How to get-toilet-paper.com?

Provision of Information as a Public Good

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Abstract

In this paper, we describe the implementation of an information sharing platform, got-toilet-paper.com. We create this web page in response to the COVID-19 pandemic to help the Pittsburgh, PA community share information about congestion and product shortages in supermarkets. We show that the public good problem of the platform makes it difficult for the platform to operate. In particular, there is sizable demand for the information, but supply satisfies only a small fraction of demand. We provide a theoretical model and show that the first best outcomes cannot be obtained in a free market and the best symmetric equilibrium outcome decreases as the number of participant increases. Also, the best symmetric equilibrium has two problems, cost inefficiency and positive probability of termination. We discuss two potential solutions. The first is a uniform random sharing mechanism, which implies randomly selecting one person every period who will be responsible for information sharing. It is ex-post individually rational but hard to implement. The second solution is the one that we began implementing. It implies selecting a person at the beginning and make her responsible to share information every period, while reimbursing her cost. We discuss the reasons for high demand and low supply both qualitatively and quantitatively.

Keywords: get-toilet-paper.com, public good provision, crowdsourcing, information aggregation.

JEL Codes: H4, D4, D8

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1 Introduction

In times of uncertainty, information becomes a valuable asset. Often, full information is available but is dispersed in the population and may be costly to report, necessitating the design of an aggregation mechanism. The COVID-19 pandemic has the changed the landscape of daily life such that simple errands like grocery shopping becomes not only complicated due to shortages but also dangerous due to the risk of virus transmission in crowded places. To help Pittsburghers navigate these challenges, we set up a mobile-friendly web page, got-toilet-paper.com, as a platform to share information about shortages and congestion in grocery stores across the city. Store crowding data is supplied by the Google Place API and augmented with user reports. Inventory data is collected solely through user reports. As this data is crowdsourced, we make no guarantees of its accuracy.

This setting has several important differences from the standard crowdsourcing environments. First, information providers and information users are usually different in crowdsourced platforms. For example, government agencies or companies use information that is aggregated from citizens and consumers. In our case, information users and providers are the same set of individuals. Also, the standard setting (i.e. Liu (2017)) features a true state of the world, information providers who privately receive noisy signals of this state, and a designer that seeks to extract the true state from partially informed reports. In our setting, each information provider (a current shopper) fully observes the true state (if an item is available). She is therefore able to perfectly reveal it to information users (future shoppers) and provides a public good, but due to reporting costs, prefers to free ride on others current shoppers' report.

In this paper, we describe both the demand and supply side of information about grocery store shortages and congestion in a pandemic. We show qualitatively and quantitatively that there is substantial demand. People want to know what products are available, where they are available, and how crowded stores are. Unfortunately, supply satisfies only a tiny fraction of demand. People want to receive information when they shop, but they do not contribute information for future shoppers. Since every user is just a small part of the larger Pittsburgh community, each needs to contribute just a little bit of information for the entire group to be fully informed. However, as the population size increases, the marginal impact of each person's contribution decreases, decreasing the likelihood of contributing.

To analyze this environment formally we provide a theoretical model of this multi-period game and show that the first best outcomes can not be obtained in a competitive market and the best symmetric equilibrium outcome decreases as the number of participants increases. Also, the best symmetric equilibrium has two problems, cost inefficiency and positive prob-

ability of termination. We discuss two potential solutions of how a market designer can overcome those two problems. The first is uniform random sharing mechanism, which implies randomly selecting one person every period who will be responsible for information sharing. It is ex-post individually rational but hard to implement. The second solution implies selecting a person at the beginning and making it her responsibility to share information every period, while reimbursing her cost for information sharing.

We are in a process of implementing the second solution. We call it a Verified Contributors (VC) system. A VC is a store employee who will submit information about product availability to our site regularly. Our goal is to have one VC per store. Upon approval, the VC receives $1.75 for each verified survey (max one per day). A VC can also earn a bonus of $10 for each contributor that they recruit from other stores.

An extensive literature on public goods points to several concerns in provision: free riding, fairness, and optimal provision level. The free riding problem arises because a public good is by definition non-excludable, meaning that those who do not contribute to it cannot be restricted from using it. The fairness problem examines the distribution of costs and benefits from the public good across the population. For example, should someone who is using a public good only rarely pay the same as someone who is using it extensively? The question of whether one should pay what they expect to consume is directly related to our ability to elicit individual's true valuation of the public good. When expected to pay, individuals will under-report, which will lead to underprovision of the public good.

In our city-wide informational public good setting, the literature on group size and voluntary public good provision is also highly relevant. Olson (1965) shows that the free riding problem is more pronounced in larger groups. This result has been debated back and forth over the past 55 years. Some authors argue that smaller groups can cooperate better (Dawes et al. (1977); Wheelan (2009); Nosenzo et al. (2015)), while others find the opposite (McGuire (1974); Chamberlin (1974); Isaac et al. (1994); Agrawal and Chhatre (2006); Masel (2007); Zhang and Zhu (2011); Mao et al. (2016)) or discover heterogeneous responses to group size (Gautam (2007); Pecorino and Temimi (2008); Rustagi et al. (2010)).[1] In this project, we find theoretically that larger group sizes result in less cooperation, and the (lack of) results from our website implementation suggest that this is the case.

