Reducing Water, Chemical and Fuel Waste in the Window Cleaning Operation Using Biology Driven Algorithm and Cyber Physical Systems

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Extended abstract

The Window Cleaning Operation in recent years has transformed from a "bucket & ladder" operation using tap-water to a high-tech industry utilising pure water and specialised van systems. The Covid-19 pandemic hereto invites the onset of more frequent cleaning and numerous window cleaning startups which is both opportunity and a challenge to shape-up an innovative growth for managing the next normal for the Window Cleaning Operation. The challenges faced with current calendar based planning, resource and route optimisation are now more critical than ever due to the growing complexity and high throughput nature of high-tech window cleaning operations along with demand for environment friendliness due to the climate change crisis. In order to establish an environment friendly and cost effective industrial scale efficient Window Cleaning Operation management system, multifactorial planning is required that will automatically input performance data from the water purification system on real time basis, locations of the water refill stations relative to customer

locations, near accurate estimation of pure water required for the planned jobs. With current calendar-based appointment solutions available for Window Cleaning Operation, planning is primarily based on human intuition or experience, and route optimisation is primarily done through the Google Map like Global Positioning System solutions which only takes locations of the customers as input. This location based Global Positioning System solution is untenable as the scale of Window Cleaning Operation has grown exponentially, especially during the COVID-19 pandemic, which has sped up the window cleaning industry itself embarking on industry 4.0 revolution with growing digitalisation of window cleaning equipment using cyber physical systems.

In order to remain competitive in this industry 4.0 revolution age, businesses need to automatise their processes and utilise digital technologies, Cyber Physical System, artificial intelligence and big data to assist human to make correct decisions in timely fashion and to deliver efficient operations.

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Addressing these challenges here we present a biology driven genetic algorithm embodied in a Cyber Physical System which reaches inference based on the Internet of Things data collected to optimise the Window Cleaning Operation management of resources and routes, using Window Cleaning Warehouse as a case study. A mobile, desktop and web app has been designed and developed to dovetail the algorithm as well as Internet of Things enabled window cleaning hardware to monitor the Window

Cleaning Operation. The app facilitates the route optimisation and appointment planning by taking near real time data from sensors integrated with hardware and other management related factors like job size, complexity, pure water refill locations and distance between jobs. The app can increase the operational and management efficiency of window cleaning business in conjunction with substantially reducing the water, chemical and fuel use with positive impact on environment. The water purification process is commonly achieved through a process called Reverse Osmosis which consists of using high grade chemicals, filters and electric pumps to remove impurities. It is estimated that monitoring the filter status in the Reverse Osmosis process and acting accordingly could increase efficiency by 600% *American Home Water and Air (2020), Whiney (2020)* saving window cleaning companies lots of money and vastly reducing water and chemical waste.

Using geospatial data and Internet of Things devices embedded in Window Cleaning Operation hardware, real-time data exchange facilitates the data needed by Cyber Physical Systems to reach inference through genomic derived algorithms. The system is designed to be easily extendible to multiple other industries to aid with industry 4.0 adoption and scale to meet the demand on the system aiding new, innovative and resilient business models to strategically plan against challenges in the post COVID new normal. With further development, the proposed framework can be adopted by other sectors in the cleaning industry in conjunction with other industries greatly affected by the pandemic like driving instructors, personal trainers, mobile vaulters and home and domiciliary carers.

References

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