



ZERO WASTE

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Abstract

Increase in the globalization and urbanization has led to increase in the lifestyle of the people. The increase in the lifestyle of the people has led to an increase in the waste generation as well. The waste generation at the alarming rate has led to a serious concern. Zero waste serves as a significant approach towards the waste management concern. This study focuses on the literature review on the concept of zero waste. A efficient literature review was conducted on numerous articles published on zero waste. The main objective of this study was to understand the idea of zero waste and to weigh its pros and cons. It was observed that the concept of zero waste has been under constant debate. Though there have been numerous articles related to zero waste there is still a lot of pragmatic studies need to be carried out. There is a wide range of scope regarding zero waste, and it is a promising answer to the rising waste management problems

Index Terms: Reuse and Recycling, waste management, waste reduction, zero waste.

I. INTRODUCTION

Waste in the society is generally perceived as inescapable and objectionable. There has been many breakthroughs in the waste management sectors but a complete reliable and ecological waste management method has not been achieved. As per data the solid waste produced annually is about 1.47 billion tons. Whereas, the quantity of waste generated keeps increasing proportionally to the increase in the urbanization and globalization, which is a major cause of

concern. There are a lot of various methods followed in the current society to deal with the municipal solid waste such as incineration, gasification, landfills etc. However, any waste that is generated is considered to be a loss of precious resources.

In the current scenario of waste management practices only the after effects of the waste have been dealt, i.e. various strategies and solutions are being invented to be practiced once the waste is generated. There has not been many strategies to focus on the initial reduction of the generation of the municipal solid waste.

Waste management is a complex system which is a bunch of various other factors such a social factors, technological factors, economical factors, political factors and environmental factors related to it. Thus, while dealing with the waste management it is important to consider all the underlying factors related to it. The present situation demands an all-inclusive view towards waste management and thus the concept of zero waste grants as a very likely waste management strategy to be embraced.

This study mainly focuses in understanding the idea of zero waste through an intensive literature review. To list out the positives and negatives of the zero waste. Finally, to discuss the possible future research areas on zero waste.

II. METHODOLOGY

In order to obtain the objectives of the current study a rigorous literature review was carried out on the topic 'zero waste'. For the literature review on the articles the choice of the data base was 'science direct'. The articles on the database were selected through keywords such as, zero waste, waste reduction, waste management. A

number of journal articles were assembled by the database based on the input keywords. The article selection for the review was done by reading the abstracts of all the suggested journal articles, and the ones that were associated to the objective of this study. Once the articles were selected for the review it was then subjected to serious rigorous evaluation to comprehend the benefits, accountabilities, chances of attainment of success, causes of failures if any.

III. LITERATURE REVIEW

Atiq Uz Zaman (2015) in their journal article, "A comprehensive review of the development of zero waste management: lessons learned and guidelines", theorised zero waste development based on a rigorous review of available academic journal publications. The author considers the concept of zero waste as visionary to tackle the waste problems in the society. The article tells that the possibility of the zero waste studies is diverse, and that the concept of zero waste is constantly developing through various strategies, programmes and policies. The study revealed that many countries have initiated zero waste programmes but have not taken a holistic approach. The author suggests that the zero waste goals can be achieved by assimilating and encouraging zero waste initiatives in the communities and industries and also by developing a national zero waste strategy. However, the author acknowledges that achieving a hundred percentage of waste diversion rate is not possible in production presently, consumption and waste management systems in the society. The author concludes that article can be used by the decision makers and policy makers to develop evidence based zero waste guidelines.

Atiq Zaman (2014) in their journal article, "Identification of key assessment indicators of the zero waste management systems", the author identifies zero waste management as a holistic waste management system that considers waste as a resource. The article aimed at identifying the core of the zero waste indicators for the zero waste management system. In order to measure the progress and performance of the zero waste management system, it becomes necessary to have a certain indicators that predict the effective development scenario on the zero waste management. According to the author there has been numerous studies performed to

determine the key indicators of the zero waste management system. After an intensive literature review, a total of 238 indicators were listed as the preliminary zero waste indicators and these indicators were then sent to six hundred fifty highly experienced waste professionals around the globe for their feedback, out of which fifty six indicators were classified as the most important indicators for zero waste management systems and were rated as very high priority indicators by the waste experts. The author then classified the key indicators into seven major domains such as geo-administrative, socio-cultural, management, economic, environmental, and organisational and policy.

