Literature Reviews on the Arrangements for the Sanitation of Public Places during and after Pandemic

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Abstract- **The pandemic of corona virus disease is a reason for the loss of a lot of lives in the world. The pandemic has taught us a lot of things. As per the reports, the main reason of spreading of this virus was the movement of people in and around the world. There are too many ways of the public transportation in the world which are air ways, railways, water ways, and roadways. The most popular, common and cheapest way of transportation is roadways. Passenger buses are most commonly used by people for transportation. Hence sanitization of passenger buses is a most important and necessary task in all aspects. There are many researchers working on too many aspects of the Covid-19 virus pandemic which includes treatment and sanitization of various places and all. The purpose of the paper is to study the various researches and find a best, cheapest and easy way to make public transport a hygienic, sanitized and disinfected.**

Index Terms: **Covid-19, Public Transportation, Disinfection, Touch less, Automation**

I. INTRODUCTION

After the disastrous years of global pandemic, stepping in where humans should not, robots are being used for various purposes such as sanitizing hospitals, delivering food and medicines, hand sanitizer robots, and have proved to be to be very useful and handy. Each and every day as health workers, doctors, sweepers, struggled to control the spread of virus that has infected a lot of people globally and claimed millions of lives. Robots were and are also being deployed for provides support to the workers and patients as well.

A two feet distance and sanitization, which has become a very important aspect from the days of pandemic, sanitization plays a very important role in preventing us from these deadly virus. There are some evidence from previous researches, the studies shows that public transportation system has an influential role in the spread of flu as well as an infectious virus due to the massive number of people confined in less space, low ventilation, common access and many common touch points which includes doors handles etc [1].

II. LITERATURE REVIEWS

The transportation system has a massive role in every city and country as well. The transportation system has changed a lot due to the cause and spread of corona virus. Government of different countries followed different types of strategies to control the spread the of corona virus and apply a necessary action for hygiene and sanitization of public transports. The necessarily sanitization of passenger buses, taxi, rickshaws, and other transportation vehicle is applied in every sector. The different countries adopted many obstructive operations for the safety of people travels in public transports. The prevention includes the disinfection and sanitation of vehicles, high touch points at regular intervals while some countries implemented some automatic and advanced technique to control the spread of virus. [2]

The forthcoming era is a technical or robotic era. The robots are evolving in too many allied areas. Automation is using in each and every sector like medical, transportation, homecare, health care and many more. The prime utilization of robots is to reduce the contact from person to person and also to ensure sanitization, cleaning, and many more works can be done with the help of robots. In medical sector the robots will be very useful in reducing the life threats to medical staffs and doctors taking an active role in the management of covid-19 pandemic. As WHO has

advised 2 feet distancing for people around the world to reduce the spread of corona virus, robots are used to deliver food, medicines, to patients, and sanitation process, which reduced the spread of virus.

The main objective is to minimizing human association as much as possible and thus automating the task such as sanitation, cleaning, with the help of robots. The robots are used to reduce human subjection to parasite which became necessarily as pandemic escalates. The main focus is to design a smart medical assistant robot by using contactless sensor technologies. The robot should compact and efficient handling design is priority to make the better implementation, a quick learning real time environment recognition technology for its locomotion in public places and also a crowded hospital. This review affirms that the new medical robots have powerful safety and quality of health management systems compared to manual systems. [3]

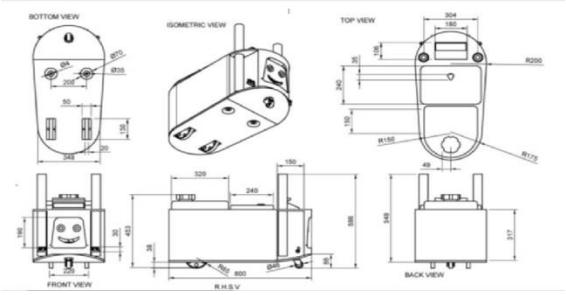

Figure 1. Mechanical Design of Sanitization Robot [3]

An increment in demand for the service robots has seen after pandemic as a replacement of humans to do various works in contaminated areas. The works includes logistics, patient care disinfection and sanitation of various high touch points, which is useful to minimize the risk of human exposure to the highly contagious and deadly infection, a unique design and development of Smart cleaner, which is a new cost effective and automatic indoor sanitation robot. As seen from the technical point of view, the deployment of robot is very much preventive operation obviously to overcome the various difficulties and boost the efficiency of combating the pandemic. It has become apparent that, the robotic system is broadly advanced persistent attacking solutions for dealing with a lot of various problems caused by covid-19. These include disinfection, tale -healthcare, manufacturing, and other interpersonal problem unique to the lockdowns of the pandemic. The robots can be sorted based on different application scenarios [4, 5] such as Hospitals, Airports, Transportation tools, hotels, and communities. The robots are immune to pathogens. The robots can easily access the places where humans have difficulty in reaching.