[1]See Ledyard (1995) for old experimental literature on effects of group size on public good provision and Chaudhuri (2011) for more resent studies.

2 Theoretical Framework

In this section we describe a simple theoretical model that reflects the public goods structure of our web page. Compared to most theoretical models of voluntary public good provision, there are two main differences in our framework. First, since a single individual can perfectly observe the state of the world (the current availability of a grocery item) the marginal utility from contribution becomes zero after the first contribution. This means that once one individual contributes, there is no additional benefit from another individual contributing. Second, the environment is dynamic and the person does not get direct utility from her own contribution; instead her contribution guarantees that the game continues for at least one more period. She receives positive utility in the next period if at least one other player reciprocates her contribution.

There is one (grocery) store used by $2N \geq 4$ shoppers. Time is discrete, t=1, 2, ..., ∞, and every period a group of N shoppers goes to the store. Assume a shopper goes to the store every other period. After a store visit, a shopper decides whether to report (share) her information or not. Shopper incurs cost of c if she submits a report and receives utility of $U > c$ if she goes to the store informed.

There are two games in this environment. The first one is the sequential game between two N-sized teams, where each team moves in every other period. Second, there is a simultaneous game among the same N shoppers acting in a period. We add rules to the inter-group interaction to focus mainly on the second game. We assume group players use a grim-trigger strategy, i.e. shoppers' stop sharing their information if in any period they went to the store uninformed. Therefore, if in any period there is no information available and one group of N shoppers go to the store uninformed, they will not share their information as well and the game is over.

The first best outcomes of this game is one where exactly one report is available every period. If we do not allow any coordination devices, the first best outcome is not attainable in a non-cooperative equilibrium. Notice that depending on cost and utility parameters, there is either unique or multiple equilibria. If the utility is not sufficiently higher than the cost, we have a unique equilibrium in which no one submits a report. Otherwise, we have multiple equilibria.

Assume player i is in period t and she has an access to a report from previous period. After a store visit she needs to decide whether to report or not. The only symmetric pure strategy equilibrium in this game is to never submit. To analyze mixed strategy equilibria we assume that every player other than i submits a report with probability $p \in [0, 1]$. Letting, δ be a discount factor, $V_{t,report}$ be the cumulative future value of reporting in period t and

$V_{t,notreport}$ be the corresponding value of not reporting, player i faces the following problem in period t.

$$V_t = max\{V_{t,report}, V_{t,not\ report}\} \tag{1}$$

Where:

$$V_{t,report} = -c + \delta(1-(1-p)^N)[U + V_{t+1}]) \tag{2}$$

$$V_{t,not\ report} = \delta(1-(1-p)^{N-1})(1-(1-p)^N)[U + V_{t+1}]) \tag{3}$$

If player i choose to report at period t, she will spend c to ensure that shoppers in period $t+1$ are provided with information and hence not have to activate the grim trigger strategy and end the game. If any of the N shoppers in period $t+1$ make a report, player i will be able to consume this information (get utility of U) when she shops at $t+2$. She is then faced with the same problem at period $t+2$ of whether to report item availability that she learned from her trip. If player i choose not to report, the game can still proceed if any of the other $N-1$ period t shoppers make a report. In order for player i to mix between reporting and not reporting, she should be indifferent between those two options. We can solve for p that makes player i indifferent by solving equation 4.

$$V_{t,report} = V_{t,not\ report} \tag{4}$$

Proposition 1: If c/U is sufficiently low there exists δ^*, such that if $\delta > \delta^*$ there exists multiple equilibrium and the best symmetric mixed strategy equilibrium is one in which players mix reporting and not reporting with probability p_B, where p_B is the highest probability of contributing among the solution of equation 4 from the interval $[0, 1]$.

All proofs and derivations are in the Appendix A. We can use proposition 1 to draw some comparative statics on relationship between number of participants and public good provision. As mentioned in the introduction, the literature has yet to arrive on a consensus on this question. Some authors argue that having more participants decreases the average as well as the total contribution to the public good, while others agree on the first statement but claim that total contribution increases as group size growth. It is also shown both experimentally and theoretically that group size can have an inverted-U-shaped relationship with total contribution, i.e. total contribution increases with group size until some point and decreases after that. In our setting, proposition 2 shows that probability that a person contributes decreases and also probability that at least one person contributes decreases in symmetric mixed strategy equilibrium.

Proposition 2: $N \to \infty$ implies $p_B \to_+ 0$ and average as well as total contribution to the public good decreases.

