TroubleChute

Long Detailed Solution:

The Problem:

Rubbish chutes are inclined or vertical passages used by residents to dispose of waste on a daily basis. They are present in all HDB buildings across Singapore, as well as other high-rise housing (e.g. condominiums) operating on similar rubbish disposal systems. In Singapore, there are 20,000 to 30,000 HDB blocks, housing more than 80% of the population. Any issue involving rubbish chutes would hence be a wide-spread and prevalent one.

The build-up of rubbish at the base of the chute poses a fire hazard. This is further accentuated when items such as flammable paint and kerosene are present in the trash. When possible ignition materials such as cigarette butts or burning embers from incense burning that have not been fully extinguished are thrown down the chute, rubbish chute fires will occur.

Minor rubbish chute fires place an unnecessary strain on scarce emergency resources. These fires are minor and of low risk, yet when the SCDF receives a call citing smoke from the rubbish chute, they would have to deploy their resources to tend to these fires. Compounded with the prevalence of rubbish chute fires in Singapore, so much more can be done to relieve SCDF's scarce emergency resources from tending to these fires, allowing them to respond better to potentially more serious and life-threatening emergencies.

Significance of The Problem:

Rubbish chute fires may be categorised as minor fires with low risk of spreading by SCDF, but they persist as the bulk of residential fires, making up more than 20% of all reported fires that occur, and nearly 50% of all residential fires. Annually, SCDF has to respond to more than 1,000 of such cases, placing a strain on scarce emergency resources. Despite not usually resulting in significant damage to property or injuries to residents, foul-smelling smoke and irritants such as soot may inconvenience residents and even affect their health and standard of living.

The large-scale nature and high frequency of rubbish chute fires are reasons why we believe they are an urgent, chronic problem that requires a long-lasting solution. Past attempts at rectifying or improving the situation have all fizzled out after a short time of implementation, which signals to us that the issue is indeed one that is worthwhile and essential to tackle.

Past Solutions:

- In 2006, automatic sprinklers were installed within some old blocks in Jurong West. However, installation costs were high as sprinklers were built on top of existing rubbish chute flushing capabilities, leading to unnecessary capital outlay.
- In 2011, a button to activate the flushing system used for chute cleaning was made accessible to the public as part of a pilot project at some blocks in Tanjong Pagar and Redhill. However, this led to numerous false alarms that led to water wastage.
- In 2015, a system that sprays water down the rubbish chute at least three times a day to prevent the refuse from being easily ignited by a heat source was implemented in 10 HDB blocks across the island.
- In 2018, a new feature in the MyResponder app would alert Community First Responders to minor fires within a 400m radius. Upon accepting the fire alert notification, CFRs can choose to put out the fires using hose reels, fire extinguishers or rubbish chute drencher systems. They can also update SCDF through the app with photos and videos of the fire. In 2019, approximately 40% of annual rubbish chute fires were put out by CFRs prior to the arrival of SCDF.

Lessons Learnt From Previous Solutions:

- *Utilisation of existing infrastructure such as chute cleaning systems in place of installation of new infrastructure such as water sprinklers would save significant cost.*
- *More reliable checks must be implemented in the system to reduce the instances of false alarms.*
- *As part of water conservation efforts, the use of water should be kept to a minimum, only when necessary.*
- *Community mobilisation has enormous potential in helping to put out fires.*

Our Idea:

Our team seeks to adopt a multi-pronged approach to tackle rubbish chute fires.

1. **Detect:** We aim to install a smoke detector and a temperature sensor in every rubbish chute, with the sensors connected wirelessly to our Cloud as IoT devices. Through data collection in our sensor testings, threshold values would be determined to identify fires. Real time sensor values would be constantly compared to our threshold values. Should the sensor values exceed the threshold values, the deterrence layer will be activated.

2. **Deter:** This is our first layer of implementation. This involves the activation of existing flushing systems in rubbish chutes that are used for cleaning. After the activation of the water flush, the system will wait for a stipulated amount of time before it compares the data read to a threshold for a second time. Should the sensors continue to bypass the designated threshold levels, the deployment layer will kick in.

