Rain On Me: A smart umbrella dryer integrated into a highly efficient public transport system in Geneva, Switzerland

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Abstract

With more than 70% of its economy based on the service sector, the early growth of metropolitan areas makes Switzerland one of a kind. Resulting in a phenomenon commonly referred to as suburbanization, a high demand for integrated transport systems emerged to grant easy mobility between suburban areas and major centers. Switzerland has implemented an outstanding public transport system that integrates fully coordinated schedules across different routes and lines, with one fare structure and ticketing system. This early integration opened up opportunities for innovation and the development of very efficient vehicles and routes. The outstanding technology named TOSA (first implemented in Geneva) allows the use of 100% electric buses, 90 of which are circulating in the city of Geneva today.

This background of progress in Swiss public transport (PT) is what makes this document relevant in its proposal. It will speculate on the new digital product "Rain On Me", that proposes an affordable integration of umbrella dryers into the Swiss PT system. The research will narrow down to one specific city, Geneva, as a means of better detailing the implementation of the proposed product.

Introduction

Having your umbrella at hand when the rain starts dropping is a matter of checking the forecast and hoping the weather remains stable. The inconvenient part comes when you want to get rid of your wet umbrella during or after your commute.

Closing it and keeping it in your bag anyway could leave you with a soaked bag. Places like restaurants, hotels, and a few public transportations, offer you to leave your umbrella in front-door stands or boxes. While this seems handy, there are at least two possible drawbacks: leaving it behind, or getting robbed by someone with a more urgent need. In the fashion industry, companies like Rains and Lindex work with waterproof materials to keep you safe and good-looking. Still, this leaves you walking around with a wet fabric and the problem remains unsolved.

Aiming to solve this problem, the first prototype of the umbrella dryer will follow the same principles of the hand dryers we find in public toilets. These umbrella dryers will be called Smart Boxes, because their mechanism will be smart enough to dry a wet umbrella. The Smart Boxes will be placed into public buses as well as in some strategic places around the city, for instance, the main train station (Gare de Genève-Cornavin). A mobile app will allow people to locate these boxe to drop off wet umbrellas and to take dry ones away at any given point in time. The "Rain On Me" app will be responsible for authentication, monitoring the boxes and any other external integrations needed for it to work, like a regional registry of passengers, bus timetables, geolocation services, payment services, etc.

Background

Being known for its prosperity and high living standard, Switzerland is often classified as one of the wealthiest countries in the world. This prosperous situation was fostered by changes in the social structure over the twentieth century, with the shift from a rural economy to a service economy, now representing 70% of the labor force (Falcon J. 2013).

One of the most notable characteristics of the country is the highly integrated urban transportation system. Crossing the country by just using public transport is extremely simple and pleasant.

Swiss public transport

Over the past five decades, Switzerland, alongside with Germany and Austria, have successfully implemented regional PT associations, called Verkehrsverbünde (VV), which coordinate PT planning, services, fare structures, ticketing, marketing, and customer

information throughout entire metropolitan areas, and, in some cases even broader (Ralph Buehler, John Pucher & Oliver Dümmler 2019). The Zurich Transport Authority, Zürcher Verkehrsverbund (ZVV), was the first and only association implemented in Switzerland in 1990 and has since operated in the Swiss canton of Zürich (Greater London Authority 2012). While having a regional scope, the initiative had a national impact and other cantons adopted an integrated PT service as well. In the relevant case of Geneva the PT network (UNIRESO) goes even further and integrates with cities on French territory located on the borders. It is an interconnected system of trams, buses, *mouettes* (yellow transport boats) and trains maintained by three partner operators, TPG, SBB, and SMGN.

Consequently, a high percentage of Swiss population uses public transport every day. As shown in Table 1, the country features around 245 public transport journeys per capita while France and the United Kingdom have 116 and 118 respectively. In simple terms, the Swiss take twice as many individual rides as French and English people, although the country has only one-tenth of their size.

