SERVICE CREATION FOR RE-NORMALISING ESSENTIAL BUSINESS ENVIRONMENT: A PREVENTION BASED DIGITAL TECH APPROACH

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ABSTRACT

This research investigates service creation in/after effect of coronavirus pandemic targeting the essential business environment. It follows prevention through design approach to facilitate business owners to maintain their business environments at low COVID contraction risks, for both customers and staff. The effectiveness of recommended prevention practices (like social distancing and hand-sanitising) is uncertain at public workplaces, simply due to inevitable workers and customers interactions. Such uncertainty, especially in cases of retail stores and hospitals, raises a need for the design of services and support systems for common/necessary public business activities to reduce the burden on people involved. This research investigates the risk-related metrics to realise such digital services, focussing on three types: congestion at the work environment, disinfection of store area/objects, and sanitisation of people and staffs involved. Based on this, a digital technology-based service COVSAFE was created and tested through a proof-of-concept implementation for a supermarket business environment. This implementation and its evaluations highlight the bottlenecks/challenges for realising this system in everyday scenarios.

Keywords: Service design, Risk management, Next Generation Systems, Design for X (DfX), Covid-19 Society

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1 INTRODUCTION

The fast-paced developments in the terms of connectivity, collaboration and globalisation came to an abrupt halt due to the sudden coronavirus pandemic (COVID-19) across the world. With no clear solution in early 2020, cities went under lockdown, everyday businesses stopped, and people were requested to *work from home* wherever possible, as a preventive measure against COVID-19 spread. Also, individuals and organisations were recommended *to maintain social-distance, to keep their environment disinfected* and *to sanitise regularly*. Following such preventive methods has been challenging in many industries, especially the essential services like retail stores and hospitals. As such services require regular interaction among the service-staffs and customers, it is difficult to guarantee the effectiveness of COVID-related recommendations. This unprecedented situation has raised several questions regarding the design and operation of services in public places, providing an unwanted opportunity to rethink/redesign them to keep our lives convenient and our neighbourhood environment safe (Lai et al., 2020). To address this issue from the design research's perspective, a "Prevention through Design" (PtB) (Manuele, 2008) or "Design for X" (where X = pandemic) research directions seems promising but it requires specific updates in the design process. In terms of technology, agile processes, 3D printing, flexible manufacturing, digital healthcare wearable and massive open collaboration are a few of many directions researchers are working to mitigate the widespread effect of COVID-19 (Reich, 2020; Brem et al., 2021). As a result, we have seen an inevitable surge in the use of digital technologies in this period, significantly facilitating work-from-home culture (De' et al., 2020), which can be categorised as *prevention types* (surveillance, data analysis, forecasting) and *action types* (isolation and disinfecting materials/equipment, medical equipment/service, treatment planning under extreme demand). In terms of service creations, the new solutions need too work coherently, both at digital and physical levels, in sync with the business activities. This research investigates the metrics to create such a solution for essential businesses, which is followed by an implementation of a specialised service to facilitate retail service operations (supermarket). It calculates, categorises and visualises possible risks of COVID-contractions at the work environment and how it impacts their employees.

2 BACKGROUND

The COVID-19 pandemic has emerged as a "wicked problem", characterised by multiple competing problems that seem to conflict with each other, such as protecting lives versus preserving livelihoods (White et al., 2020). The range of problem requires an update on every significant aspect of our everyday life and business. Many of the issues can be linked to the preventive actions or restrictions themselves, taken against COVID-19. A brief overview is shown in Figure 1. Design researchers are already addressing it through more creativity and innovation in response to the pandemic.

