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Title: Milk procurement route optimisation using GIS in a farmers' diary organisation

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Introduction:

Geospatial technology has been effectively used in route planning. Using GIS technology, it is possible to depict milk procurement routes on digitized maps and the process of visualizing alternative milk routes can be made easier in comparison to the current manual processes. It is accepted world over that vehicle route planning is a difficult combinatorial optimization problem which needs to be addressed in supply chain management, especially when the raw material has to be sourced from geographically widely dispersed areas.

Context:

The quantity of milk procured from the villages, by any dairy organisation is one of the most critical factors in its overall planning of activities. Milk procurement activities are spread over large geographical areas and it involves a large number of far flung village level dairy societies and thousands of farmers who are members of these societies. Milk procured from villages has to be transported to a chilling station or bulk milk cooler for temporary storage and then further to a dairy for processing and packaging.

The milk procurement routes of the dairy organisation are normally planned with the twin objectives that the volume of milk procured/Km is maximised and at the same time the cost of milk procurement/litre is minimised, under the given set of its current constraints. Further, seasonal or economic constraints may lead to variation in these milk routes.

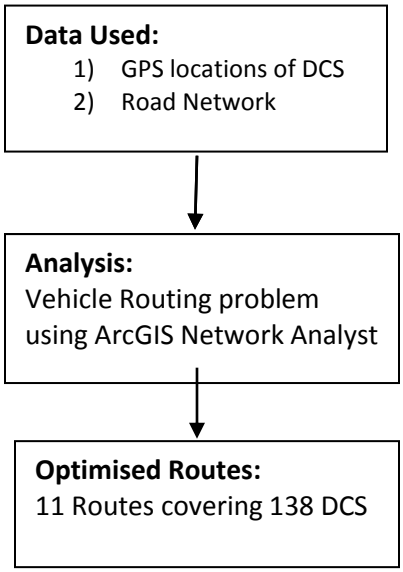
This paper would present a case study approach for milk procurement route optimisation using GIS in a farmers' diary organization.

For this case study, 138 village level societies of a typical farmers' dairy organization Maharashtra has been considered, which procured milk at a particular point in time and delivered it to the nearest dairy plant in the city.

The purpose of the study was to explore the possibilities of introducing GIS in a farmers' organization for milk procurement route optimization and to understand the practical problems, which are likely to be encountered in introducing latest technology in such an environment.

Methodology:

Methodology Flow Chart:



Description of Methodology:

1. Locations of Dairy Societies and tracks of existing milk routes were collected using hand-held GPS device. Village level milk route supervisors were trained to use the hand held device “on-the-fly” for 2-3 days by moving on the milk procurement vehicle and saving routes and milk pickup points on those routes. The Locations of Dairy Societies and the existing routes were then plotted on map (Fig.1).

2. Training was also imparted here to the MIS staff of the organization so that it can be managed by them on their own. Thus, they could send the collected raw data to us for final processing.

