

Methods and systems for selecting site(s) using geospatial modelling

TECHNICAL FIELD

[001] Embodiments disclosed herein relate to geospatial modelling, and more particularly to selecting a suitable site using geospatial modelling.

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BACKGROUND

[002] Current solutions use geospatial modelling for selecting a site for an application. The site is typically selected manually, wherein a user can manually scan/view the maps to decide on a suitable location.

OBJECTS

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[003] The principal object of embodiments herein is to disclose methods and systems for selecting a physical site using geospatial modelling data for deploying one or more solutions based on a plurality of parameters comprising, but not limited to, travel demand, energy availability, route patterns, traffic dynamics, and so on.

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[004] These and other aspects of the embodiments herein will be better appreciated and understood when considered in conjunction with the following description and the accompanying drawings. It should be understood, however, that the following descriptions, while indicating at least one embodiment and numerous specific details thereof, are given by way of illustration and not of limitation. Many changes and modifications may be made within the scope of the embodiments herein without departing from the spirit thereof, and the embodiments herein include all such modifications.

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BRIEF DESCRIPTION OF FIGURES

[005] Embodiments herein are illustrated in the accompanying drawings, through out which like reference letters indicate corresponding parts in the various figures. The embodiments herein will be better understood from the following description with reference to the drawings, in which:

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[006] FIG. 1 depicts a system for selecting at least one physical site using geospatial modelling data for deploying one or more solutions in the at least one selected physical site based on a plurality of parameters, according to embodiments as disclosed herein;

5 [007] FIGs. 2a and 2b are flowcharts depicting a process for selecting at least one physical site using geospatial modelling data for deploying one or more solutions in the at least one selected physical site based on a plurality of parameters, according to embodiments as disclosed herein;

10 [008] FIGs. 3a and 3b are example flowcharts depicting a process of determine an optimal number of battery swapping stations and their locations for a given geographical bounded region, according to embodiments as disclosed herein;

[009] FIG. 4 depicts an example plot of avg. distance with the selected number of potential locations, according to embodiments as disclosed herein;

15 [0010] FIG. 5 illustrates a plurality of components of the data management engine, according to embodiments as disclosed herein; and

[0011] FIG. 6 depicts an example region of interest with related metadata, according to embodiments as disclosed herein.

DETAILED DESCRIPTION

[0012] The embodiments herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

[0013] The embodiments herein achieve methods and systems for selecting a physical site using geospatial modelling data for deploying one or more solutions based on a plurality of parameters comprising, but not limited to, travel demand, energy availability, route patterns, traffic dynamics, and so on. Referring now to the drawings, and more particularly to FIGS. 1 through 6, where similar reference characters denote corresponding features consistently throughout the figures, there are shown embodiments.

[0014] Embodiments herein may be described and illustrated in terms of blocks which carry out a described function or functions. These blocks, which may be referred to herein as units or modules or the like, are physically implemented by analog and/or digital circuits such as logic gates, integrated circuits, microprocessors, microcontrollers, memory circuits, passive electronic components, active electronic components, optical components, hardwired circuits and the like, and may optionally be driven by firmware and/or software. The circuits may, for example, be embodied in one or more semiconductor chips, or on substrate supports such as printed circuit boards and the like. The circuits constituting a block may be implemented by dedicated hardware, or by a processor (e.g., one or more programmed microprocessors and associated circuitry), or by a combination of dedicated hardware to perform some functions

of the block and a processor to perform other functions of the block. Each block of the embodiments may be physically separated into two or more interacting and discrete blocks without departing from the scope of the disclosure. Likewise, the blocks of the embodiments may be physically combined into more complex
5 blocks without departing from the scope of the disclosure.

[0015] Embodiments herein can determine an optimal number of sites and their corresponding location for a given geographical bounded region. In an example scenario, consider that the site is for a battery swapping station, embodiments herein can select the site such that vehicle travel time/cost to come
10 to the station for battery swapping can be minimized.

[0016] FIG. 1 depicts a system for selecting at least one physical site using geospatial modelling data for deploying one or more solutions in the at least one selected physical site based on a plurality of parameters. The system 100, as depicted, comprises a modelling engine 101. The modelling engine 101 can be
15 connected to a plurality of sources, such as one or more sources of geo-spatial data 102, one or more sources of data 103 (such as user preferences, pre-configured options, site characteristics, and so on), one or more interfaces 104, and so on.

[0017] The geo-spatial data source 102 can comprise of one or more
20 sources of geo-spatial data or maps. The data source 103 can be at least one of a network (such as the Internet), a file server, a data server, a Cloud, and so on. The data source 103 can be connected to the one or more sources of geo-spatial data 102.