The main focus of the researcher is indoor disinfection or sanitation, corona virus or covid-19 can persist on inanimate surfaces for up to several days, depends on the kind of material. Hence sanitation should be contactless, that is why robots are much more efficient in sanitation of such things. Remote controlled or automatic sanitation is safer, fast and effective way of disinfection. The paper published by the author contains the design and verification of a cost effective, automatic sanitation robot for indoor disinfection. The robot was a prototype system which is named as Smart Cleaner fabricated by integrating the functions of Path planning, navigation, dry mist hydrogen peroxide disinfection using ROS programming. The project was successfully developed and fulfilled the requirements as suggested by the author. [6]

The sanitation process is very important process to control the pathogens of covid-19. Many researchers studied on various aspect of pandemic of corona virus which includes identification of the contagion, its treatment, also vaccine development. The increase in passenger traffic at various places like bus station railway station, airports was expected. The purpose of this research is to develop a solution to reduce the transmission of virus through vehicles such as passenger luggage, bags and other objects which people carry with themselves while travelling. An X-ray machine type system is proposed by the author for the disinfection of luggage through ultraviolet radiation. In addition a non foaming soap solution spray can also implement. These researches introduce the technology for a continuous sanitation of luggage and packages of passengers at high volume footfall location such as bus and railway stations. It consist a UV-C based illumination system inside surrounded passage with an optional spraying system.

The disinfection systems are very common and use one of the many disinfection strategies. The main goal of proposed system is to reduce the spread of Wuhan corona virus by sanitizing the surfaces of luggage. As described that the Ultraviolet radiation is the preferred disinfection agent. The ultraviolet radiation system is commonplace and is applied widely to treat surfaces

in hospitals, liquid sanitation systems, among many applications. [7] Some disabilities of current products are seen and studied by the author. One of them is that the designs which are available currently in the market for the sanitation of rooms and many other substances are open systems which require the motion of people out of the rooms while operation of sanitation is occurring in the room. Another major problem is that the most of designs are much more expensive for the general public. The products are designed outside of India and hence the import duty and other taxes make it costly. Product designed by the author is effective and can be operated in the presence of people also. It has cheapest cost and easy operating system. [8]

An analysis on impact of pandemic of covid-19 on the transportation sector has been done in the research. Investigation of normalization of sector has been studied. The pandemic had impacted not only the consumer interaction with producers but also it has impacted the environment, hence it is important to change the supply chain. The lockdown had improved the environment condition, it cured the ozone layer, and it had done only because of the low consumption of fuel and not using of vehicles which affected the transportation sector. The main focus of author was to normalize the transportation sector as before. The new normal should be in favor of good environment. One more proposal which is taken in the paper was to approach transport sector the 'new normal' which will be in terms of health emergency and should be expansive in terms of forthcoming outbreaks.

After the complete research the it is observed that with the help of the lockdown the transport system especially railways should be change in favor of environment friendly, the whole transport sector require to think on pathogens of virus crisis and generate a navigation map to unexplored waters. The contribution of the paper is the strategic design of the sector with the production of the 5 'R's; Return, Resilience, Reform, Re-imagination, and Research. [9]

The pandemic of corona virus has significantly affected the transport sector and service requirements across the globe. Various countries begin to direct their return to regularity. In view of this review, the systematically research and integrate the literature on the effects of virus on transportation to investigate the requirement to adapt planning measurement, on other side current methods for transportation planning at operational level. The paper synthesize the general transportation design literature from the viewpoint of modifications in require patterns and limited ability associated with the pandemic crisis.

The paper offers a research program to handle the remaining gaps. Following points are covered in the review; what are the impacts of pandemic strait and the relevant social distancing rules for public transportation planning and modeling. What are the strategic, tactical planning methods, and which of them are suitable for the distancing rules and regulations.