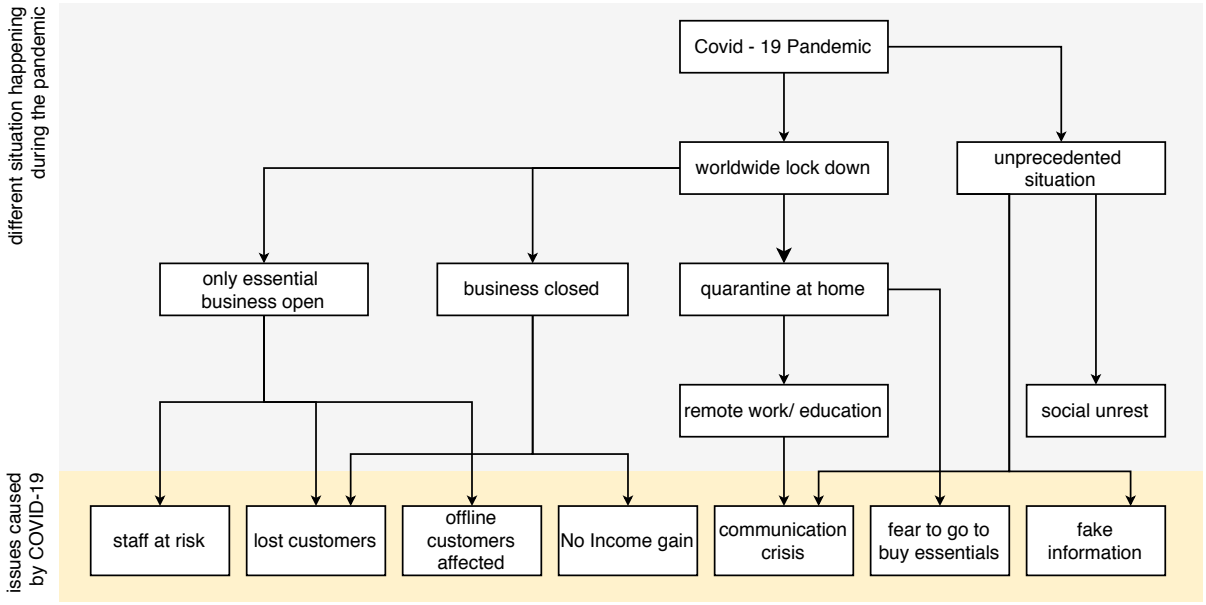

Figure 1. Representational COVID-19 impact

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2.1 COVID's impact: need for a better service design

The direct implications observed are "lost customers" and "little/no income gain" caused by closer of businesses, significantly impacting the regional/global economics. Consequently, many retail businesses shifted to "to deliver at home" requests but failed to cover their previous customer targets. The government and NGO's stimulus/reliefs to mitigate adverse impacts were temporary as these were one-time-only reliefs in many cases. Apart from the COVID-19 vaccine, only some solutions (mainly IT-based) are available for addressing everyday work and life needs that require people to "not to go outside." In the remaining scenarios, the issue of safety of essential business staff remains uncertain. Several cases have been observed where essential worker staff tested positive (and some being fatal) (Bhattarai, 2020), indicating unsafe work conditions for essential business workers, worldwide. For outside activities, one of the most common solutions are close contact tracing applications Ahmed et al. (2020) as presented by governments along-side smartphone companies (Apple/Google), tracking if an individual user had been in close-contact with a COVID-19 positive person (Zastrow, 2020). Such applications are provided free to users but their scope is individual people only. In terms of work-life balance during the pandemic, the ability to check work overload or resulting sickness becomes important. Here, predicting the possibility of risk-contraction or the resulting absence becomes crucial factors in emergency preparedness and resource allocation (Naghavi et al., 2012) for both business owners.

2.1.1 Design questions and early solutions:

As commonly seen, the adverse impact is both on people (contraction risk) and public-spaces (restricted working capacity/unsafe working condition). With medical researcher tackling the contraction problem (through vaccines), there remains a need for a better design of our working space to address service-related problems. Honey-Rosés et al. (2020) raised many questions concerning the "new normal" life regarding the future design, use and perceptions of public spaces. One prominent aspect from a design perspective is the inclusion of health criteria or prevention criteria into the design of public spaces/service environments in our future designs. This targeted design can follow Design for X approaches where X are any of the current or future prevention based scenarios like COVID-19.