[0018] The interface 104 enables one or more authorized user(s) to interact
25 with the modelling engine 101. Examples of the user interface 104 can be, but not limited to, at least one switch, a keyboard, a mouse, a touchscreen display, and so on. The interface 104 enables the user to input, modify and/or view data such as the pre-defined geographical area, number of cells, parameters, categories, weightages, fetched and populated data, required number of swapping stations in
30 a given locality (such as a city, town, locality, cell, and so on).

[0019] The interface 104 enables one or more external entities to interact with the modelling engine 101. The interface 104 can use at least one of a wired and/or a wireless interface to communicate with the at least one external entity. Examples of the external entity can be, but not limited to, the source(s) of geo-spatial data 102, the data source 103, and so on.

[0020] The modelling engine 101 can comprise of an initialization module 101a, an estimation engine 101b ,and a selection engine 101c. The initialization module 101a can fetch data related to a pre-defined geographical area (such as a city, town, state, a locality, and so on) from the data source 102 and/or the data source 103. The initialization module 101a can segment the geo-graphical area with a configurable grid to generate a plurality of contiguous cells.

[0021] Consider that the target end-user customers for electric vehicles that visit a swapping station for swapping are Intermediate public transport (IPT) (examples of which are, but not limited to, such as e-rickshaws , e-autos, e-bike rentals, and so on). In an example herein, the granularity was set to (1km x 1km) based on the underlying assumption is that if the destination was more than 1 km, a user is likely to use IPT. This also provides the flexibility to be further combined to make 1x2, 2x1, 2x2 or higher units based on requirement/need in future. Number of cells are decided based on size/extent of the locality/city, where a swapping station needs to be installed.

[0022] The initialization module 101a can fetch data at cell level, for factors such as, but not limited to, population, commercial index, education, employment, public transport ridership, vehicle population, and so on from the data source 102 and/or the data source 103. The initialization module 101a can populate the corresponding cell with the fetched data. The initialization module 101a can further fetch and add Places of Interest (POIs) with one or more attributes. Examples of the POIs can be, but not limited to, transit locations (such bus stops, bus routes, train stations, train routes, and so on), gas/fuel stations, power distribution pillars, stops/stands for auto-rickshaws/taxis, rental vehicles

(cars, two wheelers, scooters, and so on), E-Rickshaws, electricity distribution points, and so on).

[0023] The estimation engine 101b can estimate travel demand for each cell using parameters such as, but not limited to, population, employment, number
5 of bus stops, metro ridership and so on. The estimation engine 101b can estimate the travel demand, based on weightages assigned to contributing factors. In an embodiment herein, the weightages can be provided by an authorized user of the system.

[0024] The estimation engine 101b can compute a travel demand
10 coefficient dynamically based on the provided data. The parameters can be varied based on the city or locality being analyzed. In an example, the travel demand can use parameters such as, but not limited to, population (a1) in the pre-defined geographical area, employment (a2) opportunities/centers/locations in the pre-defined geographical area, education (a3) levels/institutions in the pre-defined
15 geographical area, commercial areas (a4) present in the pre-defined geographical area, length of bus routes (a5) in the pre-defined geographical area, metro ridership (a6) from the pre-defined geographical area, number and availability of buses (a7) in the pre-defined geographical area, and number of railway stations (a8) present in the pre-defined geographical area. The estimation engine can
20 estimate the travel demand coefficient using one or more of the parameter with their respective weightages. Weightages can be configured by an authorized user of the system. For example, the user can choose a higher weightage for the population attribute, if the user wants to give more importance to population for calculating the travel demand coefficient (TDC).

25 [0025] Assuming that the weightages have been decided as (w1, w2, w3, w4, w5, w6, w7, w8), the estimation engine 101b can compute the TDC as:

$$TDC = (a1 * w1 + a2 * w2 + a3 * w3 + a4 * w4 + a5 * w5 + a6 * w6 + a7 * w7 + a8 * w8) / (w1 + w2 + w3 + w4 + w5 + w6 + w7 + w8)$$

[0026] For Example: Metro ridership is a factor that could increase travel demand for a specific Cell. But this does not have an impact in a part of the city that is not served by Metro transportation. In a city that does not have Metro service – this is not a factor in any part of that city.