3. Updated road network was modeled in the Network Analyst.

4. Vehicle Routing utility of ArcGIS Network Analyst Extension was used to optimize the routes.

5. Details about Vehicle type, Carrying capacity, Maximum travel distance; Maximum orders were given as input (Fig 2).

6. Buffer of 1500 meters was given to locate the pickup points along the road network.

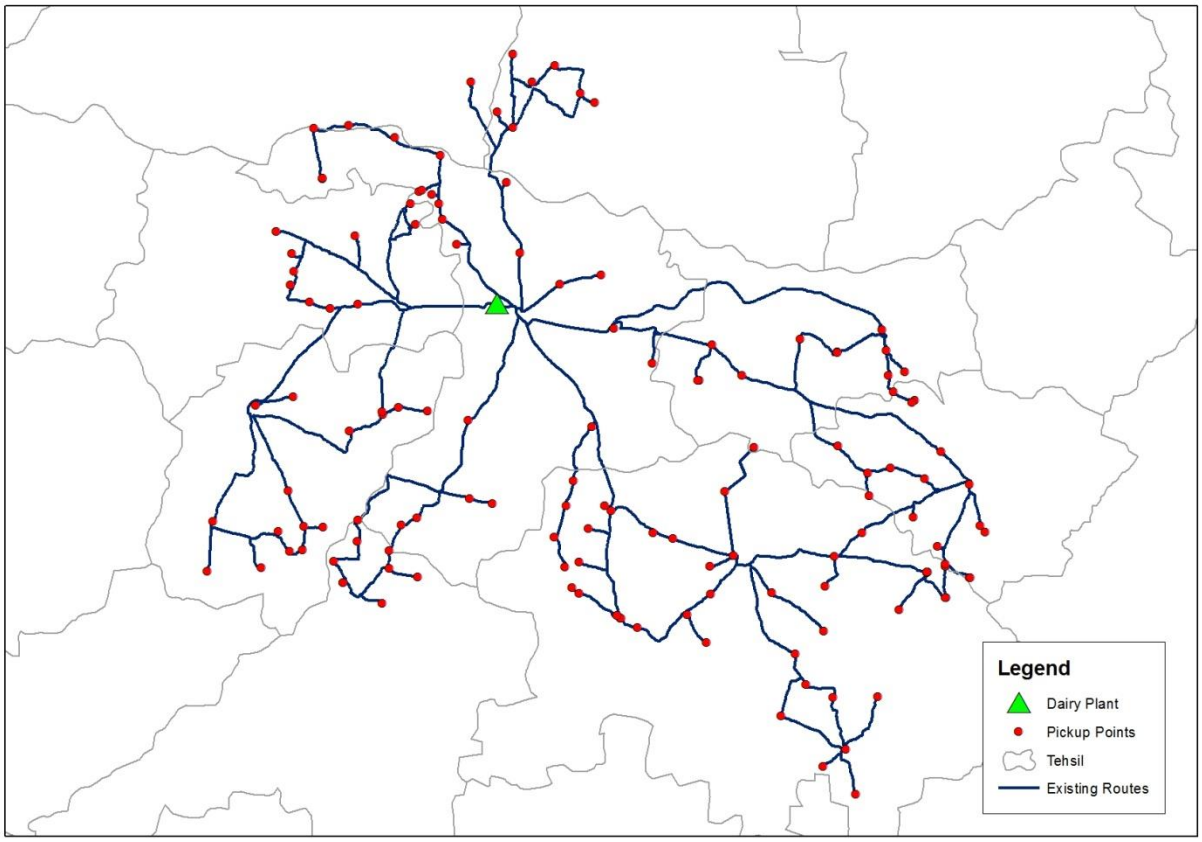


Fig 1. Existing Milk collection routes

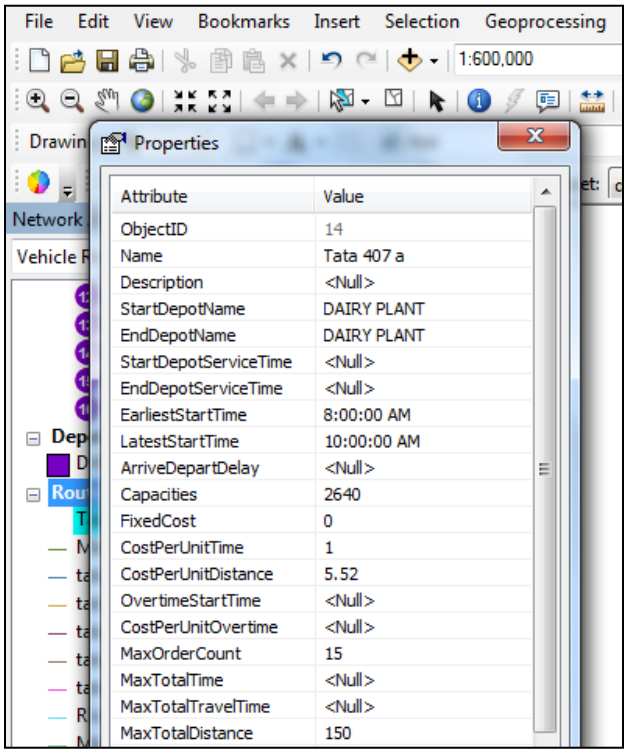


Fig 2. Inputs for Vehicle routing problem.