2.1.2 X = Health organisation's recommendations:

In response to COVID-19, health organisations (FDA, 2020) and the governments have generated an exhaustive list of recommendations for the business. The suggestions are in the form of precautionary practices to follow in our day-to-day life to keep the COVID-contraction possibility to a minimum. A summary of such guidelines concerning the essential business environment is presented in Table 1. Using the mentioned recommendations as a basis; we design the criteria to calculate risks and generated helpful notifications. The recommendations for retail food store include *managing employee health (including contracted workers), personal hygiene for employees, managing operations in a retail store* and *managing food pick-up and delivery* (FDA, 2020).

Table 1. COVID-19 related recommendations and best practices in general

	Recommendations
Control the spreading	– Avoid close contact with other people/workers – Cover face to prevent droplets spreading due to talking, coughing and sneezing
Recommend behv. (generic)	– Regular hand washing/sanitisations – Avoid touching face with hands
Organisation operations	– Clean and disinfect work-areas correctly – Have a sanitation plan – Disinfect frequently touched surfaces
Recommended practice	– Regular store cleaning – Use hand sanitiser that contains at least 60% alcohol – Throw used tissues in the trash – Immediately wash your hands with soap and water for at least 20 seconds.

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The scale of coordination and data management required for effective implementation of these strategies has—in most prosperous countries—relied on adopting digital technology and integrating it into policy and health care. This viewpoint provides a framework for the application of digital technologies in pandemic management and response, highlighting ways in which individual countries have adopted these technologies for pandemic planning, surveillance, testing, contact tracing, quarantine, and health care (Whitelaw et al., 2020).

2.2 Planned/existing COVID-19 related digital solutions

We looked into existing or proposed COVID-solutions for field workers in the essential and nonessential business sectors. We investigated the underlying technology, target users, solution format and specialisation towards COVID-19. As observed, a lot of the solutions are generic, i.e. they are non-COVID-specific while some have been optimised for COVID-19. A summary of emerging (as of July 2020) COVID-solutions is shown in the following Table 2. Our research objective's closest service is a Bluetooth-based solution by Google+Apple that predicts the risk while maintaining user privacy. Also, some solutions provide an open-business environment solution to visualises COVID-19 risk based on peoples' body temperatures and stores congestion.

Table 2. Existing solutions in the market

	Type	**Target**	**User**	**Technology**	**?**
Landing AI's AI tool (LandingAI, 2020)	AI-enabled SD tool	Public/Group	Generic	AI + CV	Yes
Smartdome (PRNewswire, 2020)	SD device (central)	Supermarkets	Customer	camera-based	Opt.
Quevision (Wells, 2020)	Crowd management	Supermarkets	Customer	camera-based	Opt.
Proximity Trace (Triax, 2020)	SD device	Construction	Staff	radio device	Yes
Raksh (Raksh, 2020)	SD device	Workplace	Staff	IoT wrist device	Yes
Hyperlocal micro markets (Frearson, 2020)	Urban planning	Local markets	Consumers	Floor-planning	Yes
Health bands/ smartwatch	Fitness and mindfulness	Individual	Users	Digital device	No

?: designed for COVID or not, Opt.: optimised for COVID-19, SD: social distancing

2.3 Issues and research statement

It was found that the current COVID-19 related solutions or the risk identification solutions mainly focus on social distancing. Many of them are device-based and assume an ecosystem in which everyone would be using the device. This assumption works well for closed work-environment like constructions site and offices but is impractical for open business environments like supermarkets and hospitals. The current risk-based solutions use metric-measurements based on real-time data (ex. AI-based tools). Many of the widely used (product based) solutions also focus on high-risk based target elimination (ex. prohibiting people showing fever-symptoms from entering the business area). Here, the challenges lie in the fact that the measurable metrics (for COVID-symptoms) do not consider all COVID spreading causes. As a result, a system to base its risk calculation on real-time along with precautionary metrics that focus on the prevention of risk-increasing behaviour is needed.