5 [0027] The estimation engine 101b can estimate an infrastructure index. The estimation engine 101b can use one or more categories from an available set for a given area such as the POIs. Each category can be assigned different weightages. In an embodiment herein, the categories and their corresponding weightages can be estimated by the estimation engine 101b. In an embodiment
10 herein, the categories and their corresponding weightages can be provided by an authorized user. The estimation engine 101b can calculate the infrastructure index (II) using the provided categories and their weightages. Infrastructure index is a measure of suitability of a cell for a given set of weightages to infrastructure Points of Interest such as, but not limited to, number of fueling stations (for
15 example, number of BPCL pumps (a1), number of IOCL pumps (a2), number of HPCL pumps (a3), number of LPG stations (a4), number of Shell pumps (a5), number of Total pumps (a6), and so on). An authorized user can set the weightages for every attribute and calculate infrastructure index as follows:

$$II = (a1 * w1 + a2 * w2 + a3 * w3 + a4 * w4 + a5 * w5 + a6 * w6) / (w1 + w2 + w3 + w4 + w5 + w6 + w7)$$

20 [0028] The estimation engine 101b can estimate a power index. The Power Index represents the suitability of a cell (pre-defined geographical area) based on contributing factor to electrical energy or power distribution points such as, but not limited to, power capacity, available capacity, power fluctuations, cost of new power connection, and so on. The estimation engine 101b can use information related to power distribution points (such as type, voltage levels, available
25 connectors, usage, availability, and so on). In an embodiment herein, the estimation engine 101b can select the power distribution points and can assign a weightage to each of the power distribution points. In an embodiment herein, a user can select the power distribution points and can assign a weightage to each of

the power distribution points. Based on distance for a location in a cell from the power distribution points, the estimation engine 101b can compute the quality of the distribution points power index. The closer the distribution point to a point in the cell, lesser would be the cost and larger the power throughput of the distribution point, the better quality and uptime.

[0029] Assuming that the weightages are assumed to be (w1,w2,w3,w4), the power index (PI) can be computed as

$$PI = (a1 * w1 + a2 * w2 + a3 * w3 + a4 * w4) / (w1 + w2 + w3 + w4)$$

[0030] The selection engine 101c can select one or more cells from the provided cells. The selection engine 101c can consider a plurality of parameters, such as travel demand, infrastructure and power. The selection engine 101c can also consider a relative weightage given to the plurality of parameters. In an embodiment herein, the selection engine 101c can determine the relative weightage given to the plurality of parameters. In an embodiment herein, a user can provide the relative weightage given to the plurality of parameters. The selection engine 101c can identify the cells in a selected area of the map. In an embodiment herein, the selection engine 101c can identify the cells in a selected area of the map automatically. In an embodiment herein, the selection engine 101c can identify the cells in a selected area of the map manually. The selection engine 101c can compute a suitability index for each cell. The selection engine 101c can grade the cells on a relative scale from most suitable to least suitable based on the computed suitability index.

[0031] The composite/suitability index can be calculated as follows (using the calculated travel demand (TDC), infrastructure (II) and energy (EI)):

$$CI = (TDC * wTDI + II * wII + EI * wEI) / (wTDI + wII + wEI)$$

where wTDI, wII, and wEI are weightages for the travel demand (TDC), infrastructure (II) and energy (EI) respectively.

[0032] Consider a scenario where a cell is categorized with high rating of suitability and there are multiple possible locations in the cell where a battery swapping station can be determined. The selection engine 101c can check the number of battery swapping station(s) required in the cell. Each cell can have one or more swapping stations, depending on requirements. The selection engine 101c can identify at least one suitable site in a cell for placing a swapping station. The selection engine 101c can further rank the identified sites based on the distance a vehicle needs to travel to reach each identified point from any point in the cell. The objective of the selection engine 101c is to minimize the travel distance to the location. In an embodiment herein, the selection engine 101c can calculate the minimum, maximum and average distance that the vehicle needs to travel to reach each identified point from any point in the cell.

[0033] FIGs. 2a and 2b are flowcharts depicting a process for selecting at least one physical site using geospatial modelling data for deploying one or more solutions in the at least one selected physical site based on a plurality of parameters. The modelling engine 101 fetches (201) data related to the pre-defined geographical area (such as a city, town, state, a locality, and so on) from the data source 102 and/or the data source 103. The modelling engine 101 segments (202) the geo-graphical area with a configurable grid to generate a plurality of contiguous cells. The modelling engine 101 fetches (203) data and POIs at the cell level with one or more attributes. The fetched data can comprise of factors such as, but not limited to, population, commercial index, education, employment, public transport ridership, vehicle population, and so on from the data source 102 and/or the data source 103. Examples of the POIs can be, but not limited to, transit locations (such bus stops, bus routes, train stations, train routes, and so on), gas/fuel stations, power distribution pillars, stops/stands for auto-rickshaws/taxis, rental vehicles (cars, two wheelers, scooters, and so on), E-Rickshaws, electricity distribution points, and so on). The modelling engine 101 populates (204) the corresponding cell with the fetched data and POIs at the cell level with one or more attributes.

