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Research Article

Assessment of the Accessibility of Urban Services at Various Slum Aggregates of Kerala, India

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Abstract

Growth of urban population in Kerala during the period of 2001 to 2011 is 92.72%. The formations of slums need to be inevitable with rapid urbanization. Kerala has 19 urban local bodies with slum aggregates. Better understandings of the existing urban services in the slums are essential for the implementation of proper policies, programs and its management. This paper describes how the categorization method will be helpful for the slum management activities in Kerala. Based on the published reports, focus group discussions and correlation analysis, we had selected 10 factors representing access to urban services for the study. A weighting score from 1 to 4 was awarded to each urban local body based on the accessibility of the urban service of the slum. The urban local bodies were categorized into 4 group viz., worst, bad, good and best based on the obtained scores. In Kerala 11%, 26%, 37% and 26% of the slum aggregates can be categorized into worst, bad, good and best respectively.

1. Introduction

The formations of slums are inevitable with rapid urbanization (Giok Ling Ooi and Kai Hong Phua 2007). Urbanization in developing countries creates massive demand for basic infrastructure in cities. The latest UN report also points out that the proportion of urban population will rise to 60 percent by 2030, which means that the 4.9 billion people out of 8 billion expected to be urban dwellers in 2030. Urban services are not increasing with the urban population that triggers forming slums in developing countries. The urban services shortages are affecting pessimistically the living conditions of the slum residents. Urban growth in developing countries tends to be made up of mostly poor people. Seventy two percent of urban populations in sub-Saharan Africa and fifty seven per cent of those in Southern Asia are slum dwellers (UNDESA 2011). The growth of slums in the last 15 years has been unprecedented. In 1990, there were nearly 715 million slum dwellers in the world. By 2000 the slum population had increased to 912 million. UNHABITAT estimates that, if current trend continue, the slum population will reach 1.4 billion by 2020 (UNHABITAT 2006).

The Census of India describes slums as, "residential areas where dwellings are unfit for human habitation by reasons of dilapidation, overcrowding, faulty arrangements and design of such buildings, narrowness or faulty arrangement of street, lack of ventilation, light, or sanitation or any combination of these factors which are harmful to the safety and health" (Census of India 2011[a]). As per 2001 census data, a total of 1743 towns are reported with slums in India but in 2011 census the figure increased to 2613. The residents of slums in particular have been affected pessimistically by urban service deficiencies (Farhat Jahan Chowdhury and Nurul Amin 2006). The slum residents are not getting adequate facilities such as: water supply, sanitation, infrastructure development etc. High population density combined with inadequate infrastructure and sanitation creates a poor environmental condition in the slums (Sohel Rana 2009). The Millennium Development Goals target of significantly improving the lives of at least 100 million slum dwellers by 2020 will depend partly on providing safe water and improved sanitation (United Nations 2014).

Government of India is implementing many policies and programs for the slum dwellers. Provision of adequate water supply, sanitation, education, health, housing and improvement of environment are part of National Slum Development Program (NSDP). Valmiki Ambedkar Awas Yojana (VAMBAY) is implemented to achieve 'cities without slum' by providing or upgrading shelter for people living below the poverty line in urban slums. Rajiv Awas Yojana (RAY) a program had been launched to have a 'slum free India'. Up gradation of existing slum and prevention of formation of new slums are the two plans envisaged under this program (Vijay Neekhra 2014).

Implementing policies and programs needs better understanding of the existing urban services in the slum. A huge difference exists on the urban services, socio economic profile, poverty level etc. at various slums across the country. Under these prevailing conditions, categorization of slums based on the accessibility of urban services, has a role in the slum growth management. The categorization of slum aggregates will help to rank the slum for the implementation of various activities needed for its improvement and also to identify the gap in the available urban services. Objectives of the study include: to assess the existing status of slum dwellers using categorization method with respect to available urban services in the State Kerala, India, to identify the urban services which require more attention for slum improvement activities using principal component analysis and to suggest proper slum management program or policy for the slum aggregates of Kerala, India. Accessibility of urban services has been used to categorize the slums, which is expected to provide a tool to manage slum growth and target worst slums for improvement in the urban areas of Kerala, India. We had explored the present condition and limitation of such services in slum aggregates. Statistical analyses were conducted to explain the interrelationship of the factor and urban services. Geographical Information System (GIS) tools were used to depict the urban services and different categories of slums. The results will also help to compare the existing sanitation status of the slums in the State.