Based on the mentioned issues, we formulate the following hypothesis: "*The solutions/services need to track and assess precautionary (prevention based) metrics in addition to the direct-measurable metrics like social distancing and body temperatures, to cover the COVID-19 contraction risk parameters*". We need to focus on "people's behaviours, sanitisation activity, environment disinfection activities along with social distancing maintenance", targeting staff alongside customers and their business operations alongside their work-environment.

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3 METHODOLOGY: SOLUTION DEFINITION

3.1 Concept solution design

Based on the studied requirements and existing solution reviews, we drew a basic framework of solution (called COVSAFE) for a generic essential business environment. The COVSAFE concept solution assesses user's (staff and customers) behavioural+movement data and presents a collective risk-index that can be visualised through digital devices. A concept representation is shown in Figure 2, and consists of the following components: *Data gathering part, Risk Calculation Framework (RCF), Notification and Management (target device), Edge interfaces*. As shown in the figure, RCF should process the incoming data and prepare appropriate output that shows visual risk-status and notifications. Therefore RCF would require service environment based metrics to work on input data. In concept, it would assess the live status of the environment variables related to possible COVID-contraction risks, allowing for live data comparisons with old activities (recent history) to establish trends and greatly facilitate operational decisions.

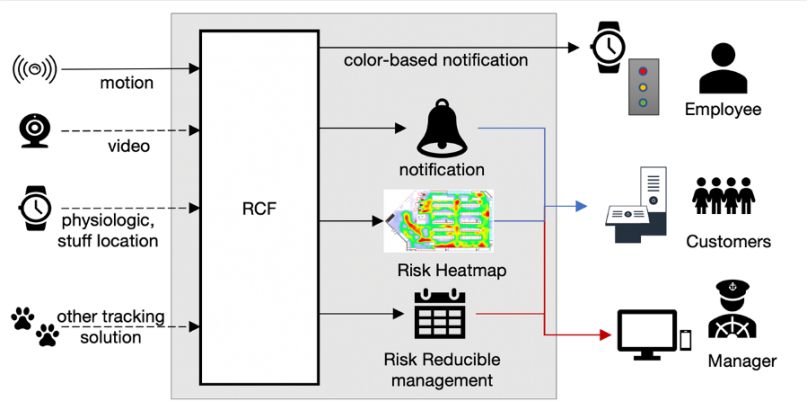

Figure 2. COVSAFE concept for generic essential business environment

3.2 Solution review: interviews with field expert

We shared this concept design with two field experts in the *retail* and *medical industry* to understand how it would satisfy the problems in terms of COVID-19 related safety for their business activities. With many positives feedback, they highlighted a few challenges to implementing such a solution, in their respective industry. A summary of their interview is presented in Table 3. Based on their feedback, we selected the supermarket environment as our use-case for designing the first instance of our solution and finalised the features for a robust solution mentioned as follows:

- Generates personalised and environment-specific risk visualisation
- Focused on social distancing, sanitising, and disinfecting activities
- Checks real-time impact on staff due to changing environment risk
- Facilitates the business environment support system by proactive prevention suggestions

3.3 Risk calculation framework: principle and metrics

To create measurable metrics, we divided the service-environment in the form of assets (store-assets and staff-assets) that can be monitored independently through digital devices. Based on the status of each asset at a given moment, we determine the following items: *detect the change in object/people states at a given time, determine if the change is increasing or decreasing the risks, generate a risk index for the detected change, generate suggestions for risk-indexes*. Here, assets' status change occurs due to the external triggers mainly caused by people interactions. The parameters to assess/represent the state changes are mentioned as:

- **Trigger Activities**: Different defined trigger types are defined as follows:
  1. *Actions*: intentional individual movements like billing products and using cash/credit card
  2. *Behaviours*: unintentional/habitual actions like coughing/sneezing/ adjusting face-mask
  3. *Movement*: movement (relative) inside the supermarket area/zone-wise
  4. *Frequently touched*: devices, screens, shopping cart, poly-bag, doorknobs, magazines