Table 1: Comparison of per capita public transport use in different big European countries for 2018 (trips per capita per year in each country).

Country name	Journeys per capita
Austria	260
France	116
Germany	136
Switzerland	245
UK	118

Source: https://www.uitp.org

TOSA

Standing for "Trolleybus Optimisation Système Alimentation" the Swiss technology represents a milestone in public transport innovation. It enabled the first articulated high-capacity bus, that's 100% electrically powered. The vehicle is eco-friendly and operates with great autonomy, making use of sustainable energy sources. TOSA is owned by the company ABB and was put to testing in May 2013 in Geneva. The main technological innovation is the energy transfer system mounted on the roof of the buses. It comprises an articulated arm that automatically lifts up when the bus approaches a stop that's equipped with a flash feeding station. When the vehicle stops the arms connect to a charging rail in just one second. In 20 seconds, while the passengers are getting on and off the bus, this connection transfers enough energy to maintain a charging time of just four minutes at the bus terminals. This technology is known as flash-charging. Thanks to this technology, buses don't need to be constantly connected to electric cables that spoil the landscape.

Free of overhead lines, the main advantage of TOSA technology is that it substantially reduces the size of the on-board batteries. This results in greater capacity (15 to 30% more seats) and less energy consumption (savings of around 10%) because the vehicle is lighter. The battery's storage capacity is 88 kWh, being more than sufficient to supply full power whilst maintaining energy reserves to handle a bus-train, a bus that follows another (République et Canton de Genève).

Smart Boxes

The collecting boxes for the umbrellas will be equipped with a dryer machine to hold and dry two or three umbrellas each, characterizing two different models: the 2x umbrella dryer and the 3x umbrella dryer. It can be fabricated from currently available technology to bring a selling (or renting) price. To speculate on the costs of the hypothetical Smart Boxes, commercial hand dryers will be used as a reference.

The drying engine would be almost the same as a hand dryer, adapting the fit to umbrellas. Considering a commercial product as the "Gorillo Pro Blade", sold by the UK producer "HandDryers", makes the job of draining the remaining water, starting and shutting off automatically as a new object is detected by its sensors and the whole heating mechanism off-the-shelf. The umbrella dryers would provide two or three holes, depending on the models 2x or 3x. At first, customized umbrellas would be

made especially for the umbrella dryer. This could maybe be expanded to a more generic system in the future. As soon as a new umbrella is detected, the drying cycle starts. According to the product specification of “Gorillo Pro Blade", it lasts 12 seconds. Since the umbrellas are not isolated from each other, one drying system would be enough for taking care of all of them, in both the 2x and 3x models.

The boxes will have a Bluetooth connection, making it easy to extract parameters like the number of umbrellas inside, the ability to lock and unlock the umbrella holes, and any information related to the dryer machine that could compromise availability. They will also have computer boards (ie., Raspberry Pi) and use a SIM card for cellular connectivity.

The umbrella’s way in and out will be from the top of the box. That way, it's possible to implement internal lockers for each umbrella individually. Simple mechanic belts will do the job and will be coordinated by an external actor, in this case the “Rain On Me” app. It will identify full boxes through reading the QR code placed on each one, following the same pattern used by similar apps like Lime (Electric Scooter Rentals) and BlaBla Ride.

Mobile Application

The “Rain On Me” mobile application will coordinate each interaction between the user and the Smart Boxes. Briefly, it's main functionality is to locate Smart Boxes around a user. The visualization will be a simplified map, showing the points where Smart Boxes are located, both the ones installed inside buses and the ones installed close to ticket machines in some fixed places. In addition, the application will be responsible for monitoring the Smart Boxes to keep them healthy as often as possible - being healthy means having at least one umbrella available. When the user finally identifies the Smart Box to be used, the application will read the QR code placed in the box and allow a user to give an umbrella in or take it off, according to its own choice.