2.Methods

2.1. Study Area

Kerala is one of the smallest States in India (38863 km^2) covering merely 1.18% of the total area of the country and is situated between $8^0$18' and $12^0$48'N latitude and 74^0 52' and 77^0 22'E longitude. The State is a home to 2.76% of India's population, with the population density at 859 persons per km^2, (Census 2011). Kerala has 1209 Local Self Government Institutions (LSGIs which comprise of 978 Grama Panchayats, 152 Block Panchayats, 14 District Panchayats, 60 Municipalities and 5 Municipal Corporations,). Municipalities and Municipal Corporations are together called Urban Local Bodies in Kerala (Supreme Audit Institution of India 2009). In Kerala, 52.28% of the total population live in rural area and 47.72% in urban area. Growth of urban population during the period of 2001 to 2011 is 92.72 % (national urban growth rate is only 31.8%). The sudden urban population growths indicate the urbanization trend in the State of Kerala which stands out from the rest of the country (Census of India., 2011[c]). In other States of India, urban population growth rate is the result of migration and settlement in the existing cities especially metropolitan cities. In Kerala, the main reason for urban population growth is the increase in the number of urban areas and urbanization of the peripheral areas of the existing major urban centers. Other peculiar feature of the urbanization process of Kerala is the existence of rural-urban continuum; no vast area is available to separate the urban and the rural areas (India Environmental Portal 2013).

As per 2011 census, Kerala has 19 urban local bodies with slums. We have used the term "slum aggregates" since, slums exists in different patches (or group) of the urban areas. The urban local bodies with slum aggregates in Kerala include 5 municipal corporation (M.Corp.) and 13 municipalities (M). Kozhikode, Thrissur, Kochi, Kollam and Thiruvananthapuram are the 5 municipal corporations and Kasaragod, Kannur, Vadakara, Palakkad, Kunnamkulam, Chavakkad, Thrippunithura, Kayamkulam, Chengannur, Mavelikkara, Paravoor, Attingal, and Nedumangad are the 13 municipalities of Kerala identified with slum aggregates. No slum aggregates are identified in Panchayat Raj Institutions (PRIs) or rural area. Slum aggregates identified in various districts of Kerala is shown in the Figure 1. The slum aggregates of Kerala is geospatially represented by using Arc Map 10.1. The urban bodies identified with slum aggregates are represented as point features and various colours are given to each districts of the State based on the number of slum aggregates.

2.2. Data collection

We have used the census data published by the Census of India, Government of India for the present work (Census of India 2011[c]). The Census of India follows a very large administrative exercise, possibly the largest such operation in the entire world. It provides the most credible and biggest source of data on demography, economic activity, literacy, education, household amenities, urbanization, fertility, mortality, language, religion and migration. Census data are source of primary data at village, town and ward level. This exercise is being carried out since 1982 with unique record of an unbroken series of decimal census and 2011 census data representing the 15^{th} of such process (Census of India 2011[d]). We had collected the details of the urban slum aggregates from Department of Census Kerala, India (Census of India 2011[c]).

