometimes be carried by livestock. It has been noted that insufficient, untraceable information of livestock has been attributable to widespread epidemics (Hirata et al., 2014). Together with reducing the potential of spreading diseases, obeying to the Good Agricultural Practice (GAP) certifies the products produced within a farm system are safe and suitable for their intended use (Food and Agriculture Organisation Of The United Nations, 2014).

2. Table of Entities

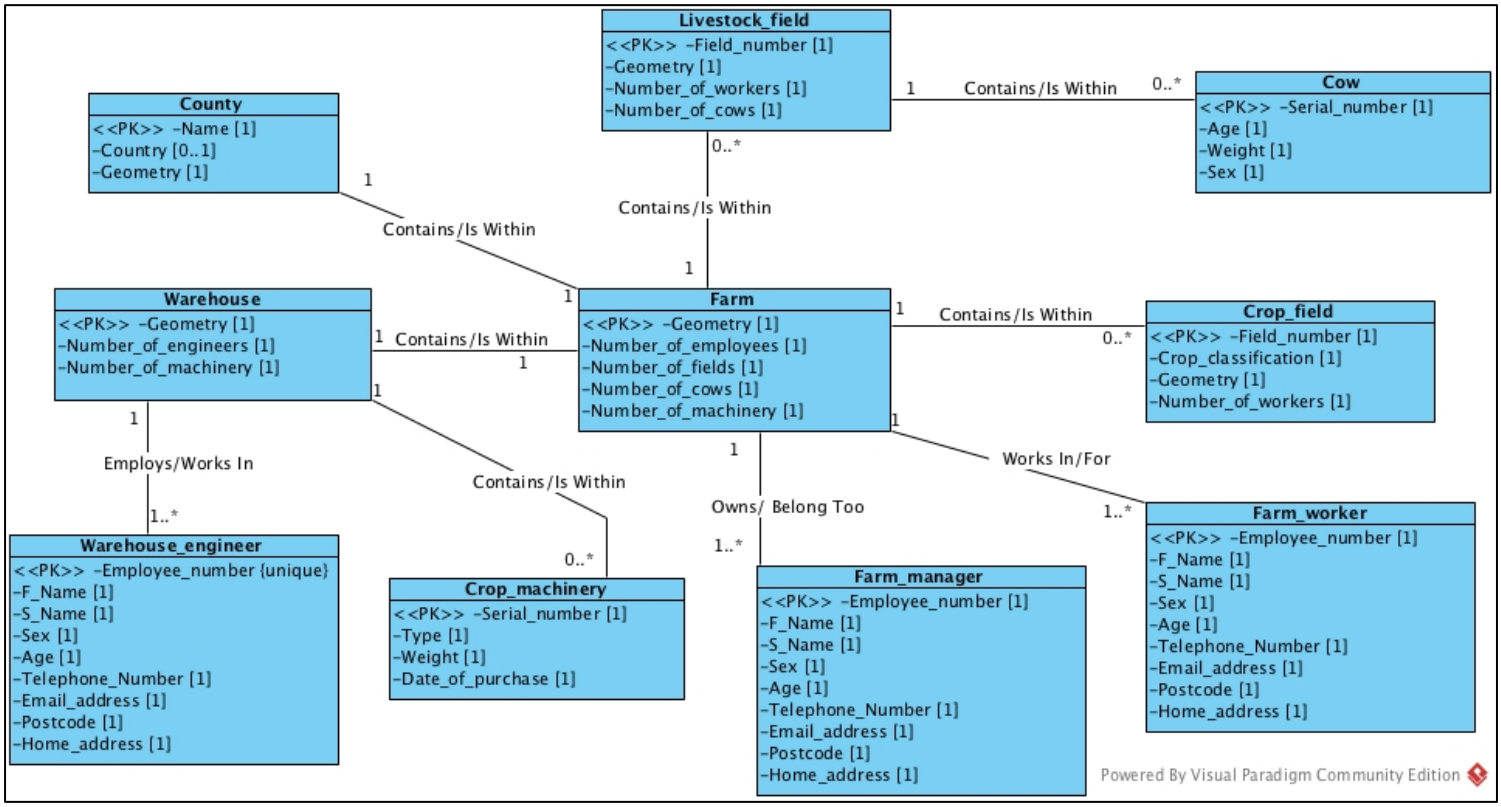
Entity #	Entity Name	Spatial	3D
1	County	Yes	No
2	Farm	Yes	No
3	Warehouse	Yes	Yes
4	Warehouse_engineer	No	No
5	Crop_machinery	No	No
6	Farm_manager	No	No
7	Farm_workers	No	No
8	Livestock_field	Yes	No
9	Crop_field	Yes	No
10	Cows	No	No
Total	**10**	**5**	**1**