Yeny Dhokhikah., et.al (2015) in their journal article, "Community participation in household solid waste reduction in Surabaya, namely, Sukolilo, Rungkut, Tenggilis, Indonesia", examines the participation of the community in three districts of Surabaya, in household waste reduction and the factors that influence it. The research objectives were to determine the waste generation rate and its characteristics, to recognise the socio-economic characteristics of the respondents in the three districts, and to determine and analyse the influence of the factors on the community's participation in sorting, recycling and composting activities. A survey was conducted in order to obtain the socio-economic characteristics of the selected household in the Surabaya's three districts. A regression method was applied to relate the response and the predictor variables. The study revealed that the average household waste generation rate was 0.33 kg/capita/day. The composition of the household were, food waste (64.19%), plastics (10.79%), paper (9.24%), used diapers (6.97%). The study concludes by suggesting strategies to support the participation of the community in the household waste reduction, the strategies were to intensify the training programs and spreading out of information through mass media and campaign, also to increase in the number of environmental cadres, and optimising the existence of waste banks.

Kiriaki M. Keramitsoglou., et.al (2013) in their journal article, "Public participation in designing a recycling scheme towards maximum public acceptance", examines the pro-recycling activities of the community of Didimoticho, a

Greek provincial town. The aim of the article was to develop a potential recycling scheme for implementing it at the local level through better understanding of the citizen's pro-recycling attitude and the factors that have significant influence at making recycling easier and more effective. A survey was carried out by designing a fully structured questionnaire to explore the resident's information level about recycling, attitude towards the recycling program, and also to understand the respondents' socio-economic situation. This articles mainly discusses the responses given to the questionnaire by its 343 participants. The study concludes that there is a clear link between the recycling attitudes and the intrinsic factors such as level of information on recycling, pro-recycling behaviour, belief in recycling values and advantages. Also, socio-economic factors such as level of education, age etc. has an effect on the recycling attitudes. However, it was observed that financial incentives did not have any effect on the recycling attitudes.

Atiq Uz Zaman., et.al (2011) in their journal article, "Urban growth and waste management optimization towards 'zero waste city'", aims at understanding the key factors of waste management and the challenges, threats, and opportunities in transforming traditional waste management and optimizing the existing practices toward zero waste practices. The study focuses mainly on two cities, Stockholm and Adelaide that are aiming to transform their existing waste management practice into more efficient and sustainable one, i.e to zero waste practice. A background study was conducted in order to understand the waste generation and valuation of resources of the existing practice at the two cities, based on the philosophical context and material flow context. The case study on the two cities, Stockholm and Adelaide was done in order to analyse the waste generation, management, treatment, and environmental impacts. The author states that the waste management system includes socio-economic, political, environmental and technical aspects which are inter related and dynamic in nature, thus, the waste management system creates a complex cluster of aspects which are inter-related and dynamic in nature. The study concludes that the strategies that focuses on these mentioned aspects can assist the cities to achieve the zero waste goal, however, these

strategies have to be affordable, practicable and effective.

T. Ramayah., et.al (2012) in their journal article, "sustaining the environment through recycling: An empirical study", attempts to examine the factors that determine the recycling behaviour among two hundred students of Universiti Sains Malaysia (USM) in Malaysia, from the perspective of the Theory of Planned Behaviour (TPB). The data was collected based on questionnaire that was distributed among the students. A non-probability sampling technique using the intercept survey method was employed to select the respondents, to determine their recycling attitudes based on their attitude, social norms, and environmental attitude. Data was analysed using Structural Equation Modelling technique. The study indicates that environmental awareness was significantly related to attitude towards recycling, whereas attitude and social norms had significant impact on recycling behaviour. The author concludes that the study has enhanced understanding the determinants of recycling behaviour and can be used by schools and government agencies to educate and encourage the recycling behaviour.

G. Zotos., et.al (2009) in their journal article, "Developing a holistic strategy for integrated waste management within municipal planning: Challenges, policies, solutions and perspectives for Hellenic municipalities in the zero-waste, low-cost direction", proposed an extensive framework in order to streamline the role of Local Authorities (LA) of Greece, towards adoption of waste reduction strategies, promotion of waste separation and alliances with a vision of zero waste Local Authorities. The author recognises a policy implementation gap among the Local Authorities, which according to the author is partially due to the decentralization of the waste management system, which resulted in disorientation of the local activities and isolated from the national strategies which resulted in the significant planning and implementation problems along with the loss of available funds. The author concludes that in order to overcome the challenges face by the local authorities in Greece is by the effective co-operation of all the stakeholders; citizens, state authorities, NGO's etc also consulting and training activities on sustainable waste management targeting local communities and specific groups should become a priority.