Results:

The total distance covered by existing milk routes for procuring 10,800 Kg/shift was 1445 km and there were 13 routes with various capacities of vehicles (Table 1). After optimization the total distance could be reduced to 1351 km with 11 routes (Table 2). Savings in transportation cost per shift is Rs. 504. We also observed that the optimized routes engage different vehicle type and visit different collection points compared to existing routes (Fig 4).

Challenges in implementation:

1. The availability of an updated village level road network is a major bottleneck as it is a crucial input for the route optimization softwares. Though, our intention was to use the entire possible road network for optimization, the exercise was finally done only for the road networks as could be captured by the village level supervisors.

2. Farmers' organization has more pronounced challenges in recruiting and retaining of employees having IT background. However, collecting field level through GPS is not a difficult task, as the existing village level supervisors can use the handheld GPS device easily.

3. Utilising the route optimization software by itself is a small part of the problem, the bigger problem is organization of a proper database and keeping it updated for analysis in real-time.

Tab1. Existing route details

Route Name	Vehical type	Trip distance (km)	Trip cost
1	TATA 407	119	657
2	MAX 207	91	521
3	TATA 407	108	596
4	TATA 407	156	874
5	TATA 407	114	645
6	TATA 407	141	835
7	TATA 407	143	847
8	RIKSHAW	24	112
9	Max Mah	102	574
10	TATA 407	114	612
11	TATA 207	100	588
12	Max Mah	173	862
13	MINI DOR	60	358
	TOTAL	1445	8080

Tab 2. Optimised routes detail.

Route Name	Vehical type	Trip distance (km)	Trip Cost
1	Max Mah	145	722
2	Max Mah	130	732
3	Max 207	130	744
4	Tata 407	83	458
5	Tata 407	117	646
6	Tata 407	101	566
7	Tata 407	62	351
8	Tata 407	146	864
9	Tata 407	148	876
10	Tata 407	149	800
11	Tata 407	139	817
	Total	1351	7576