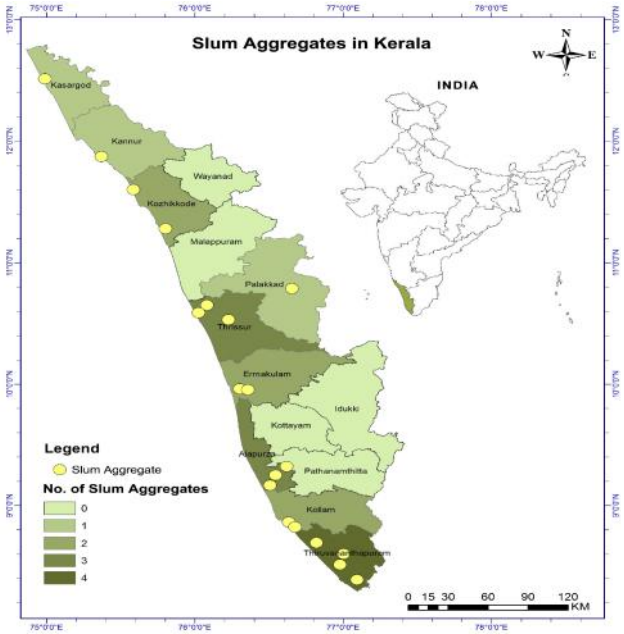

Figure 1.District map of Kerala with slum aggregates

Various factors and urban services which influence the social, cultural and environmental condition of the slums were identified and listed out from literatures (Alex Kenyl Abico et al.;Chandrasekhar 2005;Schouten & Mathenge 2010; Sohel Rana 2009; Vijay Neekhra 2014;WHO 2014).Correlation analysis and Focuss Group Discussions (FGDs) was used to screen the factors. Focus Group Discussions (FGDs) were held among the experts from various discipline including social science, environmental planners, water and sanitation experts etc. who have experience in sanitation issues of the slums. The group consists of both male and females members. The factor and urban services were ranked ('1' being the lowest score and 'n' being the highest sore) based on their priority after FGDs. After adding the score of each factor, 10 factor having the highest score in ranking was selected for the study. The factors like ownership of land, latrine, presence of streetlight, geographic locations etc. were screened out from the list. Among the various drinking water sources, treated tap water received highest rank than the drinking water from untreated tap, well, river, canal stream, etc. Wastewater discharge into closed drainage system was assigned the highest rank than the wastewater discharge into open drain and open space. Correlation analysis was also used to screen various factor. Correlation coefficients for closed drainage with other factors are higher than the wastewater discharge into open drain and open space. Similarly, good household condition have high correlation coefficient with the availability of treated water, waste water discharge into closed drainage, electricity, latrine availability etc. when compared with the correlation coefficient of livable and dilapidated household condition. The factors selected for the study include: total slum population in the urban local body, slum population proportional to Kerala slum population, literacy of the slum residents, occupation of the slum residents, household conditions, availability of electricity, availability of latrines, open defecation, availability of treated water within the premises and wastewater discharge into closed drainage. Percentage values were used to generalize the value for comparing available urban services at various slum aggregates of Kerala and were calculated from the census data of Kerala.

2.3. Description of Data

2.3.1. Population Profile

Total slum population among the 19 slum aggregates of Kerala is 202048, in which maximum slum population is reported to be in Thrissur Corporation (79809) followed by Kozhikode Corporation (50343). Thrissur and Kozhikode districts stands in second and third position according to the district urban population of the State. Slum populations in all other slum aggregates are below 20000. In the figure 2, the district urban population is denoted as various color gradation for each district, the low to high population is indicated by gradation of colour from light to dark intensity. Population of the slum aggregates is presented as point feature and various sizes of the points represent the variations in the slum population. Minimum slum population is reported in Mavelikkara Municipality (763) in Alapuzha Districts. Chavakkad, Chengannur and Paravoor Municipalities also have the slum population below 1000. The correlation analysis of district urban population and district slum population reveals that, a significant positive correlation at 0.01 significant level exists among them (correlation coefficient is 0.682). It indicates that the increasing trend in urbanization contribute to the possibility to the formation of slum aggregates in Kerala State. Slum aggregates are not reported from district, which has an urban population of 500000 or below. The correlation study explained the general trend of increasing slum formation with urbanization is also true in Kerala.

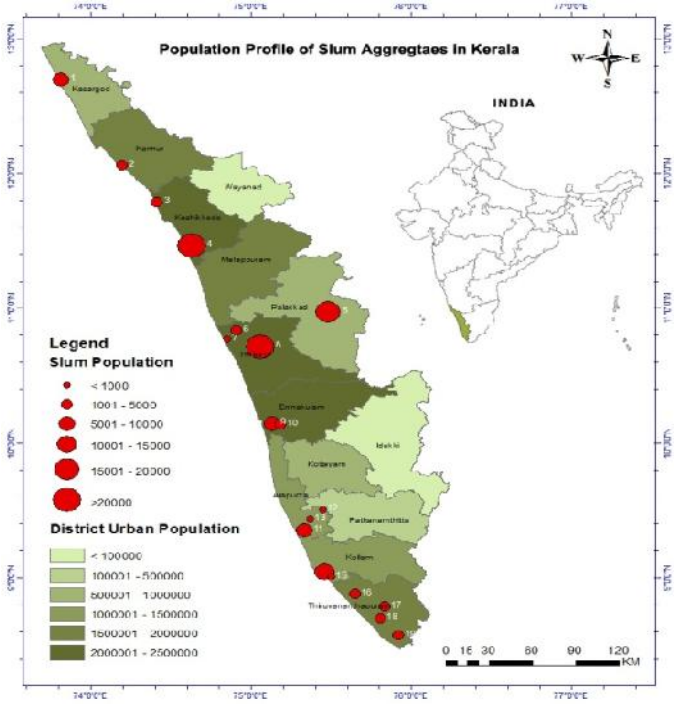

Figure 2.Population profile of slum aggregates in Kerala

2.3.2. Literacy

Kerala has a high rate of literacy (93.91%) than the national average (74.04%). But the slum aggregates of Kerala have not succeeded to achieve the literacy rate above 90%. High literacy rate was observed in Kunnamkulam Municipality (88.7%) followed by Thrippunithura Municipality (88.5%). Maximum percentage of illiterate was reported in Kochi Municipal Corporation (23.3%).