The major impacts on passenger demands are also covered in the research. The transport ridership has been reduced during the lockdown time the drop in ridership is estimated as much as 80% to 90% in major cities like China, Iran and the US and varies percentage wise from country to country. The main propaganda of the research is to develop a design which is able to make a social distancing measure to combat virus spread call and need to avoid crowding by distinguishing passenger requirements as evenly possible in both space and time.

Planning public transport services to prevent crowded conditions is considers to be instrumental in reducing the expansion of the virus. [10]

The epidemic of Covid-19 has been spreading earlier across the globe, posing a tremendous risk to universal public health. As per World Health Organization (WHO), the impact of corona virus has occurred in more than 200 countries with more than approx twenty million of confirmed cases. [11] Because of its continuous spread it is necessary to combat with the virus. The primitive mode of the transportation is public transportation. The vehicles used for public transportation contains very less and limited spaces that are contributive for men to men transmission of infection. For common flu, a research in Nottingham explained that the risk of evolving flu increased by six fold for public traveling public transportation within 5 days of symptom onrush. People during 5 days of disease attack commonly do not generate influenza symptoms but remains affected, leads in increment of infection risk of flu. [12] There are some other studies which reported that covid-19 occurred while travelling in bus. The limited space in buses is the main reason of spread of virus during traveling. [13]

To prevent the spread of virus some preventive operations should be followed as suggested in the

paper the suggestions are; sanitation, health promotion, personal care, environmental hygiene and more. Some other requirement should be adopted as per the paper are reserving materials and implementing safeguard, training and health education, formulating guidelines and strengthening cooperation, environmental cleaning and disinfection. Everyone should cooperate with each other to control the spread of virus. [14]

The pandemic raised terrific disputes for modern transport systems globally, which results in unique decline in requirement and revenue. The paper harmonize the highest development, till the June 2020, on key development with respect to public transportation and the pandemic of Covid-19, it includes the various adaption of responses by the government and transportation department across the world, the investigation needs pertinent to serious issues that reduces the pandemic risk in transportation. The focus of the research is to provide a comprehensive review and perspective for transit policy maker, and researcher to navigate a state of art and investigate requires relevant to the impacts of pathogens problems on public transport.

Some factors which contribute to make the public transportation sector a serious problem for the Covid-19 pandemic. [15] People are constrained in limited space. There might be lack of access control to recognize the people or workers who may be ill, the presence of many surfaces like seats, doors, handrails etc. that may easily transmit the germs.

Some new rules suggested in the paper for the use of public transport. The rules are made mandatory to follow for each and every person on earth. The rules are 1) compulsorily use of face mask in crowded regions. 2) Sanitation should be occur in each region and hygiene should followed by the people to control spread of virus. 3) Physical distancing should follow compulsorily to avoid the human to human contact.

A comprehensive analysis on the identifying the different levels of infection that make people transmission use increment in risk as per public health. Undeniable evolutions like vaccination or lifting isolations measures lie beyond the control of public transport service providers. [16]

As we all know that corona virus is very dangerous, extremely infectious, long lasting in nature. Its behavior highlights the requirement of hospital space sanitation technology and the prohibition of human detection to pathogenic environment. The paper provides a design of a robot with smart sterilization method to spray sanitizer in OT, or patients' ward and other places. Manual disinfection process may cause anxiety, tension, and loss of productivity to humans when exposed to potentially contaminated surfaces.

Robot disinfection can be categorized into two main categories it may be UV disinfection and liquid sanitation. The smart sterilization robotic system should be able to perform many functions, and restricted to remote movement and sanitation. The robot is designed to save the manpower and minimize the chance of human exposure to the virus atmosphere, the robot facilitate with a semi-automatic remote control or automatic intelligent sanitation function.

The main objective of the research was to combine the realistic technologies into smart sterilization robotic system to gain the efficient disinfection that is critical during pandemics. [17]

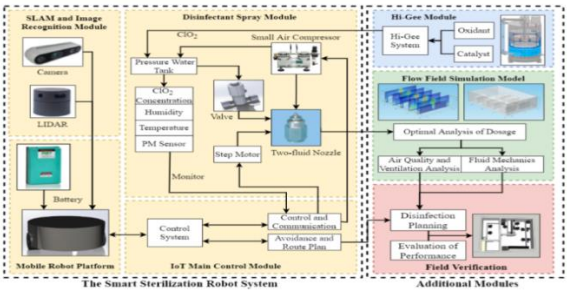

Figure 2. The Final Structure of the Smart Sterilization and Additional Modules [17]