3. Table of Functional Requirement

Requirement #	Requirement	Entity or Entities Required	Spatial Query	Join
1	Determine the total volume of the Warehouse.	Warehouse	Yes	No
2	Find out the maximum distance from a field to the Warehouse.	Warehouse Livestock_field Crop_field	Yes	Yes
3	Determine the combined total surface area of all the fields in the farm.	Livestock_field Crop_field	Yes	Yes
4	Determine the total length of fence around the largest field.	Livestock_field Crop_field	Yes	Yes
5	Determine how many Farm workers work on a Livestock field.	Farm_Worker Livestock_field	Yes	Yes
6	Find out which crop machinery has the oldest date of purchase.	Crop_machinery	No	No
7	Determine if the female employees contribute to more than 33% of the total farm workforce.	Warehouse_engineer Farm_worker Farm_manager	No	Yes
8	Count the number of cows are over 10 years of age.	Cow	No	No
9	Determine how many crop machinery items are over 5 years old.	Crop_machinery	No	No
10	Determine which crop type has the largest potential yield based on surface area.	Crop_field	Yes	No
Total	**10**	**N/A**	**6**	**5**

Part B – Conceptual Design

a) E-R Diagram:



b) Full Documentation for the E-R diagram

i) Descriptions for each entity and relationship, including cardinality of relationships and of attributes and identifiers

Livestock_field

The Livestock_field entity comprises a collection of agricultural land polygons to provide space and grazing for cows. Each Livestock_field polygon is bordered by a fence that comprises the geometric perimeter of the land parcel. The cardinality relationship between the Livestock_field and the Farm entity show a many-to-one relationship, where many Livestock_fields may be contained within the farm. Similarly, the Livestock_field is also associated with the Cow entity, having an one-to-many cardinality, where zero-many cow entities can be found within one Livestock_field. The Livestock_field entity attributes specify geospatial properties such as area and geometry. Additionally, the Livestock_field entity also contains information for both the number of workers and cows contained within each livestock field. The attribute Field_number is used as a Primary Key in order to uniquely distinguish each field.

Cow

The Cow entity represents the typical farm animal, the cow. The entity contains attributes which describe the identity of an individual cow (Age, Weight, Sex), as well as, using the Serial_number attribute as a Primary Key in order to easily identify each cow. The Cow entity only has one singular relationship, that with the

Livestock_field entity. This is a many-to-one, where zero-many cows can be contained within one Livestock_field.

County

The County entity represents the mass of land one of the constituent counties of England, from which the farm is located within. The County entity contains further spatial information in the geometry attributed, associated with this county. The Name attribute within the entity is used as a Primary Key as this is the only county named this. The County entity has a direct one-to-one relationship with the Farm. This is due to one of the constraints of the database, that the database and framework is designed for the purpose of a singular farm, additionally, only one county is available in conjunction with an assumption, being the farm can only be located within a single county.

Warehouse

The Warehouse entity is a 3-D polyhedron that is used to store and maintain the machinery used to cultivate the farm crops. The entity contains several spatial information such as the postcode and geometry, the second of which is used as the Primary Key identifier. The Warehouse entity has a one-to-one relationship with Farm entity, as the only Warehouse (in conjunction with the assumptions) is located within the Farm boundaries. The Warehouse entity also has crop machinery located within the Warehouse, where zero-many machines are contained within the one warehouse. The Warehouse also has a cardinality relationship with the Warehouse_engineer entity. This relation is one-to-many, where the singular warehouse employs many (minimum of one) warehouse engineers.

Warehouse_engineer

The Warehouse_engineer entity summarises all the engineering employees required to operate and provide maintenance to the crop machinery stored within the Warehouse. Each engineers are given an Employee_number which provides a unique Primary Key identifier in order to reliably select, identify and monitor a single employee. The other attributes contained within this entity contribute personal information about each individual employee. The Warehouse_engineer entity's only primary relationship is with the Warehouse from which many warehouse employees work within the one warehouse (many-to-one cardinality, where the many must have a least one).

Crop_machinery

The Crop_machinery entity represents the machinery required to perform the crop cultivation in the crop field's entity, performed by the Farm worker's. The machinery is stored within the Warehouse, as can be seen from cardinality relationship between the two entities, where zero-many machines are contained within the singular Warehouse, giving a many-to-one relationship. Each machinery is given a serial-number, which is then used as the Primary Key identifier. Every crop machinery is also associated with other attributes such as: type of machinery, weight, and the date of purchase.

Crop_field

The Crop_field entity is a assembly of agricultural land polygons which are used for the purpose of growing and cultivating crops. Each Crop_field polygon is bordered by a fence that comprises the geometric perimeter of the land parcel. The entity has attributes such as: geometry, area, number of workers associated to each field, the crop classification describing what crop type is cultivated in that field, and the Primary Key of Field_number to give a unique ID for each field within the entity. Crop_field has one direct relationship with the Farm entity, the cardinality of this relationship is a many-to-one, where zero-many crop fields are contained within the Farm.