Ahmed bin Hamad Al-Rabaani., et.al (2009) in their journal article, "Attitudes of Sultan Qaboos University Students towards Some Environmental Problems and their Willingness to Take Action to Reduce them", collected data from three hundred seventeen students from five different faculties using a questionnaire containing forty eight items distributed over five dimensions: Energy, water, air pollution, waste and desertification to determine the attitudes of Sultan Qaboos University students towards environmental problems, their willingness to take action to rectify these problems, to understand the effect of students' gender and college of study on their attitudes and to examine the relationship between student's attitudes and their willingness to take action to reduce these problems. The results showed generally that the students hold positive attitudes towards the issues raised, and are willing to take action to reduce environmental problems. However, the author concludes that the Omani educational system should put more effort into raising students' awareness of the importance of their individual and community role in tackling environmental problems, in order to give future generations the chance to live in a healthy environment.

I. G. Manson., et.al (2003) in their journal article, "Implementation of zero waste program in the university campus", explains in detail about the implementation of zero waste program at the Massey University, New Zealand in response to the grassroots students concern over environmental management issues. The implementation procedure in the study composed of an initial discussion with the academic and local authority staff at the target university, followed by the formation of working groups, preparation of funding proposals, establishments of externally funded research, educational and promotional programs led by the academic staff members. A campus environmental committee had been established in order to facilitate communication on environmental related matters. The author concludes that, a complete structural linkage between university management, operational and research sectors was absent and proposed them to be necessary to fully implement and progress the program.

Qingbin Song., et.al (2015) discusses about the strategy of zero waste in their journal,

"Minimising the increasing solid waste through zero waste strategy". The author in their study mainly focus on, the Industrial waste, e-waste, food waste and packaging waste, and their generation and impact on the environment. According to the author, in the present world with the depleting resources, zero waste may become absolute necessity due to the environmental pressure, in the future. The journal article also consists of case studies on various cities, companies, individual and industries who have implemented good zero waste practices. The cities include, Adelaide, Australia and San Fransisco. The companies are, Coca-Cola, Subaru US, DuPont. The individuals are, Door to Door collection program, Hernani, Spain, Community action, Taiwan, China, Waste pickers, Pune, India. The article suggests four levels for the management strategies of the zero waste which includes, Eco-design which is the design of the products using Life Cycle Analysis (LCA), Manufacturing process using clean production strategy which mainly focuses on the manufacturing process which is in co-ordination with the natural ecological cycles, followed by environmental and eco-labelling, finally, to establish an effective environmental management system. The author concludes that though many zero waste practices and approaches exist, zero waste is a complex system and to completely achieve this goal it will depend on a number factors and a require coordination and support of all the dependent factors.

IV. ZERO WASTE

Zero waste is an idealistic concept. According to the international zero waste alliance, zero waste is an objective that is virtuous, effective and visionary to guiding people to change their lifestyle and practices to imitate sustainable natural cycles in which all the unwanted materials are redesigned to become resources for other products. The zero waste believes in maintaining the natural cycles for all the materials. Hence, there is no wastage of resources.

The zero waste focuses on the product from its initial stages. It focuses on the reduction of the consumption of the resources in the earlier stages of product development. It aims at maintaining a circular economy. The concept of maintaining the natural cycles and a sustainable

society also requires a refined system of waste management.

In the literature review carried out there are mentions of life cycle assessments on products to maintain the zero waste management. The life cycle assessments not only deals with the problems of waste but also deals with the environmental impacts.

It has been observed from the review that waste management is a complex process and involves a various number of factors that would be impacting on the performance of the proposed strategies. Various studies had been carried out to understand the factors impacting the zero waste strategies. In which, social, economic, political, technical and environmental factors play a major role. For the implementation of the concept of zero waste it is important to understand it comprises of the involvement of all the mentioned factors i.e. the involvement of the citizen, political support, involvement of the stakeholders, proper technologies etc. Finally, in a zero waste world there is nothing that is considered to be a waste or undesirable or unusable but, it has to be considered to be a misplaced resource.

V. PROS AND CONS OF ZERO WASTE

Regarding the pros of the zero waste management, there is a good number of positives regarding the environmental impacts, economic benefits. Since zero waste focuses on maintaining a sustainable and natural cycle. There would a considerable decrease in the resource consumption. Due to the tracking of the products life cycle there is will also be a drastic decrease in the wastage of the resources. Reduction in the consumption of energy.

Since there is a decreased waste generation it in turn increases the efficiency of the product manufacturers thus increasing their profits. Also, since zero waste emphasizes on recycle and reuse of materials, there will a significant increase in the profits of the manufacturers.

