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"Population and Sustainable Development : Our Obligations towards Posterity

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Abstract -

Population, environment and development are inextricably linked and are critical in determining quality of life on earth, now and for generations to come. From the beginning of late 18th Century, the earth is experiencing exponential growth of population coupled with uneven economic development and environmental degradation. Rapid growth of population, over consumption and unsustainable use of natural resources, inappropriate economic policies, gender disparity are all interconnected. Clearly, current patterns of consumption and growth of population, wealth and natural resources are as much to blame for widespread environmental degradation as is the sheer number of people. Efforts to address population and degradation of environment should focus on the root causes of poverty, quality of life, migration, early age of marriage, lack of education and health care, high child mortality rates, lack of access to family planning information and services particularly reproductive health services for women, men and teenagers, etc. Addressing the consumption, lifestyles of peoples and societies is equally important. Alleviating poverty, empowering women, increasing access to family planning and health care, ensuring human rights, developing more sustainable lifestyles and improving development policies are all critical to provide a decent quality of life for future generations, without causing irreversible damage to the environment

Key Words -

Population growth, Population dynamics, Fertility, Working age, Migration, Urbanisation, Human Rights, Sustainable development etc.

Introduction :

The word 'Sustainability' has become a global buzzword, a potential solution, for many of the international, regional and local problems the society is facing today.

Sustainability has become the central concern of development planners and practitioners and has been vividly interpreted by governments, social reformers and environmental activists whose interpretations have influenced how issues are formulated and actions are proposed. It is generally assumed that the concept of sustainable development is related to social, environmental and economic infrastructure. Accordingly, the intersection of these three variables indicates the sustainability of the region's development. For this reason, sustainable development is often shown as overlapping regions of three variables. The concept of sustainable development, which is located at the intersection of the triangle of economy, society and environment, can be a sign of the activity field of these three variables. The separation of environment, society and economy often leads to a narrow techno-scientific approach that are most likely to challenge the present socio-economic structure which are often marginalized. It is usually presented as the intersection between environment, economy, and population which are conceived of as separate; although are connected entities and are critical to determining quality of life on earth, now and for the generations to come.

With a clearer discourse, societies carrying out their economic activities carry out these activities within the framework of an ecosystem. In other words, the production, man affects the atmosphere, oceans, waterways, forests, glaciers and biodiversity. Therefore, the ecosystem is the most important factor that attracts the burden of economic activities of societies.

The "future generations" of the sustainable development, as defined in the Brundt land Report, mean a very long time for human life. Thus, the use of resources that will not deprive future generations oi their ability to meet their own needs is possible only if the ecosystem, i.e. the environment, is protected for a very long time (Parkin, 2010). In that case, the community should produce goods and services that will be used to meet the consumption need, and leave a conducive

environment for posterity. However, environmental pollution caused by the continuous increase of the population and the consumption has made it difficult to protect today's environment. When the activities of social, economic and environmental variables are handled separately the results produced by each are a problem for another variable in the long run. Taking into account the sensitivity and intricacy of the topic, an attempt has been made to bring to light the relationship that lies between population and sustainable development.