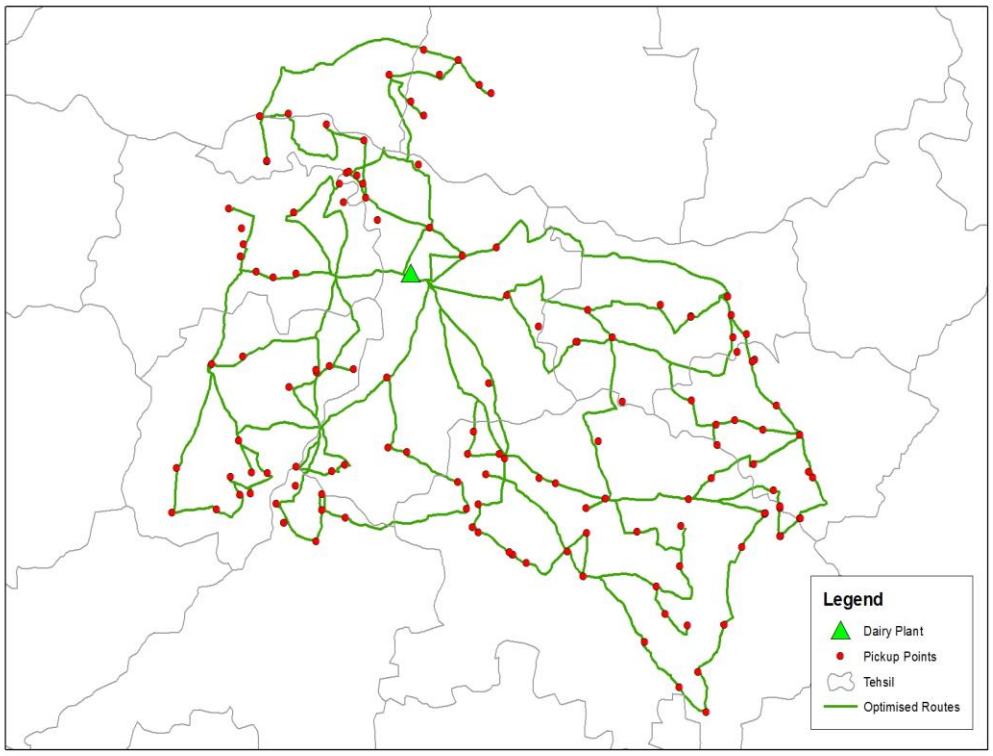


Fig 3. Optimised Milk collection Routes.

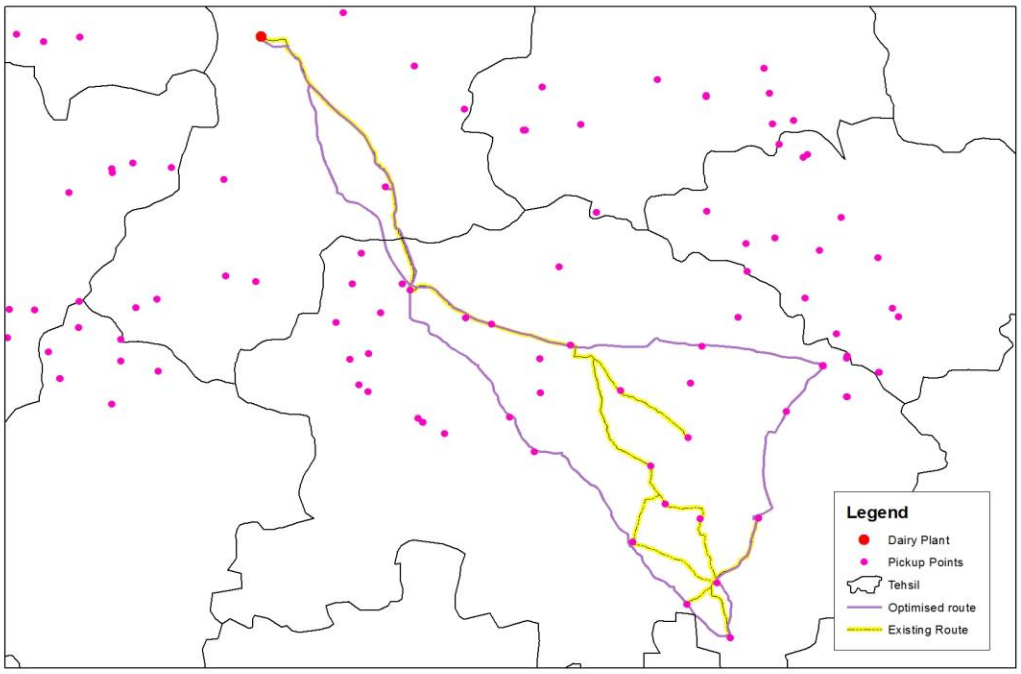


Fig 4. Existing and Optimised route example

Conclusion:

It was observed that implementing GIS technology in a farmers' organization would be quite beneficial given the current scenario of availability of cost effective hardware & software, given proper support and training is provided. Initial hand holding with the manpower and deployment of user friendly softwares is also required.

The main learning from this case study was that GIS technology can be effectively used by farmers' organization to validate the efficacy and design of their existing milk collection routes and also to discover scope for improvement.

Thus, using GIS technology for milk procurement route optimization would make significant contribution to these dairy organizations in terms of savings in money and time along with its concomitant reduction in CO_2 emission in the environment.