To control the deadly infection it is very important to follow the rule and adopt an undeniable procedure to combat the virus. Existing disinfection method relies manually on the application of synthetic liquid based sanitation which consumes time, resource exhaustive and liable to great degrees of human error. As a substitute a touch less sanitation method, like Ultraviolet Germicidal Irradiation (UVGI) have the ability to conquer many of the limitations of existing methods while substantially progressive workflow and utilization of equipments. Two experiments have been conducted in two different hospitals. The experiment was done in CT and X-ray room. As a result the UVGI system successfully deactivated the computable microbial load on 22 out of 24 surfaces and on the last two surfaces UVGI reduced the microbial load by 84 and 95 percent respectively. The demonstration has the ability to deactivate the load of microbes even with the complicated cell structures and requiring higher

ultraviolet deactivation energies than SARS-CoV-2; hence the research shows that it has more effectiveness against corona virus. The most common issues related to existing sanitation practices were more elementary, and include both scientific factors and operational factors.

Presently, optical inspection is only the usual way to access the potency of cleaning in hospitals. Though, since the majority of common germs are less than ten microns in size, which is impossible to tell with barely eyes that a surface has completed sanitized or not. [18]

When compared visual examination against chemical (ATP), microbial methods and aerobic colony count (ACC). As the result it was observed that optical evaluation was an insufficient and individual means of surveillance the disinfection of hospitals and what appear sanitized to the eyes was not much satisfied when analyzed thoroughly.

The conventional method of cleaning are restricted to surface only, hence it is unable to provide a complete sanitization. Hence they are only able to protecting against fomite transmission and somehow inefficient against droplet and aerosol transmission. [19]

The main focus of the paper was to complete research on germicidal effectualness and the physical possibility of using a UVGI device in terms of automation to sanitize the surfaces in radiology setting. This new sanitation research is approximated to be between 2 or 4 times better than existing chemical processes. The system is able to make the workflow and utilization of machines better and minimize the battlefront health care workers to dangerous pathogens. [20]

The pandemic of Covid-19 has brought a full of distress era, which cause the loss of millions of lives and also affected the mentally and economical health. To prevent the human from germs, hand sanitation has made a priority for each and everyone. In the era of technology, everything is automated, fast, easy and innovative. In this paper "Automated Sanitization" device is proposed, which is useful to make the sanitization process and screening of body temperature very fast, automatic and easier. The suggested device contributes substantially to reduce the spread of deadly virus and raises the attention to maximize the hygiene at public places. The methodological design is also discussed in the paper with focusing on the technical and financial aspects.

Proper hygiene and sanitation is requiring to prevention from the disease, it is considered as the most crucial component to control pathogens. The acceptance of proper hand hygiene can be raised only when suitable and easily accessible dispensers are established. [21, 22]

A touch less disinfectant dispenser which also has the facility of automatic mist based mechanism for raising the use of sanitizer is developed by one of the best organization which is Defence Research and Development Organization (DRDO). [23]

As per the research, there is great demand automatic contact-less disinfection device as it is very useful and its touch-less technology which reduces the chance of direct contact with germs. The device proposed in the paper is extremely helpful for consenting with hygiene standards especially at public places. [24]

Table 1 Components used in Automated Sanitization Device [24]

Component Used	Specifications	Cost (INR)
Arduino pre mini (1)	5V/16 MHz	300
Ultrasonic sensor (1)	5V	100
OLED display (1)	5V/1.3inch	350
DC pump (1)	12V DC, Flow rate 240L/H	300
Temperature Module (1)	5V, High Accuracy	2000
LED and Buzzer (1)	Altering Purpose	50
Frame	3d printed Metallic body	900
Printed Circuit Board	Embedded with PCB	500
Node MCU	Wireless data transfer	300
Miscellaneous	Assembling cost	200
Total		5000