3. **Deploy:** The second layer of implementation taps on Community First Responders (CFRs) more efficiently and effectively.
    - Firstly, to reduce the time taken for a fire to be detected and for a case alert to be sent out on the MyResponder App, the process of creating a case alert would be automated, bypassing the process of having a concerned bystander calling in to 995 to report the fire and having SCDF send out fire alerts.
    - Secondly, to further enhance outreach to the general population not using the MyResponder App, an automated post/message will also be created on social media platforms (Facebook, Twitter, Telegram channel) to leverage the power of netizens.

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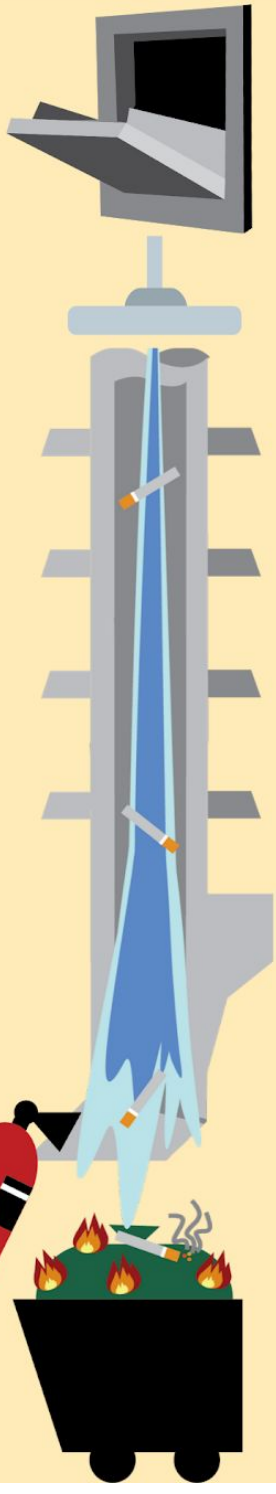
DETECT

Usage of sensors and IoT

In the first stage, a **smoke detector** and a **temperature sensor**, both connected **wirelessly** to our **IoT system**, will continuously **receive readings** from the surrounding **environment of the rubbish chute**. Through data collection in our pilot testings, **threshold values** have been **determined to identify an instance of a fire**. The real time sensor values would be **constantly compared** against these threshold values. Should the **sensor values exceed the threshold values**, our first line of defense, the **deterrence layer**, will be **activated**.



DETER

Flushing system of Rubbish Chutes

Our first layer of defense makes use of the **existing flushing systems** in rubbish chutes that are usually **used for cleaning**. The flush is **automatically activated** upon **detection of a fire** in the initial step. After the activation of the water flush, the system will **wait for a stipulated amount of time** before it **compares the data read** to a **threshold** for a **second time**. If the readings from the sensors **continue to exceed** the **designated threshold levels**, the deployment layer will then kick in.

DEPLOY

The second layer of our defense mechanism taps on existing (and hopefully future) **Community First Responders (CFRs)** more **efficiently and effectively**.

MyResponder App

Firstly, to **reduce the time taken** for a **fire to be detected** and for a **case alert** to be sent out on the **MyResponder app**, we have automated the process of creating a case alert. This completely **bypasses the process** of fire reporting which currently requires a concerned bystander **calling in to 995** and having **SCDF send out a 'minor fire' alert** on the MyResponder app.

Social Media Outreach

Secondly, to **further enhance outreach** to the **general population** who may not necessarily be using the MyResponder App, an **automated post/message** will also be **created on social media platforms** (Facebook, Twitter, Telegram channel) to **leverage on** the **power of netizens to respond or spread the word** on minor fire incidents.

How our solution tackles the problem:
In responding to fire incidents, time is of the essence. Our solution automates the process of early fire detection in rubbish chutes, and emphasises on early intervention to curb the spread of the fire. The flushing system, which serves as the first layer of defence, will ideally eradicate the need for any members of the public or SCDF personnel to be involved in the occurrence of the fire by fully automating the management of fires at an early stage.