[0034] The modelling engine 101 estimates (205) the travel demand coefficient. The modelling engine 101 can estimate the travel demand coefficient, based on weightages assigned to contributing factors. In an embodiment herein, the weightages can be estimated by the modelling engine 101. In an embodiment
5 herein, the weightages can be provided by a user. The parameters can be varied based on the city or locality being analyzed.

[0035] The modelling engine 101 estimates (206) the infrastructure index. The modelling engine 101 uses one or more categories from an available set for a given area such as the POIs. Each category can be assigned different weightages.
10 In an embodiment herein, the categories and their corresponding weightages can be estimated by modelling engine 101. In an embodiment herein, the categories and their corresponding weightages can be provided by an authorized user.

[0036] The modelling engine 101 estimates (207) the power index. The modelling engine 101 uses information related to power distribution points (such
15 as type, voltage levels, available connectors, usage, availability, and so on). In an embodiment herein, the modelling engine 101 selects the power distribution points and can assign a weightage to each of the power distribution points. In an embodiment herein, a user can select the power distribution points and can assign a weightage to each of the power distribution points. Based on distance for a
20 location in a cell from the power distribution points, the modelling engine 101 computes the quality of the distribution points power index. The closer the distribution point to a point in the cell, lesser would be the cost and larger the power throughput of the distribution point, the better quality and uptime.

[0037] The modelling engine 101 selects (208) one or more cells from the
25 provided cells. The modelling engine 101 considers a plurality of parameters, such as travel demand, infrastructure and power. The modelling engine 101 also considers a relative weightage given to the plurality of parameters. In an embodiment herein, the modelling engine 101 determines the relative weightage given to the plurality of parameters. In an embodiment herein, a user can provide
30 the relative weightage given to the plurality of parameters. The modelling engine

101 identifies the cells in a selected area of the map. In an embodiment herein, the modelling engine 101 identifies the cells in a selected area of the map automatically. In an embodiment herein, the modelling engine 101 identifies the cells in a selected area of the map manually. The modelling engine 101 computes
5 a suitability index for each cell. The modelling engine 101 grades the cells on a relative scale from most suitable to least suitable based on the computed suitability index.

[0038] If the modelling engine 101 has identified (209) at least one suitable site in a cell for placing a swapping station, the modelling engine 101
10 further ranks (210) the identified sites based on the distance a vehicle needs to travel to reach each identified point from any point in the cell. The objective of the modelling engine 101 is to minimize the travel distance to the identified site(s). In an embodiment herein, the modelling engine 101 calculates the minimum, maximum and average distance that the vehicle needs to travel to reach
15 each identified point from any point in the cell.

[0039] The various actions in method 200 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 2 may be omitted.

[0040] Embodiments herein can determine an optimal number of battery
20 swapping stations and their locations for a given geographical bounded region (such as a city, town, locality, cell, and so on). Embodiments herein can provide a subset of all candidate locations such that vehicle travel time/cost to come to the battery swapping station for battery swapping can be minimized.

[0041] FIGs. 3a and 3b are example flowcharts depicting a process of
25 determine an optimal number of battery swapping stations and their locations for a given geographical bounded region. Consider that a geographical bounded area (let us say, R) (also referred to herein as cell) has been provided with a plurality of possible potential candidate locations (L). L is set of m candidate locations i.e. $L = \{q_1, q_2, q_3, \dots, q_m\}$. Consider that the travel demand coefficient (also referred
30 to herein as travel demand index (TDI)) for intermediate public transport for a

1km*1km cell. Popular stops where vehicles are frequently parked or wait for passengers have also been identified.

[0042] The modelling engine 101 extracts (301) a sample of coordinates (latitude and longitude) from the roads inside the given region R. The modelling engine 101 associates (302) all possible candidate locations (L) with a respective TDI based on which cell they fall in. The modelling engine 101 tags (303) points in the cells as popular stops or not. The modelling engine 101 can consider points in proximity of popular stops as popular stops. Table 1 depicts an example of the prepared data.

ID	Latitude	Longitude	TDI	Popular Stop
p1	77.5946	12.9716	0.62	1
p2	77.595	12.9716	0.62	0
p3	77.5964	12.972	0.51	0
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.