The Indian transport sector is vast, large and disparate and this sector contributes around 5.2 percent to the India's GDP with the great shares of road transport itself. Corona virus has consequential implications for the transport department. The sudden down in the use of public transport was observed by the initial period of covid-19. [25] Sudden decrement of use of transportation has impacted the economical health also but improved the environmental health. A complete research on Impact of Covid-19 on Passenger transportation has been discussed in the paper. The

focus of the paper is to minimize spread of covid-19 and literature on intermediary health advisory. A conclusion on integral assessment of measures on socially related effects are rare is being discussed. [26]
Mobile Robot Application against covid-19 is an article which investigates about the various applications of mobile robots to minimize the spread of covid-19. The paper describes the different contributions of various companies around the globe that seeks to adapt the necessary needs in able to mitigate the progress of covid-19 using automatic machine tools like mobile robots. The main focus of the writer is in area of health, medical and sanitation services. [27]
In Taiwan, year 2020 an examination was done. The research of examination was published which shows the examination of two chemical disinfectants viz. chlorine dioxide and weak acid hypo-chlorous water in a soiled room and complete dishwashing of a hospital's infectious ward. The study concluded that the application of chlorine dioxide twice daily provided the most effective means of satisfying the Taiwan EPA guidelines for indoor air quality of wards of hospitals. [28]
Robots are used a lot for health care and services. The robots are used as service robots as they make a contact less environment for humans in hospitals and other places also, the robots are very efficient in reducing the spread of corona virus and prevent the humans from direct contact with the bacteria. Robots not only prevents human from virus but also make the human work easy, fast, and with accuracy. The way of providing benefits to hospital staffs, patients, customers, and all living being have been focused in the paper. [29]
A study of Mobile Robots navigation in indoor environment is discussed. In the paper, the discussion is about the current trends in robot navigation systems. As per the study the navigation system is completely depend abstraction level of environment representation. The main objective of the paper was to study about the different approaches of mobile robot which is better applies to indoor environments. [30]
In December 2019, a lot of cases of covid-19 have been reported in Wuhan as per the study, and the virus spread dramatically in all over the world. To overcome the problem different protocols and strategies are followed by the different countries in the world. The study of different protocols adapted by the world has been discussed in the paper. The treatment, diagnosis, prevention and other suitable strategies and decisions have been discussed. [31]
In almost every country, covid-19 cases have been reported. Thousands of people have died and millions of people have been affected due to pandemic. After understanding the reason of disease World Health Organization (WHO) has released the precaution guidelines in terms of droplets and at the same time US centre for disease control also issued guidelines and recommended the aerial precautions. [32]
A guideline and technique for workplace cleaning and sanitizing are focused in the paper. Industrial hygiene is most important to reduce the sickness, impaired health and significant discomfort for workers and also for the citizens of different community. [33] A complete Guidance for disinfecting the public spaces, workplaces, homes, Schools, Public transportation and other such places has been covered by the Environmental Protection Agency, United States. [34]
Scientific Reports is a publishers published a paper on Far Ultraviolet C radiations which have the wavelength of 222 nm is very efficient and safe to deactivate the bacteria of corona virus aerially [35]. Ultraviolet radiations vulnerability is direct germicide approach and also it is very effective against the various viruses which spread aerially. [36-37]
A program named Innovations Deserving Exploratory Analysis (IDEA) which was organized by Transportation Research Board of The National Academies in which innovative ideas and procedures advancing transportation has been practiced. The topic Ultraviolet Germicidal Irradiation for Transit Buses has been discussed. The paper was prepared by Lee Huston. [38]
A methodology report on A Guide for Public Transportation Pandemic Planning has been published which includes some steps of simple guidelines to be followed. The main purpose for the paper is to create a guideline summary and develop a comprehensive planning for pandemic guide. The guide has been developed for some agencies which are urban transportation agencies, rural transportation agencies, and State Department of transportation Agencies. [39]
To reduce the spread of any virus aerially, careful control, regular disinfection, regular cleaning of places, disinfection of surfaces, and all these managements are very essential. The traditional cleaning manually is often substandard. To improve

continuously the manual cleaning is the main focus of the research done by John M. Boyce. [40]

III. CONCLUSION

As per the study, it was observed that the main reason of spread of corona virus was mainly by the travelers from one country to another, and from one city or village to another, which indicates transportation department majorly contributes in spread of corona virus across the globe. The above study is a complete study of the investigations done by the various researchers on the impacts of pandemic of covid-19 on transportation sector and public places. As per the study, it is found that various managements are to be done for sanitation purpose at public places.

Automation in disinfection and use of new technologies should be adapted for sanitation of various places. An automatic, easy, usable and cheapest technique should be priority for sanitation purpose. The techniques discussed above are somehow costly and difficult to operate for general purpose.

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