Need for sustainable development -

According to Malthus, population control is necessary for humanity in order not to overtake the world's carrying capacity, because the power of the population in this direction is unlimitedly greater than the power of the earth to provide for the livelihood of the human being. In this view, Thomas Malthus together with Adam Smith, was one of the first to examine the relationship between population size and control of economic growth. Nevertheless, the Neo-Malthusianism movement argues that population is at the heart of all global problems and that population growth must be controlled. For example, Paul R. Ehrlich in his book 'The Population Bomb', published in 1968, emphasizes that in the near future the increase in human population will accelerate the depletion of resources, as competition for limited resources will increase. From a historical perspective, it is clear that this thought is correct. According to Jiang and Hardee (2011), economic growth, energy consumption and carbon emissions have increased in parallel with population growth between 1800 and 2000. In this 200-year period, energy consumption is 35 times, carbon emissions 20 times, and world population has increased 6 times. Global income has increased 70 times. Despite technological advances in these figures, it remains to be argued how exactly the population increase or consumption will cause carbon emissions (Nakicenovic et al., 2007; Dietz et al., 2007; Meyerson, 1998; Ehrlich and Holden, 1971). On the other hand, in the world, the 'optimum population' in which standard life in European qualities is supported by the Earth planet is less than two billion (Anthony, 2004). In 2000, the world population was 6.1 billion and by 2015 it was 7.2 billion. These figures show that the population growth is increasingly pressing on the environment. Moreover, the only problem is not pressure. Today more than one billion people live an extraordinary poverty. Some of these people live in slums (FAO, 2008; UN Habitat, 2010), while others are far from finding a good job to rescue their lives (ILO, 2011; 2012). Increasing human population also causes unbalanced distribution of resources, leading more people to food insufficiency. According to the Food and Agriculture Organization (FAO) estimates, agricultural production should not show less than 70 per cent growth in order to satisfy the world population in 2050 (FAO, 2009; 2010; 2010; Godfray et al., 2010; IFPRI, 2010). Therefore, the slowdown in population growth will contribute not only to reducing the pressure on the environment, but also to the further deterioration of resource allocation.

With the unstoppable growth of the population every day, the concept of 'sustainable development' ran to the aid of our world, which has to feed more people with more scarce resources. Becoming known by our Common Future report, discussed in the 1970's and 1980's but prepared by the World Commission on Environment and Development (WCED, 1987), sustainable development has been able to meet the needs of today's society through the use of resources that will not deprive future generations of their ability to meet their own needs. The most important variables in this definition are the human population and scarce resources. For this reason, population according to UNFPA (2012) will always remain a very important variable for sustainable development. As it is said in the first principle of the Rio Declaration, one is at the center of the sustainable development (UNCED, 1992). The Action Plan agreed on in 1994 emphasizes the importance of population variability for a sustainable economic growth that will develop on the sustainable development axis (ICPD, 1994). In other words, the involvement of both the present population and the population of future generations in the accounts constitutes the essence of sustainable development. As can be seen from the above explanations, the population growth and the sustainable development relationship, which are tightly connected to one another, are worthy of being examined empirically.

Population and Sustainable Development -

The world population has surpassed the 7 billion mark and is projected to grow to over 9 billion by 2043. Population trends today are characterized by an increasing divergence across countries and regions. Whereas many of the poorer countries continue to be characterized by rapid population growth, others that are more advanced in their demographic transition are experiencing rapid population ageing and even population decline in some cases. Furthermore, the world is witnessing increasingly complex international migration patterns and many countries continue to experience very high rates of urbanization.

Population growth, population ageing and decline, as well as migration and urbanization, affect virtually all development objectives that are on top of national and global development agendas. They affect consumption, production, employment, income distribution, poverty and social protections, including pensions; they also complicate our efforts to ensure universal access to health, education, housing, sanitation, water, food and energy.

Population growth, in particular places increasing pressures on the planet's resources - water, forests, land and the earth's atmosphere contributing to climate change and challenging environmental sustainability. However, population dynamics not only affect critical development objectives; they are themselves affected by social, economic and environmental changes.

Population dynamics not only pose challenges, they also provide important opportunities for more sustainable development. A fall in fertility levels and slower population growth, for example, leads to an increased concentration of the population in the working age range, which can enable countries to reap a demographic bonus and jumpstart economic development.

Migration can be an important enabler of social and economic development. Today, more than a billion people rely on international and internal migration to escape from poverty and conflict, adapt to environmental and economic shocks, and improve the income, health, and education of their families.

Urbanization can be a powerful driver of sustainable development. Higher population density enables governments to more easily deliver essential infrastructure and services in urban areas at relatively low cost per capita. Liveable and sustainable cities have knock-on effects in terms of providing rural populations with greater access to services such as education and healthcare, while also empowering them economically. Furthermore, urbanization can produce energy savings, particularly in the housing and transportation sectors.