Table 1

[0043] The modelling engine 101 constructs (304) a matrix of weighted distance values of all points from all the candidate locations. d_{ij} can be considered as the weighted distance between point i and a potential location j. The modelling engine 101 can give more weightage to the points falling in grid cells which are having higher TDI. The modelling engine 101 can give a higher weightage to the points which are popular stops because it is more likely for a driver to go for swapping a battery in a vehicle when there is no passenger in vehicle and it is going to be parked at some popular stop. Taking example from table 1, the

minimum road distance of p1, p2 and p3 from q1 is d11, d21 and d31 respectively. Now the distances will be modified by multiplying by ratios rTDI and rPS where,

$$rTDI_i = \frac{TDI_i}{\text{mean}(TDI)} \text{ for point } i$$

$$\text{mean}(TDI)$$

$$= \frac{\sum TDI}{n}, \text{ where } n \text{ is the total number of possible locations /points}$$

$$rPS_i = 10, \text{ if the point is a popular stop}$$

$$rPS_i = 1, \text{ if the point is not a popular stop}$$

[0044] These weightage definitions are configurable to analyze the variance in selected locations to enable selection of better locations/points.

[0045] Table 2 depicts an example of the matrix.

Potential location/points	q1	q2	q3	..	..	..	qm
p1	d11	d12	d13	..	..	..	d1m
p2	d21	d22	d23	..	..	..	d2m
p3	d31	d32	d33	..	..	..	d3m
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
pn	dn1	dn2	dn3	..	..	..	dnm

Table 2

[0046] For selecting s locations out of all m locations, the modelling engine 101 minimizes (305) the sum of weighted distances. The modelling engine 101 makes (306) multiple sets of s locations. For every set, the modelling engine 101 calculates (307) a cost function.

- 5 [0047] For a set having s locations, d_{mn} is weighted distance between point m and potential location n .

$$\text{Min. distance for point } p1(\min_{p1}) = \min(d_{11}, d_{12}, d_{13} \dots d_{1s})$$

$$\text{Cost Function, } f = \min_{p1} + \min_{p2} + \min_{p3} \dots \min_{pn}$$

- [0048] The modelling engine 101 can consider the set with minimum cost function value as the final set of s selected locations. For example, for a set of potential locations (say set A) containing s locations, the modelling engine 101
10 can consider a matrix (which is a subset of M), as depicted in the example in table 3.

Potential location/points	A1	A2	A3	..	..	..	As
p1	d11	d12	d13	..	..	..	d1s
p2	d21	d22	d23	..	..	..	d2s
p3	d31	d32	d33	..	..	..	d3s
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
pn	dn1	dn2	dn3	..	..	..	dns

Table 3

[0049] Now for every point, the modelling engine 101 calculates (308) a minimum distance from the point to any potential location from set A. For example,

$$\text{Min. distance for point } p1(\text{min_}p1) = \min(d11, d12, d13 \dots \dots d1s)$$

$$\text{Cost Function, } f = \text{min_}p1 + \text{min_}p2 + \text{min_}p3 \dots \dots \text{min_}pn$$

[0050] Now for every possible set of potential locations, the modelling engine 101 calculates (309) f. The modelling engine 101 selects (310) the set with the minimum f value as the set of total potential locations.

[0051] For the final set, the modelling engine 101 calculates (311) metrics as defined below:

$$\text{Avg. Distance} = \text{mean}(\text{min_}p1, \text{min_}p2, \text{min_}p3, \dots \dots \text{min_}pn)$$

$$\text{Max. Distance} = \text{max}(\text{min_}p1, \text{min_}p2, \text{min_}p3, \dots \dots \text{min_}pn)$$

[0052] The modelling engine 101 makes (312) the final selected sets (as described above) of different number of potential locations. Consider that S2 is a selected set containing two potential locations with the same Avg. Distance and Max. Distance. The modelling engine 101 can create multiple sets and based on business defined thresholds (for example, the avg. distance, the max. distance, infrastructure costs, and so on), the modelling engine 101 can decide on one set. Plotting Avg. Distance with selected number of potential locations will look like an elbow curve (as depicted in the example in FIG. 4, where the number of potential locations is denoted by QIS).

[0053] Based on business rules, the modelling engine 101 decides (313) the locations. For that decided number, only one selected set is there, which will be the set of optimal selected locations.

[0054] The various actions in method 300 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIGs. 3a and 3b may be omitted.

[0055] FIG. 5 illustrates a plurality of components of the data management engine. Referring to FIG. 5, the modelling engine 101 is illustrated in accordance with an embodiment of the present subject matter. In an embodiment, the modelling engine 101 may include at least one processor 502, an input/output (I/O) interface 504 (herein a configurable user interface), and a memory 506. The at least one processor 502 may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. Among other capabilities, the at least one processor 502 is configured to fetch and execute computer-readable instructions stored in the memory 506.