2.3.3.Occupation

People in slum aggregates of Kerala depend on various occupations for their income source. The occupations include; agriculture, labors in industries, self-employment, small entrepreneurship etc. Majority of the people in slum aggregates are non-workers, maximum percentage of non-workers were reported in Vadakara Municipality and workers are in Kochi Municipal Corporation.

2.3.4. Household Condition

According to census of India a ‘household’ is a group of person who normally live together and take their meals from a common kitchen unless the exigencies of work prevent any of them from doing so. Census of India has categorized various slums as good, livable and dilapidated based on the existing household condition. Houses which do not require any repairs is considered as 'good' and which require minor repairs is considered as ‘livable’. Houses which are showing signs of decay or those breaking down and require major repairs is considered as 'dilapidated'. Maximum good household condition was reported at slum aggregates of Paravoor Municipality and minimum was observed at Chavakkad Municipality. Wood, grass, polythene or plastic sheets are generally used as construction materials for dilapidated households; life in such houses is a great challenge especially in the monsoon season. From the total slum households of Kerala, 63% are in good condition and the remaining households are in livable (31%) and dilapidated (6%) conditions.

2.3.5. Electricity

Kerala State Electricity Board Limited is a public sector agency under the Government of Kerala that generates, transmits and distributes the electricity supply in the State from 23 hydroelectric power stations and other projects. Ninety four percentage of household in the slum aggregates of Kerala are electrified. Thrissur Municipal Corporation has the maximum percentage (99%) of houses which is electrified and Nedumangad the least (82%). Non-electrified slum households mainly depend on kerosene, solar energy and other oil for lighting needs.

2.3.6. Latrine Availability and Open Defecation

Maintaining sanitation system is a major challenge in urban slums because of their high population density and lack of infrastructure. Ninety three percentages of the slum households of Kerala have latrines. The remaining 7% of slum households do not have latrines and they depend on public toilet (84%) or defecate at open space (16%) and creates environmental nuisance. The slum households who are using the onsite sanitation use flush and pour flush latrine connected to septic tank (56%) followed by pit latrine (22%). Other sanitation methods which are common in Kerala include: flush and pour flush latrine connected to piped

sewer system, flush and pour flush latrine connected to other system and service latrine etc. Households using open defecation are comparatively less in slum households of Kerala. Paravoor Municipality is free of open defecation and highest percentage (31.2%) is reported in the Chavakkad Municipality.

2.3.7. Water Availability and Water Source

Water supply with good quality and quantity are necessary for assessing the living environment of the slum (Sohel Rana 2009). Water availability in various slum aggregates of Kerala is given in the. Majority of the slum households can access drinking water source within the premises (79%). But the persons in slum aggregates of Kerala still faces problem to access safe drinking water sources. Sixteen percentages of the slum households can access the drinking water source near the premise and remaining five percentages looking for various water resources away from their premises for the drinking water needs. Maximum percentage of drinking water accessibility within the premises (98%) is reported in Chavakkad Municipality, which has the minimum number of slum households and followed by Kannur Municipality. In Thiruvananthapuram Municipal Corporation, only 45% of the slum households can access drinking water within the premises. The rest of the people depend on sources near (19%) and away (36%) from the premises for their drinking purposes.

Safe drinking water has to meet the quality guideline set either by WHO or National Standards. Access of safe drinking water is the proportion of people using improved drinking water source, this include: household connection, public stand pipe, borehole, protected dug well, protected spring and rain water (WHO 2014). Slum households of Kerala depend on various water sources such as; tap water from treated source, tap water from un-treated source, covered well, un-covered well, hand pump, open well, borehole and other sources includes spring, ponds, river, canals, lakes etc. According to Census of India, water from treated source refers to a source of drinking water which is provided to individual households through taps by the Govt. departments, local bodies, panchayats, public or private estate agencies, etc. after the removal of impurities by filtration and disinfection by chemical treatment. Fifty three percentages of slum households of Kerala depend on tap water from treated sources, 24.8% depend on un-covered well, 14.2% depend on covered well and 1.4% depends on tap water from untreated water source for their drinking purposes. Hand pump (0.73%), tube well (1.6%) and other sources (0.73%) constitutes the drinking water source for the remaining 3.1% of the slum households. More than 98% of slum aggregates of Kochi Municipal Corporation, Thiruvananthapuram Municipal Corporation and Kannur Municipality are using tap water from the treated water source for their drinking purposes. Water availability and water source together used to describe the factor 'availability of treated water within the premises'. Highest percentage for treated water within the premises was obtained for Kannur Municipality (94%) followed by Kochi Municipal Corporation (69%).