The above discussed population dynamics not only influence development at the national and sub-national levels, but also at regional and global levels. Thus, the challenge of the century is to solve the problem of meeting the increasing needs and expectations of a growing population while at the same time modifying the current production and consumption patterns to achieve a more sustainable development model and address the links between development and rapid population change.

However, the benefits of demographic transitions, urbanization and migration do not materialize automatically and inevitably. Whether population dynamics pose challenges or brings opportunities depends largely on the policies that are in force.

Out obligation towards posterity -

Population dynamics are the result of individual choices and opportunities. To address and harness the opportunities of population dynamics for sustainable development, countries should seek to enlarge, not restrict, individual rights. Countries should work to expand people's choices, resourcefulness, creativity and resilience, by adopting policies that are human rights-based and gender-responsive.

Human rights-based and gender-responsive policies, such as promoting universal access to sexual and reproductive health and rights like voluntary family planning, comprehensive sexuality education etc., can make a world of difference for people and societies. Together, these measures help to avoid unwanted pregnancies, reduce teenage pregnancies, curb infant and maternal mortality, and reduce gender-based violence and unsafe abortions. They also help to combat HIV/AIDS and other sexually transmitted diseases, which continue to claim millions of lives every year.

Rights-based and gender-responsive policies are also critical in a context of low fertility and rapid population ageing or population decline. Policies addressing low fertility should promote a better work life balance and ensure access to essential services, such as child care and social protections. Furthermore, non-discriminatory policies are important to allow older people to contribute fully to society while at the same time receiving the care, services and social protections they need. Fiscal policies, social protections and non-financial support systems for families can influence decisions about family size.

A human rights approach is also crucial in migration policies, which should be designed in full respect for the protection of the human rights of the migrants and migrant workers. Such policies can generate large economic and social gains from migration, while ensuring decent living and working conditions for migrants. A rights-based approach is essential, as well, in choosing policies for addressing urbanization and sustainable settlement patterns.

How the post-2015 development agenda should reflect the actions needed to harness the opportunities that population dynamics present to sustainable development -

The wide consultations on population dynamics have suggested unequivocally the importance of mainstreaming the following priorities in the framework for the post 2015 development agenda:

1. A concerted effort is needed to ensure that young people have access to education, sexual and reproductive health care, and decent work opportunities. Investment in the formation of human capital, which strengthens the employability of young people, must be complemented by economic policies that promote productive investment and contribute to the creation of employment opportunities for young people.
2. To seize the benefits that can come with population ageing, countries will need to promote the active and healthy ageing of the older persons. This calls for adequate access to social protections, including pensions and health care,

as well as investment in continuing education and lifelong learning, complemented by policies that counter discrimination against older persons.

3. Promote the development benefits of migration. with a focus on ensuring the rights and safety of migrants and combating discrimination against migrants, and a perspective on realizing the developmental benefits of migration for both sending and receiving countries. To reap the developmental benefits of migration, countries need to establish comprehensive, balanced and inclusive national policies on migration, and at the same time need to strengthen bilateral, regional and global partnerships on migration. Countries should also work to reduce the social and economic costs of migration, including facilitating the transfer of remittances and lowering the costs of such transfers. Finally, countries should take measures to ensure the portability of acquired rights and benefits across borders, including old-age pensions.
4. Create equitable, liveable and sustainable cities that can accommodate increased demands for livelihoods and services, while strengthening the linkages between rural and urban areas, and promoting the sustainable development of rural communities. By 2050 the global proportion of people living in cities and towns is expected to rise to about 67 per cent. The rapidly increasing dominance of cities places the process of urbanization among the most significant global social transformations of the twenty-first century. Thus, if well managed, cities can make an important contribution to social, economic and environmental sustainability.
5. Strengthen national capacities to collect, use and analyze population data and projections. People-centred development strategies must systematically consider changes in the number, age and location of people; and use population data and projections to inform development goals, targets and indicators, as well as policies and programmes. Data producers should systematically disaggregate relevant socio-economic data by sex, age and location.