[0056] The I/O interface 504 may include a variety of software and hardware interfaces, for example, a web interface, a graphical user interface such as a display screen, a keyboard, and the like. The I/O interface 504 enables one or more external entities to interact with the modelling engine 101. The I/O interface 504 can use at least one of a wired and/or a wireless interface to communicate with the at least one external entity. Examples of the external entity can be, but not limited to, the source(s) of geo-spatial data 102, the data source 103, and so on.

[0057] The I/O interface modelling engine 10104 may allow the modelling engine 101 to communicate with other devices. The I/O interface 504 may facilitate multiple communications within a wide variety of networks and protocol types, including wired networks, for example, Local Area network (LAN), cable, etc., and wireless networks, such as Wireless LAN, cellular, Device to Device (D2D) communication network, Wi-Fi networks and so on. The modules 508 include routines, programs, objects, components, data structures, and so on, which perform particular tasks, functions or implement particular abstract data types. In one implementation, the modules 508 may include a device operation module 510. The device operation module 510 can be configured for selecting at least one physical site using geospatial modelling data for deploying one or more solutions

in the at least one selected physical site based on a plurality of parameters. The device operation module 510 can be configured to execute one or more tasks corresponding to the application on the modelling engine 101 in accordance with embodiments as disclosed herein.

- 5 [0058] The device operation module 510 can fetch data related to the pre-defined geographical area from the data source 102 and/or the data source 103. The device operation module 510 can segment the geo-graphical area with a configurable grid to generate a plurality of contiguous cells. The device operation module 510 can fetch data and POIs at the cell level with one or more attributes.
- 10 The device operation module 510 can populate the corresponding cell with the fetched data and POIs at the cell level with one or more attributes.

[0059] The device operation module 510 can estimate the travel demand coefficient. The device operation module 510 can estimate the travel demand coefficient, based on weightages assigned to contributing factors.

- 15 [0060] The device operation module 510 can estimate the infrastructure index. The device operation module 510 can use one or more categories from an available set for a given area such as the POIs. Each category can be assigned different weightages. In an embodiment herein, the device operation module 510 can estimate the categories and their corresponding weightages.

- 20 [0061] The device operation module 510 can estimate the power index. The device operation module 510 can use information related to power distribution points (such as type, voltage levels, available connectors, usage, availability, and so on). In an embodiment herein, the device operation module 510 can select the power distribution points and can assign a weightage to each of
- 25 the power distribution points. Based on distance for a location in a cell from the power distribution points, the device operation module 510 can compute the quality of the distribution points power index. The closer the distribution point to a point in the cell, lesser would be the cost and larger the power throughput of the distribution point, the better quality and uptime.

[0062] The device operation module 510 can select one or more cells from the provided cells. The device operation module 510 can consider a plurality of parameters, such as travel demand, infrastructure and power. The device operation module 510 can also consider a relative weightage given to the plurality of parameters. In an embodiment herein, the device operation module 510 can determine the relative weightage given to the plurality of parameters. The device operation module 510 can identify the cells in a selected area of the map. In an embodiment herein, the device operation module 510 can identify the cells in a selected area of the map automatically. In an embodiment herein, the device operation module 510 can identify the cells in a selected area of the map manually. The device operation module 510 can compute a suitability index for each cell. The device operation module 510 can grade the cells on a relative scale from most suitable to least suitable based on the computed suitability index.

[0063] The device operation module 510 can identify at least one suitable site in a cell for placing a swapping station. The modelling engine 101 can further rank the identified sites based on the distance a vehicle needs to travel to reach each identified point from any point in the cell. The device operation module 510 can minimize the travel distance to the identified site(s). In an embodiment herein, the device operation module 510 can calculate the minimum, maximum and average distance that the vehicle needs to travel to reach each identified point from any point in the cell.

[0064] The modules 208 may include programs or coded instructions that supplement applications and functions of the data management engine 104. The data 212, amongst other things, serves as a repository for storing data processed, received, and generated by one or more of the modules 208. Further, the names of the other components and modules of the data management engine 104 are illustrative and need not be construed as a limitation.