Farm_manager

The Farm_manager entity provides personal information regarding the manager of the farm. The same attributes used to create individuality and uniqueness between employees is used within the farm manager entity. These attributes are as follows: Employee_number, F_Name (Forename), S_Name (Surname), Sex, Age, Telephone Number, Email address, Postcode, Home_address. The Employee_number is used as the unique Primary Key identifier. The Farm_manager's only cardinality relationship is a many-to-one with the Farm, where the Farm_manager entity must contain a minimum of 1 employee that owns the farm.

Farm_worker

The Farm_worker entity comprises the personal information of each employee within the farm department required to make them uniquely identifiable. The attributes within the Farm_worker entity as the same as those as from Farm_manager and Warehouse_engineer. Each farm worker is given an Employee_number as it provides a unique Primary Key identifier. The Farm_worker entity has one relationship with the Farm entity. The relationship has a cardinality of many-to-one, where at least one but many farm workers work in the Farm.

Farm

The Farm entity is the main conceptual component of the Entity-Relationship Diagram as it has relationships with many of the other entities within the database. The Farm entity has spatial information stipulated by the geometry. Additionally, the Farm entity contains summary information on data from other entities such as, total; number of employees, number of fields, number of cows, and number machinery. Due to one of the constraints of the database, there is only one Farm entity, allowing the farm's geometry to be used as the Primary Key identifier. This results in every cardinality relationship the Farm entity is involved in, the Farm entity has 1. The farm is directly related to the following entites: Livestock_field, Crop_field, Farm_worker, Farm_manager, Warehouse, and County. Only County and Warehouse have a one-to-one cardinality with the Farm entity, all others mentioned have a one-to-many.

ii) Descriptions of any business rules and integrity constraints associated with the diagram

The following list details any constraints and reasons for this constraint specified within the database framework and ER-diagram:

- A maximum of 10 cows can be contained within a single field.
    - This is to ensure a high quality of living is given to every cow on the farm, and consequently helps to minimise risk of spreading potential diseases.

- Any field, both livestock and crop fields, cannot being in excess of 5 miles from the Warehouse or Farm.
    - This allows the fields to be easily accessible from both the warehouse and the farm when necessary.

- Every farm worker employee is assigned a single field, either a livestock or crop field. The employee is then only responsible for this one field, and consequently each field is assigned only a single farm worker employee.
    - This allows the user of this database to monitor and assess the quality and quantity of product produced by each farm worker employee.

- Any crop machinery which has a date of purchase excess of 5 years must receive quarterly maintenance evaluations.
    - Reduces the probability of a faulty machinery, ensuring the machinery is safe for the employees to use.

- Every employee must be minimum of 18 years of age.
    - Ensure safe working conditions for every employee.

- The employee workforce of the farm must consist of a minimum of 33% women. This meaning that for every two male employers, there must be a minimum of one female employee.
    - Promotes equal opportunities to women than men within the industry.

iii) Any derivations, information calculated from stored data or mathematical formulae that are required to fulfil the system brief

- The geometry attribute is a collection of many spatial attributes, including location, area, perimeter, and volume.
- Serial number, employee number, and field number are randomly generated figures. All have a minimum of 5 numbers, and a maximum of 7 numbers.

iv) Any assumptions made

The following list provides additional details of any derivations, information calculated from stored data or mathematical formulae, specified within the database framework and ER-diagram:

- There is only one county for this database. Each entity can only be contained within this County.
- The database framework is designed to work for a singular farm system.
- There is only one warehouse on the farm.
- The warehouse building is modelled as a 3D polyhedron.
- An employee can only be part of one department, either Warehouse Engineer or Farm Worker.
- When measuring the distance from a field to both the warehouse and farm, the measurement is taken from the centroid of the polygon.
- The land type for each crop field is not seasonal and therefore only land type is necessary.
- The farm can only be located within a single county of England.
- Each input in attribute Serial_number from the Cow entity is unique.
- Each input in attribute Field_number from Crop_field and Livestock_field entities is unique.
- Each input in attribute Employee_number from Farm_worker, Farm_manager and Warehouse_engineer entities is unique.

- Each input in attribute Serial_number from the Crop_machinery entity is unique.
- Every employee in attribute 'Sex' identifies as male or female.
- The data input for the attribute Crop_classification within the Crop_field entity must be chosen from one of the following classifications: Cereals, Vegetables, Fruit and Nuts, Oilseed, Root, Spice, Leguminous, Sugar, Other. Classifications derived from Food and Agriculture Organisation Of The United Nations (2010).
- The data input for the attribute 'Type' within the Crop_machinery entity must be chosen from one of the following options: Plough, Fertiliser, Seed planter, Tractor.
- The data input for the attribute 'Name' within the County entity, must be chosen from one of the official 48 ceremonial counties of England.

Reference List

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