Thus from the above we can conclude that, the means of harnessing the opportunities offered by population dynamics will need to rely on more effective and stronger global, regional and national partnerships, with an emphasis on knowledge sharing, and on technical and financial assistance that will enable countries to adopt evidence- and rights-based policies informed by population data, projections and analysis.

Conclusion -

The rapid growth of population and uneven economic development in the country are threatening the environment. This is the result of expansion and intensification of agriculture, uncontrolled growth of urbanization and industrialization, and destruction of natural habitats. Humanity has tried various paths to develop the country/region, some of these efforts ended in wars, others in economic slumps and economic depression. Choosing a wrong path again is not an option, as too many important things are at stake: Our well-being, economic prosperity, the environment, our future and that of generations to come. Only the path of sustainable development which has emerged as an important concern for mankind can lead us to a proper future. Human well-being, can be ensured by equitable share of resources in the present and in the future. This requires the interrelationships between population, environment and development to be fully recognized, appropriately managed and brought into harmonious, dynamic balance. Hence, it is a matter of immediate concern which needs to be discussed and debated.

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Route Optimisation of Municipal Solid Waste Management in Belagavi City

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Abstract

The environment is heading towards a potential risk due to unsustainable waste disposal. It is a sensitive issu which concerns about serious environmental problems in today's world. The present situation of direct dumping of th waste without proper inspection and separation leaves a serious impact of environmental pollution causing a tremendou growth in health related problems. "Domestic, industrial and other wastes, whether they are of low or medium level wastes they are causing environmental pollution and have become perennial problems for mankind." If this situation is not handle in a proper manner within time then it would lead to worse consequences on a global level. There has been awarenes regarding waste management amongst many countries. There has been development of new technologies for improvin the waste management systems. GIS is one of the new technologies which have contributed a lot in very less time span t the waste management society. "The Geographic Information System (GIS) helps to manipulate data in the computer t simulate alternatives and to take the most effective decisions." The geo-informatics is proposed to determine the minimum cost/distance efficient collection paths for transporting the solid wastes to the dumping site. This paper is attempted to optimize the route for collection and transportation of municipal solid waste of Belagavi city using geo-informatics technique.

Keyword: Municipal Solid Waste, collection, Optimization, Geographical Information System (GIS).

Introduction

The environment is heading towards a potential risk due to unsustainable waste disposal. It is a sensitive issue which concerns about serious environmental problems in today's world. The present situation of direct dumping of the waste without proper inspection and separation leaves a serious impact of environmental pollution causing a tremendous growth in health related problems. "Domestic, industrial and other wastes, whether they are of low or medium level wastes, they are causing environmental pollution and have become perennial problems for mankind." If this situation is not handled in a proper manner within time then it would lead to worse consequences on a global level. Though India took extensive measures for its management, the management of solid waste has always been a major public health and environmental concern in urban areas. The concern is serious, particularly in the capital and major cities, as the environment is heading towards a potential risk due to unsustainable waste disposal. Belagavi city is also one of the major cities situated in the northwest part of Karnataka state (15° 51' North Latitudes and 74° 51' East Longitude), is plagued with inefficient and insufficient civil amenities. With the growth of city, its trash mainly hazardous plastic, metals, residential wastes, commercial wastes, papers and packaging is growing exponentially. Since the last decade, the solid waste is increasing very fast as compared to previous decades, which has become a great threat to the City Corporation and Cantonment board as well as to the city dwellers. Since the city is well known for industries, commerce, medical, hospital, education, administration, and pleasant climate, it has attracted a huge number of the people from its hinterland and surrounding regions. The population of Belagavi city has increased sharply from 83,483 in 1951 to 4, 88,292 in 2011 which has led to generate more and more waste in the city. In addition to this, the growth of industries, commercial establishments and complexes, educational institutions has lead to an increase in the amount of solid waste in the city.