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Table 3. Feedback from retail and medical expert

	Summarised comments
Retail expert	- better to focus on risk-visualisation directly for the customers, instead of staff intervention. - possible to confidently targeting supermarket sections that require similar prevention methods like of meats/food sections to avoid food poisoning (use of mask/gloves) - changing roles of target employees are challenging and complex due to their capabilities/ experience, so frequent rest and active disinfection should be prioritised - supermarket would easily implement such solutions to avoid losses due to business closure - focus should be on what the workers cannot detect directly, like air contamination by someone's sneeze. It would be a waste to focus on obvious stuff like hand-wash count. - automated system should reduce safety-load of the employees as many workers want to leave their workplace due to issues caused by a coronavirus; the solution should make them feel safe. - a way to track workers' health-status outside of the supermarket in addition to work-environment should also be incorporated - focus on adapting the store environment instead of introducing new hardware dependencies in the store environment. The supermarket may prefer to implement the solutions on their local systems, so the new solution cannot be cloud-only.
Medical expert	- such an early solution is not viable for doctors and nurse due to lack of scientific validation. However, it will be useful in the reception area to manage the crowd and workloads of employees. - hospitals' current congestion levels should be made available to incoming people - risk calculations should weigh the sub risks in severity order: water droplets, congestion, having a face-mask not, disinfecting, and cleaning. - better to use other words for "infection risk," e.g. "necessity of actions or disinfecting." - PoC implementations should target smaller hospitals that have less than 100 beds because more prominent hospitals would take a long time to allow implementing such solutions - engaging with gamification can be one of the features to relax the people involved. - health institutions use thermography devices and alcohol sanitiser at entrances, also gather those who have headaches and fevers into one specific place. - hospitals may use current measures for at least one year as a precaution against other diseases. - suggestions like to monitor the "number of hugs" for international deployment, adding the air verification data and duration of people stay in a specific area as risk calculator's inputs - it would be interesting to add individual characteristics and attributes, like introvert-ness/extrovert-ness or friendliness.

5. *Frequently visited*: shopping aisle, register/counter, parking-area machine
6. *Cleaning*: spray-clean-wipe, wash, sanitise, Wash clothes/mask/napkin
7. *Disposal*: local, general, box, open poly-bag
8. *Promotions/Reminders*: store periodic suggestions like please maintain social distance, sanitise every 10 minutes, keep moving

- **Type (+*ve* / −*ve*)**: The risk index is assigned a positive or negative sign based on the type of trigger activity, and is derived from recommended guidelines by the health organisations. Here positive means that trigger increases the risks and vice-versa. For example, frequent group activities near the aisle/door at the supermarket are associated with increases in COVID-contraction risk. Staff's cleaning activity or store's crowd management based on social distancing norms would decrease/control the risks.
- **Threshold**: For each asset, we defined a threshold value that indicates a *low-risk state, medium or acceptable risk state* and *high/very high-risk states*. Using this threshold as the step function, we categorise the real-time data for each asset.
- **Weights (*w*)**: For any given asset for which the risk index is frequently observed *high* or/and for a long duration of time, we assign a weight to that asset to indicated high priority.
- **Risk index (*r*(..))**: Using the threshold values and respective weights, we calculate a normalised index, range [0,1], to indicate real-time risk of a given asset. This results in a ratio scale (Vogt,

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2005), as addition and subtraction of risk are assumed by definition of different risk types (explained in next section). The risk-index range shows the severity of the risk, where the severity level determines type of required suggestions and risk visualisations. The severity levels are defined as *low, acceptable*, and *high* for risk-index values <= 0.4, <=0.6, and >0.6 respectively (modifiable). Whereas absolute zero risk shows no change in states of an asset.

- **Cumulative risk**: We add the current risk-index to the last risk-index to get the cumulative risk index for a given asset. If risks at both times are positive, it will result in a rise in risk. If the current risk is negative, it will reset or decrease the risk. Cumulative risk is significant when risk-indexes not high but accumulate over a long period as real-time (instant) data does not take into around time-based risk behaviours.
- **Total risk**: Is a normalised-linear representation of risk-indexes for all the assets defined in the supermarket workplace.