2.3.8. Mode of Wastewater Discharge

The wastewater from slum households is discharged into closed drainage, open drainage and open space or no drainage area. Kerala has very low coverage of sewage treatment facility. Except Thiruvananthapuram (30% coverage) and Kochi (5%coverage), no other cities in Kerala have sewage treatment facility. Majority of the slum households of Kerala discharge their wastewater into open space or no drainage area (Harikumar & Bindhya 2012)]. Majority of the Slum households in Kannur Municipality (65.81%) are using the closed drainage system. Very low percentages of people in Chavakkad Municipality (2.3%) are using closed drainage system.

2.4. Slum Categorization

The classification and slum categories were established by considering 10 factors representing access to urban services. Based on the accessibility of the services to the slum the weighting score from 1 to 4 were awarded to each urban local body. The score 1 was assigned to the lowest accessibility and 4 to the highest accessibility of the urban service except in the case of total slum population in the urban local body, slum population in proportion to Kerala slum population and open defection (highest score is assigned to the lowest value) which has negative impact on the sustainable sanitation. Criteria for scoring are formulated based on the minimum, maximumand standard deviation value (Table 1). For example, in the case of household condition, the percentages of good household condition in the slum aggregates of each urban local body were calculated. The calculated minimum, maximum and standard deviation value for the percentage of good household conditions were; 27%, 83% and 16% respectively. Standard deviation was used to fix the range of each score. The first category starts from the minimum value of 27%, and the range 27% to 42% of good household condition was set for the score 1. Largest value of each range was added with the standard deviation value (16) and the resulted value was fixed as largest value of next range. Similarly the score 2 was given to the range 43% to 58% having good household condition (largest value of first range 42 is added with standard deviation 16 hence it results is 58 and it is fixed as the largest value of second range), score 3 for 59 to 74% having good household and the highest score of 4 was assigned to the urban local bodies which have more than 74% having good household condition. Total weighting score of each slum aggregates were calculated. Based on the total score, the 19 urban local bodies were further divided into four categories (Worst, Bad, Good and Best). Each range contains 4 divisions, lowest score range of 19 to 22 represent the worst category of slum aggregates and highest score range of 31 to 34 represent the best category of slum aggregates among the existing slum aggregates of Kerala.The criteria used for the categorization is given in the Table.2.

Table 1.Criteria for the Weighting Score

Factor and Urban Service	Standard Deviation	Score 1	Score 2	Score 3	Score 4
Total slum population in the urban local body(% of slum population in ULBs)	5	>15%	11to 15%	6to 10%	0 to 5%
Slum population proportional to Kerala slum population (% of slum population contribute to Kerala slum population)	10	>20%	11to 20%	1to 10%	<1%
Literacy (% of literates)	3	76 to 79%	80 to 82%	83 to 85%	>85%
Occupation of the slum residents (%of workers)	6	27 to 32%	33 to 38%	39 to 44%	>44%
Good household conditions (% of good households)	16	27 to 42%	43 to 58%	59to 74 %	> 74 %
Availability of electricity (% of electrified households)	5	81 to 85%	86 to 90%	91 to 95%	>95%
Availability of latrine (% of latrine availability)	10	62 to 71%	72 to 81%	82 to 91%	>92%
Open defecation (% of open defecation)	7	>21%	15 to 21%	8 to 14%	0-7%
Availability of treated water within the premises (% of treated tap water within the premises)	16	5 to 30%	31 to 55%	56 to 80%	>80%
Wastewater discharge into closed drainage (% of wastewater into closed drainage)	15	2 to 17%	8 to 33%	34 to 50%	>50%

Table 2.Criteria for the slum categorization

ID	Criteria	Score	Category
1	M-2SD to M-1SD	19to22	Worst
2	M-1SD to M	23 to 26	Bad
3	M to M+1SD	27to 30	Good
4	M+1SD to M+2SD	31 to 34	Best
M= Mean (27), SD= Standard Deviation (4)			