Belagavi with its ever growing population reached a population of 4,88,292 during 2011 with this the solid waste in the city has also greatly increased from 83456 Kgs/day in 1991 to 180454 Kgs/day in 2011 and around 200,000 Kgs./day in 2015. It is projected that waste to be handled in 2020 would be 250 tons per day. Per capita generation of solid waste is also increased from 260 grams/day in 1991 to 369 grams/day in 2011 and which will continue to only increase in the days to come. Belagavi City Corporation occupies the center stage but civil issues and problems faced by citizens continue to remain. Garbage management has become a perennial problem and it is intense in city core areas.

Objective :

This paper attempted to optimise the route for collection and transportation of municipal solid waste of the city using geo-informatics technique. Thus, in this study an attempt has been made to design the GIS model i.e. Arc GIS Network Analyst for proposing a system which could reconsider the existing bin locations in the city and providing some better alternatives in allocating and relocating the existing and the new proposed waste bins. The proposed amendments in the system through this model would reduce the waste management workload to some extent and solve some of the present situation problems.

Research Problem And Significance of The Study :

The present paper deals with the implementation of GIS model to develop the designs to manage the MSW conditions at Belagavi city, because the city conditions are such that the inhabitants face a lot of problems due to improper management of solid wastes. This is not because the municipality is not doing their work properly or due to work negligence, but it is due to the old conventional working methods which need to be upgraded with the advanced system like GIS and a better management system. "Municipal bodies are unable to prove a 100% efficient system and even are not able to reach the efficiency of 60%." (Ogra, A., 2003). The maintenance and the management of data is an important thing which was found missing in the system due to which it was quite difficult to know about the systems functioning. The data should be managed in an integrated way to reduce the complexity of different issues related to the function of the work involved in the waste management system.

There are several areas where the municipal bodies are striving hard to provide the best of their services for the betterment of the city. They even follow their methods promptly and perform their duties in a way that could run this system perfectly. In these kind of situations, there has to be a better and a refined system which is developed with the consideration of all the facts and figures of the situation. This can be achieved with the help of GIS which can handle different data forms like spatial as well attribute data simultaneously. The system seems to fell short in terms of its approaches to maintain a clean environment and it needs to be upgraded and refined. Solid Waste Management is one of the important areas where the problem arises from time to time. "One of the simplest ways to bring innovations in any system is to document and study the existing system and bring the possible reforms by adopting appropriate measures at various levels through the introduction of innovative and cost effective solutions." (Ogra. A., 2003).

Methodology and Data Used:

In this paper Geo-informatics technology has been proposed to determine the minimum cost/distance efficient collection paths for transporting the solid wastes to the dumping site. This uses information on population density, waste generation capacity, road network, storage bins and collection vehicles etc. In this paper initially all ancillary data have been collected from various sources. Using hand held GPS, the position of the entire dust bin in the city are collected and the data are converted into shape file. The roads are digitised from the road network map of the municipal corporation. From the shape file of existing road network, network database for the entire road are prepared using Arc-GIS. Taking capacity of solid waste carrying vehicle into consideration, the routes are optimised for each trip of vehicle and total distance to be travelled is calculated for each trip. Finally cost is compared for solid waste disposal using this technique with the existing system of Municipal Corporation.

Route Optimization Method Using Arc Gis

Arc GIS Network Analyst extension allows users to perform complex calculations to solve vehicle routing problems. The program performs analysis over a network of connected edges and decides fleet routing, travel directions, closest facility, service area, and location allocation.

In the application for route optimization, network data set edges represent the road network being traversed. Network Analyst allows the user to dynamically model genuine network situations. These conditions can include speed limit, traffic volume at different times of the day, one-way streets, turn restrictions, obstacles, road conditions, and limitations.