In the scenario where the fire is unable to be put out by the initial approach and continues to be detected, the second layer of defence automatically alerts the public and SCDF through the myResponder App and social media, building on an existing solution that engages the community to respond to minor fires like rubbish chute fires.
Automating fire alerts would relieve the strain on the SCDF Ops Centre, which received more than 191,468 EMS calls and 2,862 fire calls in 2019, and sent out alerts for 1,708 rubbish fire incidents that year. Given the large volume of calls received every day, any improvement that reduces the incoming traffic would be a welcome relief for the Ops Centre, and allows more attention and resources to be re-directed towards responding to more serious incidents.

Furthermore, tapping on social media would mobilize a greater proportion of the public that is not on the MyResponder App. SCDF has published a brochure on tackling rubbish chute fires, which encourages the community and residents themselves to assist in putting out rubbish chute fires in a few simple steps. This indicates that there is no certification or barriers that limit only certain groups of people to being able to perform these steps. As such, by reaching out to a larger audience through multiple platforms and channels instead of simply relying on the MyResponder app, the likelihood of the fire being attended to as soon as possible becomes higher as well.

Gov.sg announcement platforms on Telegram have up to 295,754 subscribers (as of 13 June 2020) compared to 78,542 registered responders on the MyResponder App (as of 13 June 2020). This shows that much more users are on Telegram than MyResponder and utilising Telegram Channels or Bots to send out alerts could potentially reach a much larger audience. Additionally, SCDF's Facebook page has approximately 145,721 followers while SCDF's Twitter has approximately 47,800 followers. While these numbers are not as high as the number of subscribers on Telegram, both Facebook and Telegram have share and retweet functions that would allow these posts to quickly gain traction and reach the feeds of users who are not even following SCDF's page.

By expanding on our outreach and automating the creation of the case, this system also serves the purpose of reducing response time to such incidents. By empowering residents with this knowledge through faster alerts, we hope that the responsibility of attending to minor fires in rubbish chutes of residential areas could be effectively delegated to members of the public. Riding on this trajectory, the eventual goal would be a self-sustaining community where SCDF will no longer be required to activate their emergency services to respond to such calls.

Challenges and Mitigation Strategies:

1. To utilise IoT Cloud Services and send out alerts on MyResponder and Social Media, the system would require constant internet access.
    - Mitigation Strategy: For blocks that have preschool centres, town council offices or other services located at the ground floor, we could look into partnerships to share a central router for internet connection. Otherwise, we could look into expanding the coverage of Wireless @ SG as part of Singapore's Smart Nation Strategy to enhance internet penetration. Another direct solution would be to install local internet connections at the bin areas themselves. The selection of strategies would be guided by maximising cost savings.

2. As the sensor is constantly sending data to Node Red, battery life would be a concern.
    - Mitigation Strategy: By doing greater research into the electrical wirings of each block, we could implement wiring extensions to connect nearby electrical mains to the sensor to power it. As such, the battery would then play a supplementary role in providing power rather than a primary role.

3. SCDF would still have to manually update both MyResponder and Twitter to close the case.
    - Mitigation Strategy: As the situation at every fire site varies according to the type of waste present, the time of intervention as well as the methods of intervention, it will be difficult to algorithmically determine the closure of each case. Hence, our team discussed and decided that it remains more reliable for the corporate communications team at SCDF to manually announce the conclusion of each case.

4. The implementation of the entire system would require a significant cost, especially if it is scaled to all HDB flats and private high rise apartments in Singapore.
    - Mitigation Strategy: Rather than reducing the cost of the implementation, we could strive to provide greater benefits by integrating our sensors to aid in existing operations of the rubbish chute. For example, since the sensor will likely be located at the 3rd floor, installing a light sensor together with the sensor and analysing data readings could serve as a proxy to alerting the town council that the rubbish chute is overloaded up to the 3rd floor and prompt the members of the town council to take action to relieve the choking that proves to be unsanitary and unhygienic to its residents.

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