For gathering input data, we used LiDar sensors and specially designed disinfection, sanitisation, and garbage detection sensors to track the changes in each asset's state.

3.4 Different kinds of risk assessments

Store environment-specific: Based on the literature review, we defined (see Figure 3) three types of risk associated as a function of *location, objects* and *people behaviours*:

- **Congestion** (C): Risk due to the crowdedness of a given area, measured based on the number of people present in a location per $m^2 = r_s(C)$ related to the staff and customer movement
- **Disinfection** (D): Risk due to long time usage of certain area/object, represented by the dominance of usage over cleaning activity= $r_s(D)$ related to store-cleanliness
- **Sanitisation** (S): Risk due to lack of regular sanitisation for people related activities like hand-washing and the use of gloves = $r_s(S)$ associated with staffs/people's cleanliness

Individual specific: The individual-risk index assesses risk possibility for each staff at the supermarket work environment using the aforementioned asset risk-indexes and staff's data (like job location, work duration, rest frequency, and sanitisation habits). It is based on a hypothesis that increment in staff's area-risk, both short and long duration, along with the staff's working duration, would increase the COVID-contraction risk for individual staff. We look at the following parameters for store-employees concerning high-risk physical assets (locations/objects) in the supermarket:

- **Congestion** (C): Risk due staff's long-time presence/frequent movement in high R(C) areas = $r_i(C)$ related to the staff and customer movement
- **Disinfection** (D): Risk due to long time work related to high R(D) related disinfection jobs = $r_i(D)$ associated with store-cleanliness
- **Sanitisation** (S): Risk due to lack of regular sanitisation by the staff during active job duration like hand-washing and use of gloves = $r_i(S)$ associated with staffs/people's cleanliness

Using respective C, D, S values, RCF generates a normalised value representing the total-risk index ($0 \leq$risk-index≤ 1) representing the scale of the unsafe state of staff/store environment. Based on the risk-indexes, RCF outputs suggestions or notifications to lower/reset the risk-index.

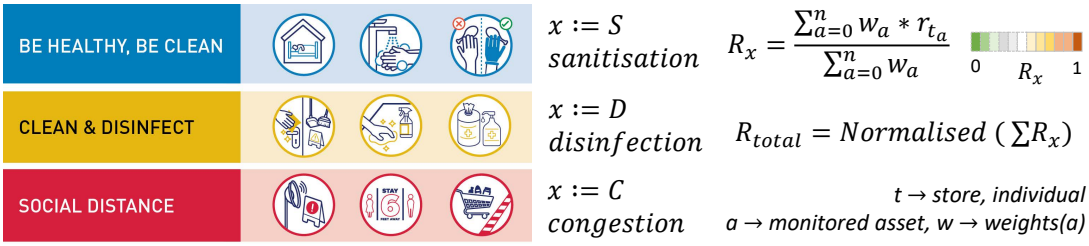

Figure 3. Risk-types definitions based on best practices for retail-stores (left) (FDA, 2020)

Assessment Flow: Here, the risk-assessment and response-action flow for the store is indicated as: *if many people use a specific area over the time-period or in real-time → then risk build-up → then suggestion/warning generated → then respond appropriately in order of priority → then risk intensity is reduced or reset → always show the intensity on a heat-map.*

For staff, this flow starts with *if the staff has not taken self-precaution or the staff visits high-risk area* and ends with *always show the intensity on staff profile/device.*

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3.5 Generating notifications

Custom notifications were prepared targeted towards customers, staff, managers and were classified under calculated risk types. Special notifications were also created for group risk behaviours as seen for entrances, billing areas, and toilet areas. A complete process from state change detection to creating is shown in Figure 4. The implementation was first modelled on dummy data (GitHub repository[1]) and then adjusted to a real environment for a proof-of-concept (PoC) experiment.