The technical decisions made so far are listed below and will be better detailed later:

1. Authenticating the user through a well-known mechanism, for instance OAuth, by connecting to the SwissPass web service.
2. Showing a geographical map with locations of Smart Boxes, as well as listing the bus timetables.
3. Monitoring the number of umbrellas available in each Smart Box to inform the user about the nearest collection point.
4. Possibly communicating with an external mobile payment app like Twint, in case the user doesn't have a SwissPass.

1. Authentication via SwissPass

The SwissPass is an offer that associates over 250 Swiss transport companies in one source. The national subscriptions and promotions are all done using this card. It's also a way of keeping your data under control.

From 2020, every first registration for public transport in Geneva gives a user a SwissPass. Thus, it would be strategic to use it for authentication on “Rain On Me”. It also facilitates integration with other TPG applications.

2. Geographical map

To better guide the users in finding a place for collecting a dry umbrella or return a previous pickup, a geographical map will point out the locations of fixed Smart Boxes as well as the buses that hold them.

In order to gain access to the buses, it will be necessary to communicate to TPG API. The documentation is available on the company's official website "Open data TPG" and gives access to bus locations in real-time as well as to the physical stops.

3. Monitoring the Smart Boxes

To provide relevant data to the users, a monitoring system will communicate with the Smart Boxes and collect information about the number of available umbrellas in each. The monitoring system will operate with the goal of

keeping each Box's availability high, trying to have at least one umbrella per box at all times.

4. Mobile Payment Apps integration

As an alternative for people who don't have the SwissPass, an external mobile payment application can be used. Apps like TWINT would solve the problem.

Originally, the idea is not to charge for the umbrellas, but credit a symbolic value would help in case of theft.

5. Visual Identity

Figure 1: Mobile application icon.

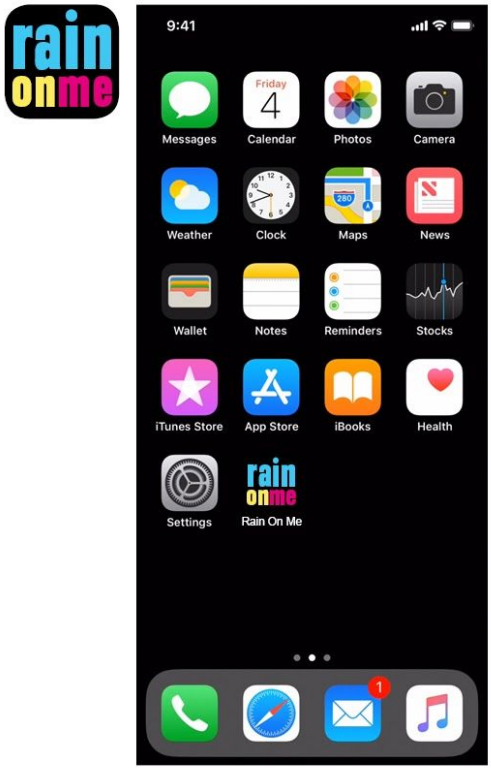
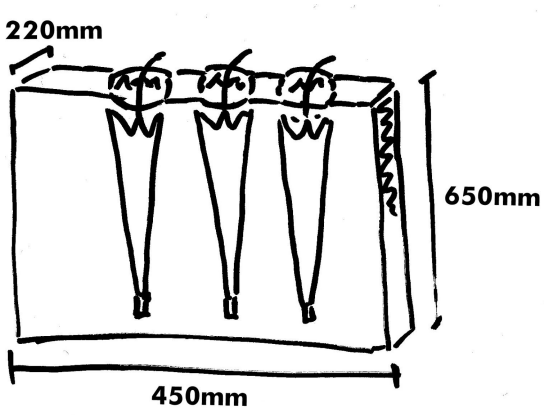


Figure 2: Visualisation of the umbrella.

Sizes and Costs

Figure 3: Drawing schema of a Smart Box.