Various statistical analyses were conducted to explore the interrelationships between the factors and slum categories. The relationships between various factors were analyzed using correlation analysis (SPSS statistical software). Chi square analysis was conducted to determine the significant association between the various categories. Distributions of various factors to the score 1 to score 4 were also determined through the chi square analysis. Principal Component Analysis (PCA) was used to identify the important factor which required more attention in slum management activities. In this study the utility of PCA for ranking the variables based on the factor score were used. PCA produces factor scores with mean 0 and variance 1. A score of 0 on a factor indicates the factor is close to the average, similarly positive and negative scores represents the higher and lower ratings to the factors (Christine Distefano et al., 2009). Factor score was determined using SPSS statistical software to prioritise the various factors and urban services. The factor which gets highest score was considered as the critical factor.

3. Results and Discussion

According to the 2011 census, nine districts in Kerala have slum aggregates (Thiruvananthapuram, Kollam, Alapuzha, Ernakulam, Thrissur, Palakkad, Kozhikode, Kannur and Kasaragode). Slum aggregates in various district of Kerala is shown in the figure 1. Among the nine districts, Thiruvananthapuram district has the maximum number of slum aggregates; four urban administrative bodies have slum households in the district, which is the capital of Kerala State. Alappuzha and Trissur are the Districts having three urban administrative bodies with slum aggregates. In Kollam, Ernakulam and Kozhikode Districts have two slum aggregates and the remaining districts such as Palakkad, Kannur and Kasargode Districts have one slum aggregates.

3.1. Correlation Analysis of Factors and Urban Services

The relationship among the factors representing access to urban services was identified through a correlation analysis. SPSS statistical software was used for the correlation analysis in the current study. Total number of slum households (slum settlement), population of literates (literacy), population of workers (occupation), households who use treated tap water within the premises , households who use latrine, households practicing open defecation, households having electricity and households who discharge waste water into closed drainage were used as input data. Pearson correlation analysis explains correlation significant level less than 0.05 indicates that there is significant correlations exist between the variable. In the present study literacy, occupation, good household condition, treated water availability, latrine availability, electricity and wastewater discharge were correlated at the significant level 0.01(**), that indicate there is a strong relationship between the factors. Open defecation has a negative correlation with literacy, occupation and wastewater discharge. The correlation study concluded that the factors are interrelated to each other and that all the factors contribute to the social and environmental sanitation status of the slum aggregates of Kerala. Correlation matrix of the factors and urban services are given in the Table 3.

3.2. Slum Categorization

The existing slum aggregates of Kerala are categorized into four types by assigning a weighting score of 1 to 4 based on their accessibility to urban services. The categorization study describes the variation of urban services within each urban slum aggregates of Kerala (Table 4). Kannur, Kunnamkulam, Chengannur, Mavelikkara and Paravoor had a highest score of 31 to 34 and they are categorized as best among the existing slum aggregates of Kerala. Kozhikode Municipal Corporation, Palakkad Municipality, Thrissur Municipal Corporation, Kochi Municipal Corporation, Thrippunithura Municipality, Kayamkulam Municipality and Kollam Municipal Corporation which constitute 37% of slum aggregates with weighting score of 27 to 30 can be classified in good category. Kasaragod Municipality, Vadakara Municipality, Attingal Municipality, Thiruvananthapuram Municipal Corporation and Neyyattinkara Municipality scored between values of 23 to 26 and can be categorized as bad. Chavakkad and Nedumangad Municipalities is coming under worst category since they received only a score of 19 to 22. A total of 4 slums aggregates are reported in the Thiruvananthapuram District in which 3 are in the bad category and the remaining 1 is in the worst category, that indicate the factors and urban services provided to the slum aggregates of the district are not sufficient to solve the sanitation issues. Efficient implementation of slum improvement activities are required to solve the sanitation issues of the slum aggregates of Thiruvananthapuram District. Figure.3 shows the categorization of urban slum aggregates of Kerala.