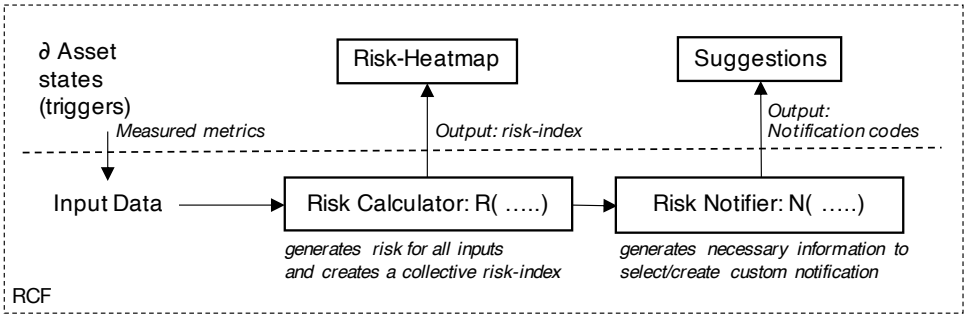

Figure 4. RCF structure

4 POC AND PRIMARY EVALUATION

Real-world Implementation: We conducted a PoC implementation with a regional supermarket from September 01 - September 30 2020, 24 hrs a day. COVSAFE solution was optimised to fit the supermarket's business operations. This supermarket is connected to the metro-station exit and is on the ground floor, consisting of cafes, grocery stores, and small restaurants. Figure 5 shows the implemented solution (sample). We collected questionnaire-feedback from the retail store shops tenants through quantitative analysis of digital data, and its modelling is still in progress.

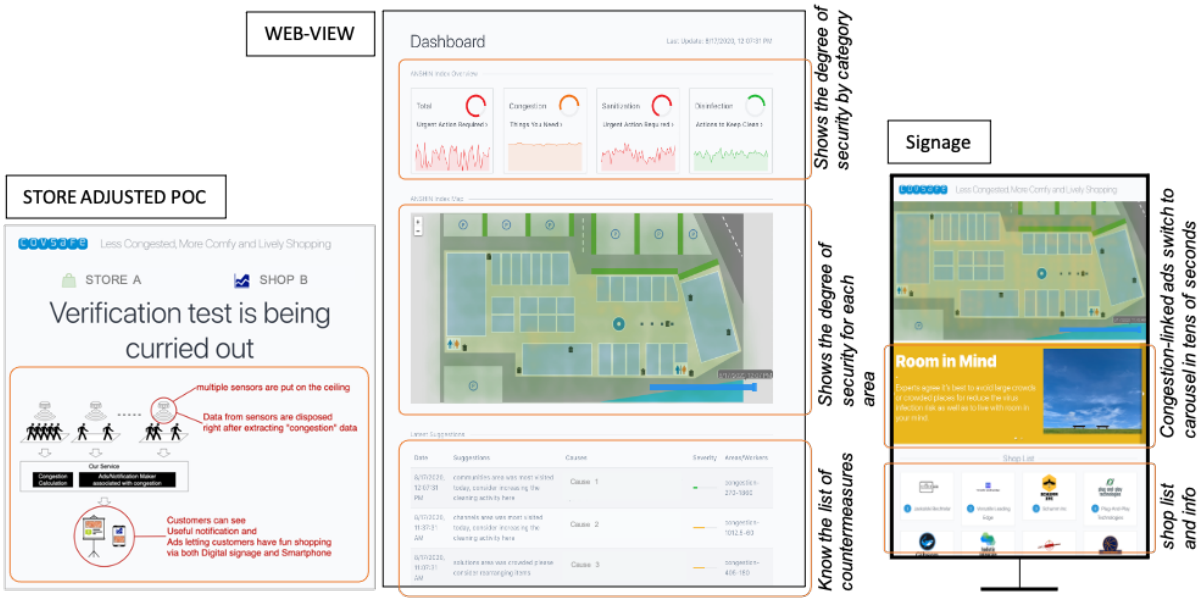

Figure 5. COVSAFE dashboard and signage samples (adjusted for supermarket)