[0065] FIG. 6 depicts an example region of interest with related metadata. Examples of the data given can be the bounded region (as depicted in FIG. 5),

grids with their TDI, and 7 points on road (including one popular stop). The data can be in tabular form, as depicted in the example in FIG. 4

ID	Latitude	Longitude	TDI	Popular Stop
p1	77.5946	12.9716	0.61	0
p2	77.595	12.9716	0.72	0
p3	77.5964	12.972	0.81	0
p4	77.7465	13.972	0.55	0
p5	77.5964	14.972	0.47	0
p6	77.5964	15.972	0.52	0
p7	77.47477	16.972	0.52	1
Mean			0.6	

Table 4

[0066] The calculated matrix, M, can be

Possible locations	q1	q2	q3	q4	q5
p1	d11*c1	d12*c1	d13*c1	d14*c1	d15*c1
p2	d21*c2	d22*c2	d23*c2	d24*c2	d25*c2
p3	d31*c3	d32*c3	d33*c3	d34*c3	d35*c3
p4	d41*c4	d42*c4	d43*c4	d44*c4	d45*c4

p5	d51*c5	d52*c5	d53*c5	d54*c5	d55*c5
p6	d61*c6	d62*c6	d63*c6	d64*c6	d65*c6
p7	d71*10*c7	d72*10*c7	d73*10*c7	d74*10*c7	d75*10*c7

Table 5

[0067] Where d_{ij} is distance via shortest road from point i to location j and, coefficients are defined as follows:

$$c1 = 0.61/\text{mean}(\text{TDI}) = 0.61/0.6$$

5 $c2 = 0.72/0.6$

$$c3 = 0.81/0.6$$

$$c4 = 0.55/0.6$$

$$c5 = 0.47/0.6$$

$$c6 = 0.52/0.6$$

10 $c7 = 0.52/0.6$

[0068] Distances from point $p7$ to all potential locations is multiplied by 10, because it's a popular stop. Now, for optimal set of 2, 3 and 4 locations, the Avg. Distance and Max. Distance for that set are determined.

[0069] For a set of 2 locations:

15 Possible sets can be $\{q1, q2\}$, $\{q1, q3\}$, $\{q1, q4\}$, $\{q1, q5\}$, $\{q2, q3\}$, $\{q2, q4\}$, $\{q2, q5\}$, $\{q3, q4\}$, $\{q3, q5\}$, and $\{q4, q5\}$. Out of these sets, $\{q4, q5\}$ can be directly discarded because they are in near proximity to each other.

[0070] Now, for each set of 2 potential locations, the cost function f is determined. For first set $\{q1, q2\}$, the process is as follows (as depicted in the
20 example Table 6):

Potential locations	q1	q2	
p1	$d_{11} * c_1$	$d_{12} * c_1$	→ min1
p2	$d_{21} * c_2$	$d_{22} * c_2$	→ min2
p3	$d_{31} * c_3$	$d_{32} * c_3$	→ min3
p4	$d_{41} * c_4$	$d_{42} * c_4$	→ min4
p5	$d_{51} * c_5$	$d_{52} * c_5$	→ min5
p6	$d_{61} * c_6$	$d_{62} * c_6$	→ min6
p7	$d_{71} * c_7$	$d_{72} * c_7$	→ min7

Table 6

[0071] The minimum weighted distance is found for every point and all minimum values are added.

Cost Function, $f = \text{min1} + \text{min2} + \text{min3} + \text{min4} + \text{min5} + \text{min6} + \text{min7}$

5 [0072] Likewise, all sets containing two possible locations will be having f value and whichever set has the lowest f value can be considered as the optimal set. The Avg. distance of all points from nearest possible locations can be found for the optimal set. The Max. distance of all points from nearest possible locations can be found for the optimal set.

10 [0073] After repeating same process for set of 3 and 4 possible location, consider that the following results are found:

Optimal Set of 2 possible locations: {q1,q4}, with an Avg. Distance of 0.72KM, and a Max. Distance of 2.1KM.

15 Optimal Set of 3 possible locations: {q1,q2,q4}, with an Avg. Distance of 0.61KM and a Max. Distance of 1.8KM.

Optimal Set of 4 possible locations: {q1,q2,q3,q4} with an Avg. Distance of 0.46KM, and a Max. Distance of 1.8KM

[0074] Now, it can be decided which set to adopt based on threshold avg. distance or infrastructure cost. Consider that the below business rules need to be fulfilled:

Avg. Distance should be less than 0.65 KM

Max. Distance should be less than 2 KM

Infrastructure cost should be minimum possible

[0075] Based on these rules, {q1,q2,q4} can be selected for placing the battery swapping station.

[0076] The embodiments disclosed herein can be implemented through at least one software program running on at least one hardware device and performing network management functions to control the network elements. The network elements shown in FIG. 1 include blocks which can be at least one of a hardware device, or a combination of hardware device and software module.