Table 3.Correlation matrix of factors and urban service

	Slum settlement	Literacy	Occupation	Good Household condition	Treated water availability within the premises	Latrine availability	Open defecation	Electricity	Wastewater discharge (closed drainage)
Slum settlement	1								
Literacy	.062	1							
Occupation	.032	.997**	1						
Good Household condition	-.030	.936**	.947**	1					
Treated water availability within the premises	-.051	.948**	.962**	.990**	1				
Latrine availability	-.035	.950**	.962**	.994**	.997**	1			
Open defecation	.325	-.053	-.055	.044	.018	.032	1		
Electricity	-.044	.943**	.957**	.995**	.996**	.999**	.024	1	
Wastewater discharge (closed drainage)	-.015	.964**	.973**	.991**	.993**	.996**	-.011	.994**	1

**. Correlation is significant at the 0.01 level (2-tailed).

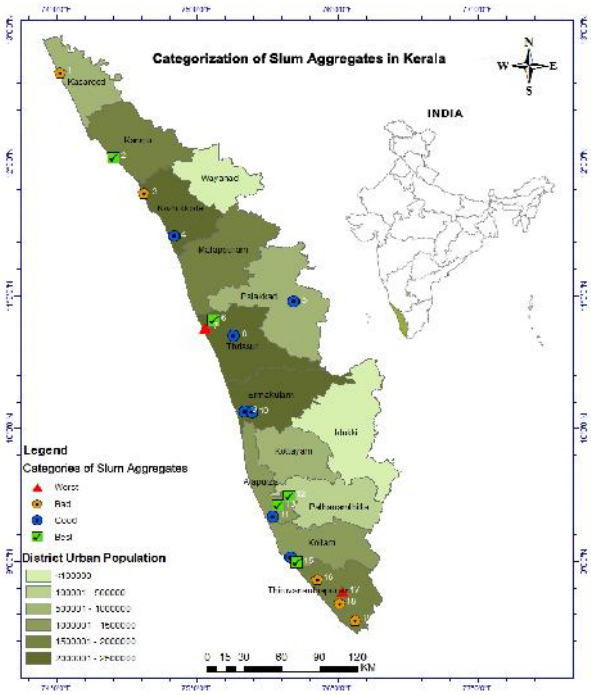

Figure 3.Categorization of slum aggregates in Kerala

Table 4.Categories of slum aggregates in Kerala

Weighting Score	Slum Categories	No. of urban local body with Slum aggregates in Kerala	Percentage of Slum aggregates in Kerala
19 to22	**Worst**	2	11
23 to 26	**Bad**	5	26
27to 30	**Good**	7	37
31 to 34	**Best**	5	26
Grand Total		*19*	*100*

Chi square analysis was conducted to determine the significant association between the various categories. Estimated chi square value for best and good category is 0.334 at 1 degree of freedom, it is less than the tabled value (3.841) that indicates there is no significant association between best and good categories at 0.5% level. Chi square value for best and bad category is zero and best and worst category is 1.284 at 1 degree of freedom, both are not significant at 0.5% level. So it is concluded that best is not associated with any one of the three, indicating that they are all independent categories.

Distribution of various 10 factor for score 1 to score 4 was calculated through Chi- square test (Table 5). Tabled Chi square value for 9 degree of freedom is 16.919. Calculated Chi square value is less than the tabled value for score 1 and score 3 indicating that there is no significant difference in the distribution of 10 factor for score 1 and score 3. Chi square value of score 2 is significantly higher than the tabled value. The 10 factor for score 2 is not equally distributed. The distribution score of the wastewater discharge into closed drainage and occupation of the slum residents are significantly higher than all the rest. Chi square value of score 4 is also significantly higher than the tabled value it indicates that the10 factors are not distributed equally for score 4. The factor open defecation is a significantly higher score contributing factor it is followed by percentage of total slum population in the urban local body (ULBs).

Table 5.Chi square analysis

Score	Chi Square Value	df	Significant Level
Score 1	16.24	9	P<0.05
Score 2	22.79	9	P>0.05
Score 3	6.86	9	P<0.05
Score 4	32.34	9	P>0.05

Table 6.Chi square analysis

Factor and urban services	Factor Score	% of variance
Wastewater discharge into closed drainage	0.936	2.183
Availability of treated water within the premises	0.915	3.657
Availability of electricity	0.881	13.099
Percentage of slum population proportional to Kerala slum population	0.837	30.837
Good household conditions	0.821	8.279
Occupation of the slum residents	0.818	16.009
Open defecation	0.719	1.214
Percentage of total slum population in the urban local body (ulbs)	0.716	18.661
Availability of latrine facility	0.616	5.154
Literacy	0.602	0.907

Principal component analysis was conducted to identify the factor which required more attention for the slum management activities. Results of principal component analysis are given in the table 6. Wastewater discharge into closed drainage received higher factor score of 0.936 with 2.183 percentage of variance followed by the availability of treated water within the premises (factor score of 0.915 and percentage of variance 3.657). In the categorization method treated water within the premises received the maximum lowest score of 1 and wastewater discharge into closed drainage and occupation of the slum residents received maximum score of 2. Based on the principal component analysis and categorization score, wastewater discharge into closed drainage and availability of treated water within the premises can be identified as the most critical factors. Government institutions shall take more care on supplying safe drinking water in their premises and implementation of proper wastewater management system in the slum aggregates of Kerala. The slum in Kerala can be improved through National Slum Development Program (NSDP) by providing adequate water supply, acceptable sanitation better education, enough health care facilities, satisfactory housing and living conditions. Open defecation received the maximum highest score of 4 which indicates that, majority of the slum households in Kerala are free of open defecation.