Evaluation metrics: For evaluation purposes, experience and perception based data was collected through questionnaire feedbacks while behavioural data was collected through sensors and store business transaction data. Three types of evaluation metrics were selected/defined for the purpose:

- **Retail related**: metrics related to business activity of supermarket store, namely *foot traffic, relative sales, customer churn, store transactions*
- **Customer related**: metrics related to customer/solution experience like, namely *net promoter score, store experience, new effort level*

[1] https://github.com/Hitachi-CTI-Call-For-Code-COVID-19-Team/COVSAFE

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- **COVID-19 related**: new metrics were define targeting COVID-19 in the business (store) environment *Awareness* (area, crowd, product,sanitisation) and *Confidence*(shopping,selling)

First Evaluation - Feedback Result: Twenty-nine shop employees provided feedback on PoC implementation, 26 of them over 6 hours per day on average, 17 of them expressing coronavirus related concerns while serving customers. Staff working at the shop near the signage (Risk visualisation display) approved the implemented solution's positive impact through signage. Installing a sanitation device next to signage was recommended. In the non-signage area, it has not contributed to diffuse the congestion. Contents of UI (Web risk-display) though challenging to comprehend at first, make the mind feel comfortable and give realisation. A net promoter score of +36 was reported showing a positive impact with weak points to improve, like finding better ways to communicate suggestion. The solution concept was well accepted among the management and shop operator, but the implementation was rated inadequate. One issue with the PoC solution was a method to visualise risks and risk-prevention suggestions which were found to have low exposure on people in the store—for instance, notifying the risk-prevention suggestions in the shopping mall through store speakers.

5 DISCUSSION: CONCEPT SOLUTION AND BOTTLENECKS

The COVSAFE idea was found suitable for current retail operations, but it was not clear the positive impact on business activity. Preliminary analysis was completed from the feedback received at the end of the PoC. The comparative analysis based on raw sensor data and data modelling is currently going on. We faced bottlenecks, both at the design end and deployment end; the design bottlenecks were:

- **Lack of standard Literature - *defining weights***: As COVID-19 is a recent problem, there is little standard academic literature or state-of-the-art industry implementation. As a result, we designed the base for risk calculation and related algorithm based on a small sample of observations. We intend to optimise overtime through real-life data from different sources.
- **Idea Generation - *ethical***: Several interruptions were observed due to limitations on the type of monitoring devices we could use due to ethical issues in getting work-management related information. It also highlights the issue of different ethical limitations in different regions of the world due to privacy issues related to monitored data (Yallop and Aliasghar, 2020)
- **Behaviour Identifications - *ambiguity***: The existing/implemented system cannot detect different behaviours and is limited to movement-based macro actions. It restricted us from proposing sophisticated notifications based on the supermarket's activity and customers in the supermarket.

6 CONCLUSION

In the COVID-19 crisis, many businesses stopped due to an unsafe service-work environment for both their employees and customers. Though technical solutions were made available, they mainly focused on work-from-home type businesses, individual safety or relied on physical measures like thermal checking and alcohol sanitisation at the public places. As such solution focus on avoidance or direct risk elimination, they were found unsuitable for essential activities. In this regard, we inquired about measures (existing or new) to facilitate essential activities and developed a robust support system for this purpose. This work discussed the need for more inclusive design directions to include preventive metrics and directly measurable metrics, as high uncertainty due to asymptomatic cases among people and high work-overload among employees was observed. Following *the prevention by design* direction to define such service environment metrics for the retail store and its employees, a low-risk maintenance solution COVSAFE was created. It was based on area congestion, disinfection and sanitation to support essential businesses like retail store and supermarkets. Solution creation and the PoC process also highlighted the limitations and challenging aspects for future improvements. In continuation, this research will focus on other services (like banks/hospitals) to define standardised metrics and future service creations. We also plan to investigate the risk-index scale's impact on resulting outputs.

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