One of the major factors for zero waste is the active participation of the community. With the active community participation there will be a likely increase in the awareness among the people and also increase in the sanitary and hygiene conditions.

Though being very environmental friendly and sustainable type of waste management system, zero waste also has its cons. Since waste

management includes a large number of influencing factors, and each factor is interdependent on each other it becomes difficult to manage such a complex structure. Among the social factors it is important to note that it is difficult to maintain an active participation from the community and to modify the consumption pattern of the society. It would also be difficult for the society to adapt to the zero waste life style

A zero waste strategy would be difficult to be implemented without strict and well defined policies, rules and regulations. These policies must be clearly defined and free from any ambiguity, so that each sector is aware of their duties and responsibilities towards waste management.

VI. CONCLUSION

Research work on zero waste have been increasing in the recent years and people are becoming more aware of the zero waste. Zero waste has now caught a global attention, due to the increasing waste problems. Zero waste is a promising solution to our current waste problems.

Zero waste is not only a visionary concept it can also be brought into practice. This is possible by integrating all the influencing factors of the zero waste. With more awareness campaigns and educational programs the society can be made more aware of zero waste and its benefits. With such campaigns and awareness programs it would also encourage the society to take up zero waste lifestyles, i.e. reduction in consumption and waste generation.

A strong support from the political parties and stakeholders would be necessary for the successful implementation of zero waste. Strong policies and regulations would help in the better implementation of the strategies.

It is also observed from the literature review that not a lot of work has been carried out under zero waste. There is a lot of scope for the works to be carried out in zero waste management.

REFERENCES

Journal articles / Conference paper:

1. Atiq Uz Zaman, "A comprehensive review of the development of zero waste management: lessons learned and guidelines", *Journal of cleaner production*, 91, 2015, pp 12-25..

2. Atiq Uz Zaman, "Identification of key assessment indicators of the zero waste management system", Ecological indicators, 36, 2014, pp 682-693.
3. Natália Pietzsch, José Luis Duarte Ribeiro, Janine Fleith de Medeiros, "Benefits, challenges and critical factors of success for Zero Waste: A systematic literature review", Waste management, 67, 2017, pp 324-353.
4. Yeny Dhokhikah, Yulinah Trihadiningrum, Sony Sunaryo, "Community participation in household solid waste reduction in Surabaya, namely, Sukolilo, Rungkut, Tenggilis, Indonesia", Resources conservation and recycling, 102, 2015, pp 153-162.
5. Kiriaki M. Keramitsoglou, Konstantinos P. Tsagarakis, "Public participation in designing a recycling scheme towards maximum public acceptance", Resources conservation and recycling, 70, 2013, pp 55-67.
6. Atiq Uz Zaman, Steffen Lehmann, "Urban growth and waste management optimization towards 'zero waste city'", City, culture and society, 2, 2011, pp 177-187.
7. T. Ramayah, Jason Wai Chow Lee b, Shuwen Lim, "sustaining the environment through recycling: An empirical study" Journal of environmental management, 102, 2012, pp 141-147.
8. Asmawati Desa, Nor Ba'yah Abd Kadir, Fatimah Yusoff, "A Study on the Knowledge, Attitudes, Awareness Status and Behaviour Concerning Solid Waste Management", Procedia Social and Behavioral Sciences, 18, 2011, pp 643-648.
9. G. Zotos, A. Karagiannidis, S. Zampetoglou, A. Malamakis, I.-S. Antonopoulos, S. Kontogianni, G. Tchobanoglous, "Developing a holistic strategy for integrated waste management within municipal planning: Challenges, policies, solutions and perspectives for Hellenic municipalities in the zero-waste, low-cost direction", Waste management, 29, 2009, pp 1686-1692.
10. Ahmed bin Hamad Al-Rabaani, S.S. Mohammed Al-Mekhlafi, "Attitudes of Sultan Qaboos University Students towards Some Environmental Problems and their Willingness to Take Action to Reduce them", journal of social sciences, 5(1), 2009, pp 9-15.
11. R.E. Timlett, I.D. Williams, "Public participation and recycling performance in England: A comparison of tools for behaviour change", Resources conservation and recycling, 52, 2008, pp 622-634.
12. Atiq Uz Zaman, "A comprehensive study of the environmental and economic benefits of resource recovery from global waste management systems", Journal of cleaner production, 124, 2016, pp 41-50.
13. Qingbin Song, Jinhui Li, Xianlai Zeng, "Minimising the increasing solid waste through zero waste strategy", Journal of cleaner production, 104, 2015, pp 199-210.

Electronic sources:

14. Zero waste International alliance
Available at: <http://zwia.org>