3.3. Conclusions

Growth of global population will naturally results in increase of slum population. The existing policies and programs for slum management are not effective for solving the sanitation and other related issues because of the lack of proper planning and implementation strategy. There is a need to study all the issues faced by slum population with its complexity to modify the slum development programs. As per the 2011 census, Kerala has 19 urban local bodies with slum aggregates. Slum population and number of slum households vary in each slum aggregates of Kerala. There is a significant positive correlation exist between the district urban population and slum population of Kerala. The increasing trend in urbanization may contribute to the possibility of the formation of slum aggregates in Kerala State.

The assessment of the accessibility of urban services in 19 slum aggregates of Kerala indicates that the existing living conditions are not same in the various slum aggregates of the State. Total slum population in the urban local body, slum population proportional to Kerala slum population, literacy of the slum residents, occupation of the slum residents, household conditions, availability of electricity, availability of latrine facility, open defecation, availability of treated water within the premises, and wastewater discharge into closed drainage are the factors considered for the study. From the total slum households of Kerala, 63% are in good condition and majority of the slum households have the facility to access drinking water source within the premises (79%). But only 53.5 % of slum households have the facility to access tap water from treated sources and other slum residents depend on various water source like tap water from un-treated source, covered well, un-covered well, hand pump, bore well and other sources includes spring, ponds, river, canals, lakes etc. Wastewater discharge into open space and no drainage area are very common in most of the slum aggregates of Kerala irrespective of district urban population. Ninety three percentages of the slum households avail the latrine. From the correlation study the factors like, literacy, occupation, good household condition, treated water availability, latrine availability, electricity and wastewater discharge were correlated at the significant level 0.01, that indicate there is a strong relationship between the factors. Open defecation has a negative correlation with literacy, occupation and wastewater discharge.

The sanitation status of the slum aggregates of Kerala was identified by categorization method. These will provide a better target mechanism to identify which slum require more attention in the slum management activities and it will also define major policies and strategies to manage slum growth in urban area.

The existing slum aggregates of Kerala are categorized into four types by assigning a weighting score of 1 to 4 based on their accessibility to urban services. The categorization study describes the variation of urban services within each urban slum aggregates of Kerala. Kannur Municipality, Kunnamkulam Municipality, Chengannur Municipality, Mavelikkara Municipality and Paravoor Municipality had a highest score of 31 to 34. Kozhikode Municipal Corporation, Palakkad Municipality, Thrissur Municipal Corporation, Kochi Municipal Corporation, Thrippunithura Municipality, Kayamkulam Municipality and Kollam Municipal Corporation which constitute 37% of slum aggregates with weighting score of 27 to 30 can be classified in good category. Kasaragod Municipality, Vadakara Municipality, Attingal Municipality, Thiruvananthapuram Municipal Corporation and Neyyattinkara Municipality scored only between values of 23 to 26 and can be categorized as bad. Chavakkad and Nedumangad Municipalities is coming under worst category since they received only a score of 19 to 22. A total of 4 slums aggregates are reported in the Thiruvananthapuram District in which 3 are in the bad category and the remaining 1 is in the worst category, that indicate the factors and urban services provided to the slum aggregates of the district are not sufficient to solve the sanitation issues.

Based on the chi square analysis it is noted that there is no significant association exist between the various categories of Kerala Slum aggregates. It indicates that all the slum categories; best, good, bad and worst are independent to each other. Principal component analysis was conducted to identify the factor which required more attention for the slum management activities. Based on the principal component analysis and categorization score, wastewater discharge into closed drainage and availability of treated water within the premises are identified as the most critical factors among various urban services. Government institutions shall take more care on supplying safe drinking water in their premises and implementation of proper wastewater management system in the slum aggregates of Kerala. The slum in Kerala can be improved through National Slum Development Program (NSDP) by providing adequate water supply, acceptable sanitation, better education, enough health care facilities, satisfactory housing and living conditions.

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