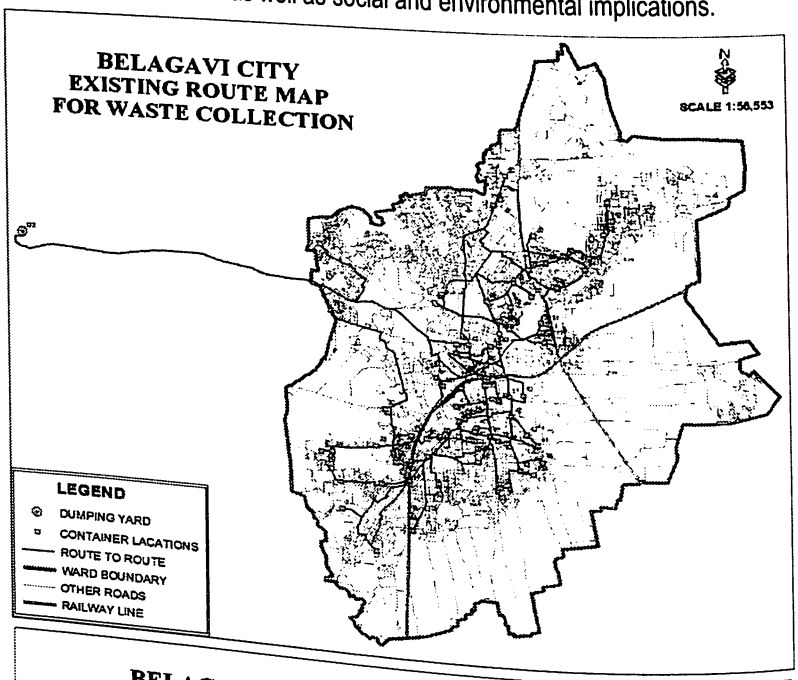
Network Analyst key functions include:

- Establish a network with current GIS data.
- Detect closest facilities.
- Produce travel network cost matrix.
- Define optimal facility positions using location allocation.
- Use time windows in vehicle scheduling.
- Determine shortest routes to travel.

Optimisation of Routes

With Arc Gis Network Analyst for Msw Collection:

The present study has made an attempt to introduce the ArcGIS Network Analyst for best routing identification applied in municipal waste collection in Belagavi city. The proposed application takes into account all the required parameters for the waste collection so that its desktop user is able to model realistic network conditions and scenarios. In this case, the simulation consists of scenarios of visiting loading spots in the municipality of Belagavi, in order to collect Municipal Solid Waste that could not be collected by the standard waste collection trucks, due to size and other prohibitive obstacles. The Network Analyst is used to estimate interrelations between the dynamic factors, like network traffic changes (closed roads due to natural or technical causes, for example, fallen trees, car accidents, etc.) in the area under study and to produce optimized solutions. The user is able to define or modify all the required dynamic factors for the creation of an initial scenario, and by modifying these particular parameters, alternative scenarios can be generated leading to several solutions. Finally, the optimal solution is identified by a function that takes into consideration various parameters, for example the shortest distance, road network as well as social and environmental implications.