Considering the subjectivity of predicting the cost of software development, the prices described here will be limited to the production of the Smart Boxes.

The Smart Box can now be postulated as a single machine consisting of:

(1) A hand dryer "Gorillo Pro Blade" by "HandDryers" (478.62 CHF)
    (a) Power rating: 1.6 kW
    (b) Drying time: 10 to 12 s
(2) Raspberry Pi 4 Model B by "Reichelt" (38,68 CHF)

Summing up the individual values, a Smart Box would cost about **517.30 CHF**.

Moving on to the implementation of the boxes on a real bus, let's consider a TPG trolleybus. Its two wagons combined hold a capacity for 134 people and a battery of 88 kW.

As follows, some assumptions will be made, according to the experience of taking Geneva's public transport and to information from TPG's official website.

Two 3x Smart Boxes in each wagon would make four boxes per bus-train, which equals 12 umbrellas.

The average journey of a bus that works in just one line a day is 32 min. The first bus departs at 5:05 and the last at 2:07, making for a total 21h of operation. So, one bus will take roughly 42 journeys a day.

During one journey, the distance between stops ranges from 4 to 6 min. 5 min is the period between new passengers getting in and out. On a heavily rainy day, where all dryers will be turned on at each stop, each Smart Box would go through six cycles per journey, adding up to 24 cycles per bus-train. If each cycle takes 12s, the total time of drying will be 288s per journey.

$$6\ cycles\ x\ 4\ boxes\ x\ 12\ s/cycle\ =\ 288\ s/route$$

So, in one workday, a trolleybus would demand about 12,096s of drying, equalling 3.36h.

$$288\ s/route\ x\ 42\ routes\ =\ 12,096\ s/day\ =\ 3.36\ h/day$$

Based on the numbers given by "HandDryers", we will calculate the daily energy consumption of one bus-train in kilowatt-hour (kWh).

$$3.36\ h\ x\ 1.6\ kW\ =\ 5.38\ kWh$$

With this information, we can estimate the cost of four Smart Boxes in a regional bus in Geneva. Using the electricity price given by GlobalPetrolPrices.com for 2019, we would have:

$$5.38\ kWh\ x\ 0.156\ CHF/kWh\ =\ 0.84\ CHF/day$$

The daily use of Smart Boxes in Geneva's buses would cost around 0.84 CHF.

Going further, we will calculate the daily cost of having Smart Boxes in all 90 TOSA buses and the fixed Boxes.

$$0.84\ CHF\ *\ (90\ buses\ +\ 10\ spots)\ =\ 84.00\ CHF/day$$

Adding the daily maintenance cost and the production cost of each Smart Box would give us:

1. Initial investment of 51,730.00 CHF
2. Maintenance cost of 84.00 CHF per day

To maintain a total of 360 Smart Boxes in buses plus 10 fixed ones in Geneva, providing slots for 1110 umbrellas to be dried and exchanged.

Conclusion

The average energy consumption of 5.38 kW is very small compared to the 88 kW available in the batteries of a trolleybus. The effective cost of producing and implementing the Smart Boxes is extremely low, which makes it attractive from an economic perspective. The efficient drying system fits well with the ecological values of the country. And the pick-up and drop-off dynamic of umbrellas supports its idea of convenient mobility.

The idea for "Rain On Me" is possible because of the history of continuous progress in Swiss public transport systems. The first VV model implemented in Zurich culminated in an efficient and highly integrated system of PT on a national level. Technologies like TOSA cultivate an environment for innovation and new ideas, such as "Rain On Me".

The "Rain On Me" project, as outlined in this document, is just a prototype. It can for sure be enhanced to aggregate more subtle features. One would be integrating umbrellas that are already owned by the user. This would create a collaborative platform, with the key idea of social collectivity and sustainability.

In conclusion, the implementation of the "Rain On Me" app and its Smart Boxes shows itself to be feasible in the case study of Geneva.

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