[0077] The embodiment disclosed herein describes methods and systems for selecting at least one physical site using geospatial modelling data for deploying one or more solutions in the at least one selected physical site based on a plurality of parameters. Therefore, it is understood that the scope of the protection is extended to such a program and in addition to a computer readable means having a message therein, such computer readable storage means contain program code means for implementation of one or more steps of the method, when the program runs on a server or mobile device or any suitable programmable device. The method is implemented in at least one embodiment through or together with a software program written in e.g. Very high speed integrated circuit Hardware Description Language (VHDL) another programming language, or implemented by one or more VHDL or several software modules being executed on at least one hardware device. The hardware device can be any kind of portable device that can be programmed. The device may also include

means which could be e.g. hardware means like e.g. an ASIC, or a combination of hardware and software means, e.g. an ASIC and an FPGA, or at least one microprocessor and at least one memory with software modules located therein. The method embodiments described herein could be implemented partly in hardware and partly in software. Alternatively, the invention may be implemented on different hardware devices, e.g. using a plurality of CPUs.

[0078] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of embodiments and examples, those skilled in the art will recognize that the embodiments and examples disclosed herein can be practiced with modification within the spirit and scope of the embodiments as described herein.

STATEMENT OF CLAIMS

I/We claim:

1. A method for selecting a physical site using geospatial modelling data, the method comprising:

segmenting, by a modelling engine (101), a pre-defined geographical area into a plurality of contiguous cells;

fetching data, by the modelling engine (101), related to the segmented plurality of contiguous cells;

estimating, by the modelling engine (101), a travel demand coefficient for each of the segmented plurality of contiguous cells using at least one parameter and a weightage corresponding to each of the at least one parameter;

estimating, by the modelling engine (101), an infrastructure index using at least one category of Points of Interest (POI) present in each of the segmented plurality of contiguous cells and a weightage corresponding to each category;

estimating, by the modelling engine (101), a power index using at least one power distribution points present in each of the segmented plurality of contiguous cells and a weightage assigned to each of the at least one power distribution point;

computing a suitability index, by the modelling engine (101), for each of the plurality of contiguous cells using the travel demand coefficient, the estimated power index, and the infrastructure index;

selecting at least one cell from the segmented plurality of contiguous cells, by the modelling engine (101), based on the computed suitability index; and identifying at least one site, by the modelling engine (101), from the at least one selected at least one cell.

2. The method, as claimed in claim 1, wherein the at least one parameter for estimating the travel demand coefficient comprises population of the pre-defined geographical area, employment statistics in the pre-defined

geographical area, education levels in the pre-defined geographical area, commercial areas present in the pre-defined geographical area, bus route lengths in the pre-defined geographical area, metro ridership in the pre-defined geographical area, number and availability of buses in the pre-defined geographical area , and number of railway stations in the pre-defined geographical area.

3. The method, as claimed in claim 1, wherein the at least one category of the POI is fueling stations present in the pre-defined geographical area.
4. The method, as claimed in claim 1, wherein the modelling engine (101) is configured for computing the suitability index for each of the plurality of contiguous cells using the travel demand coefficient, the estimated power index, and the infrastructure index and a weightage assigned to each of the travel demand coefficient, the estimated power index, and the infrastructure index
5. The method, as claimed in claim 1, wherein identifying the at least one site comprises
 - extracting, by the modelling engine (101), a sample of coordinates from roads inside the at least one selected cell;
 - associating, by the modelling engine (101), a plurality of candidate locations with a travel demand index (TDI);
 - tagging, by the modelling engine (101), a plurality of points in the at least one selected cell as popular stops or not;
 - constructing, by the modelling engine (101), a matrix of weighted distance values of the plurality of points from the plurality of candidate locations, wherein the weighted distance depends on if the plurality of points is a popular stop or not;
 - minimizing, by the modelling engine (101), sum of the weighted distances;

making, by the modelling engine (101), at least one set, wherein each set comprises at least one selected point from the plurality of points;

calculating, by the modelling engine (101), a cost function for each of the plurality of selected points from the at least one set based on a minimum distance from each of the selected plurality of points to any potential location; and

identifying, by the modelling engine (101), the at least one site, wherein the identified at least one site is present in a set with minimum cost function.

6. The method, as claimed in claim 1, wherein the method further comprises ranking each of the identified site by the modelling engine (101), on a plurality of sites being identified.
7. The method, as claimed in claim 1, wherein the method further comprises selecting no site, by the modelling engine (101), from the at least one selected at least one cell.