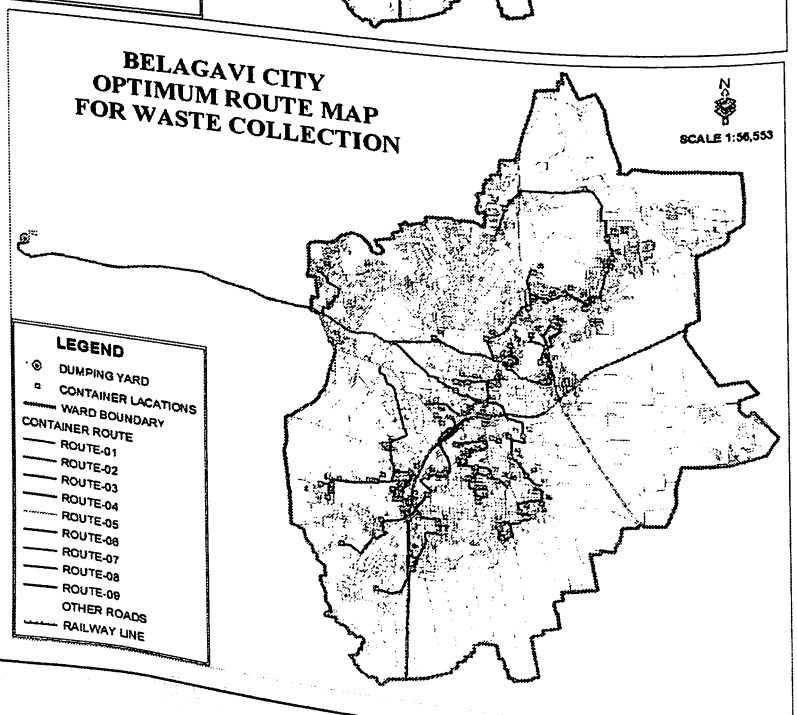


Table : Network Analyst showing the Closest Routes for solid Waste Collection

ROUTE - 1				
Container to Container		From	To	Kms
Stop #1	Stop #2	79	58	0.81
Stop #2	Stop #3	58	77	4.40
Stop #3	Stop #4	77	82	0.61
Stop #4	Stop #5	82	78	0.37
Stop #5	Stop #6	78	83	0.13
Stop #6	Stop #7	83	81	1.06
Stop #7	Stop #8	81	84	0.15
Stop #8	Stop #9	84	85	0.67
Stop #9	Stop #10	85	86	0.46
Stop #10	Stop #11	86	88	1.10
Stop #11	Stop #12	88	87	1.08
Stop #12	Stop #13	87	68	0.73
Stop #13	Stop #14	68	69	0.86
Stop #14	Stop #15	69	**102**	12.77
			Total	**25.20**

ROUTE - 2				
Container to Container		From	To	Kms
Stop #1	Stop #2	7	80	1.33
Stop #2	Stop #3	80	76	0.27
Stop #3	Stop #4	76	90	1.16
Stop #4	Stop #5	90	91	0.55
Stop #5	Stop #6	91	75	0.79
Stop #6	Stop #7	75	73	0.95
Stop #7	Stop #8	73	72	0.88
Stop #8	Stop #9	72	71	0.58
Stop #9	Stop #10	71	89	1.64
Stop #10	Stop #11	89	**102**	11.25
			Total	**19.40**

ROUTE - 3				
Container to Container		From	To	Kms
Stop #1	Stop #2	16	101	0.33
Stop #2	Stop #3	101	65	0.92
Stop #3	Stop #4	65	63	0.89

Stop #4	Stop #5	63	62	0.19
Stop #5	Stop #6	62	60	0.62
Stop #6	Stop #7	60	61	0.86
Stop #7	Stop #8	61	**102**	11.75
			Total	**15.56**

ROUTE - 4

Container to Container		**From**	**To**	**Kms**
Stop #1	Stop #2	17	94	0.26
Stop #2	Stop #3	94	19	0.41
Stop #3	Stop #4	19	100	1.24
Stop #4	Stop #5	100	92	0.35
Stop #5	Stop #6	92	99	0.88
Stop #6	Stop #7	99	41	0.46
Stop #7	Stop #8	41	42	0.35
Stop #8	Stop #9	42	43	0.63
Stop #9	Stop #10	43	51	0.51
Stop #10	Stop #11	51	52	0.54
Stop #11	Stop #12	52	**102**	13.92
			Total	**19.55**

ROUTE - 5

Container to Container		From	To	Kms
Stop #1	Stop #2	7	58	0.18
Stop #2	Stop #3	58	49	0.81
Stop #3	Stop #4	49	48	0.22
Stop #4	Stop #5	48	46	0.93
Stop #5	Stop #6	46	55	0.64
Stop #6	Stop #7	55	57	0.49
Stop #7	Stop #8	57	59	0.56
Stop #8	Stop #9	59	56	0.37
Stop #9	Stop #10	56	50	0.75
Stop #10	Stop #11	50	64	0.24
Stop #11	Stop #12	64	**102**	11.76
			Total	**16.95**

ROUTE - 6

Container to Container		From	To	Kms
Stop #1	Stop #2	15	20	0.57

Stop #2	Stop #3	20	23	0.46
Stop #3	Stop #4	23	22	0.26
Stop #4	Stop #5	22	97	0.55
Stop #5	Stop #6	97	39	0.45
Stop #6	Stop #7	39	98	0.23
Stop #7	Stop #8	98	40	0.68
Stop #8	Stop #9	40	34	0.55
Stop #9	Stop #10	34	44	0.46
Stop #10	Stop #11	44	24	0.26
Stop #11	Stop #12	24	45	0.26
Stop #12	Stop #13	45	47	1.08
Stop #13	Stop #14	47	**102**	14.18
			Total	**19.99**

ROUTE - 7

Container to Container		From	To	Kms
Stop #1	Stop #2	5	6	0.56
Stop #2	Stop #3	6	30	0.38
Stop #3	Stop #4	30	28	1.18
Stop #4	Stop #5	28	32	1.45
Stop #5	Stop #6	32	31	3.88
Stop #6	Stop #7	31	54	2.55
Stop #7	Stop #8	54	**102**	9.89
			Total	**19.89**

ROUTE - 8

Container to Container		From	To	Kms
Stop #1	Stop #2	1	9	1.73
Stop #2	Stop #3	9	8	0.58
Stop #3	Stop #4	8	11	1.39
Stop #4	Stop #5	11	12	0.24
Stop #5	Stop #6	12	14	1.05
Stop #6	Stop #7	14	13	0.78
Stop #7	Stop #8	13	36	0.68
Stop #8	Stop #9	36	37	0.35
Stop #9	Stop #10	37	38	0.00
Stop #10	Stop #11	38	35	0.13
Stop #11	Stop #12	35	**102**	13.96

			Total	20.89
ROUTE - 9				
Container to Container		From	To	Kms
Stop #1	Stop #2	2	4	1.84
Stop #2	Stop #3	4	25	0.82
Stop #3	Stop #4	25	66	0.12
Stop #4	Stop #5	66	67	0.17
Stop #5	Stop #6	67	3	0.13
Stop #6	Stop #7	3	21	0.43
Stop #7	Stop #8	21	27	0.19
Stop #8	Stop #9	27	26	0.26
Stop #9	Stop #10	26	29	0.29
Stop #10	Stop #11	29	33	0.71
Stop #11	Stop #12	33	102	13.52
			Total	18.48

Routes	Total Distance (Kms)
1	25.20
2	19.40
3	15.56
4	19.55
5	16.95
6	19.99
7	19.89
8	20.89
9	18.48
	175.91

Results :

The ArcGIS geo-database developed in this study consisted of raster photo images of the city, street network data, waste bin locations, waste bin capacity, current collection routes driven, service time to collect bins, truck type and their capacity. Some essential restrictions were taken into account, such as the streets' directions, no U-Turns rules (with the exception of the dead-ends) and also, the fact that the truck should follow true-shape route. Moreover, Network Analyst was asked to show the results in meters, as the distance criterion was selected, and to reorder the stop-points in order to find the shortest route. It is worth mentioning that, in the special case where some piece of refuse causes traffic problems, the Network Analyst was asked to find the shortest route starting from this certain point, so as to relieve the traffic. Finally, pushing the "solve" button of Network Analyst, the closest route for the solid waste collection was produced. In this work, optimized solid waste collection route for vehicle in Belgaum City is shown by using Arc map Network Analyst. With the GIS technique, optimum route was identified which found to be cost effective and less time consuming when compared with the existing run route. The original collection route length was 250 Kms, while the new method produced a waste collection route of 175 km in length, for a 30 per cent decrease in overall kilometers traveled. The cost for these operations

is saved. Thus, it is possible to find an optimized solid waste collection route by the use of such type of software which is quick/fast and easy to understand as compared to the manual analysis.

Conclusion :

From the analysis and results, it is concluded that the Geo-informatics technique gives better accuracy for route optimisation and can be used as a decision support tool by municipal authorities for efficient management of the daily operations for transporting solid wastes, load balancing within vehicles, managing fuel consumption and generating work schedules for the workers and vehicles for overall cost minimization.

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