Example:

Let's fix $c = 2$, $U = 10$ and $\delta = 0.9$. We look at the best symmetric mixed strategy for the cases $N = 2$, $N = 10$ and $N = 100$. For the two player case, $p_B \approx 0.966$. Even the best equilibrium has two drawbacks compared to the first best. The first is cost inefficiency, in other words probability that two players will both submit in any single period is $0.966^2 \approx 0.933$. So there is a good chance of unnecessary cost duplication. Second is the chance of termination: for two player game in the best symmetric equilibrium chance of termination is not high but still positive. Probability that the game will last no more then 10 periods is $1 - (1 - (1 - 0.966)^2)^{10} \approx 1.2\%$.

We now show what happens when N increases. Like above, we can use equation 4 to find $p_B \approx 0.312$ for N=10, and $p_B \approx 0.032$ for N=100. Using the best symmetric mixed strategies, the probability that the game will be terminated in the first 10 periods is 21% and 33% for N=10 and N=100, respectively. Therefore, as number of shoppers increases, probability that average person contributes decreases and also termination probability increases. So keeping our web-page working on such a big market without intervention is hard.

The first best outcome implies exactly one contribution per period. As we show above, even the best symmetric equilibrium of this game is not good enough for our web page to keep the cost at minimum and be sustainable for several periods as N increases. There are several ways to reach the first best outcome. We discuss two possibilities, one in which all the agents (shoppers) are participating and another in which only one is participating.

If there is a social planner who can coordinate information sharing, then a uniform random selection mechanism is ex post individually rational and can result in the first best outcomes. A uniform random selection mechanism implies that the social planner selects one person in every period from among the shoppers from that period who will be responsible to submit a report. Since $U > c$, this mechanism is ex post individually rational.[2]

Another way to approximate the first best outcome is to select one person at the beginning of the game, make her responsible for all the reports, and subsidize her so that she has an incentive to submit reports. Since the first solution discussed in the previous paragraph requires a huge coordination effort, we focused on the second one and designed VC system. The way the VC system works taking one person from each shopper groups and reimbursing her cost to report every time she goes to the store with probability 1. This will avoid the

[2]We assume there is no discounting. With discounting, we require U to be sufficiently larger then c.

two problems of non-cooperative equilibrium, cost inefficiency and a chance of termination.

3 Implementation

Our site is currently limited to grocery stores in the Pittsburgh metropolitan area. In total, users can contribute or view information for about 264 stores. Got-toilet-paper.com has three main features: contribute data, view data, and product locator.

If a user wants to contribute data for a particular store, she can either search or select it on the map. After selecting a store, the survey is displayed. The survey (figure 4 in Appendix B) has six questions about crowdedness and product availability for the selected store. Similar to the contribution, user can select a store on the map to see crowdedness and product availability in that store (figure 5 in Appendix B). Users can also select a product to see a the set of stores where this product is reported to be available using the Product Locator feature (figure 5 in Appendix B).

We are in a progress of developing the VC program. Store employees can apply for the VC position online through our web-page. In order to be aa VC, person must be an employee of one of the stores that is included on our site. We limited grocery-store worker VCs to one verified contributor per store location. We also accept people who visit grocery stores frequently as part of their occupation (such as Instacart shoppers). Frequent shoppers that do not visit the stores as part of their occupation cannot be verified contributors at this time.

To advertise, we used multiple social media channels. The first channel was Facebook, through both promoted Facebook posts and through Facebook ads (see figure 7 in Appendix B for the content of the Facebook promoted post). Both the promoted Facebook posts and the Facebook ads were run through the official Pitt Smart Living Project Facebook page. From April 17th through May 10th, 117,165 people saw our posts or ads and our posts/ads were interacted with 2,067 times.[3]

The second social media channel was Google ads. Google ads were posted from April 20th through May 3rd. 78,682 saw this ad and the ad was interacted with 1,008 times.[4]

The third social media channel was Twitter (see figure 8 in Appendix B for tweet content). This tweet was sent out from a study PI on her personal Twitter account, and linked to the official Pitt Smart Living Twitter account, various University of Pittsburgh official

[3]Both views and interactions may include the same person viewing/interacting multiple times. One person viewing/interacting multiple times would be counted as multiple views/interactions.

[4]Like with the Facebook ads/posts, both views and interactions may include the same person viewing/interacting multiple times. One person viewing/interacting multiple times would be counted as multiple views/interactions.

departmental Twitter accounts, other team member's personal Twitter accounts, and the official Twitter accounts of various stores for which data was being collected. This tweet was seen by 4355 times by Twitter users and interacted with 385 times. 84 people clicked the link from this tweet.

The forth social media channel was Nextdoor.[5] Two posts were made to Nextdoor by one researcher on the project. These posts were viewable by users of Nextdoor in 9 neighborhoods in Pittsburgh near the neighborhood of Friendship. The first post (figure 9 in Appendix B) focused on the demand side of the market with the intention of attracting interest to the market. While Nextdoor does not provide information about the number of people who saw the post or interacted with it, we can see that 6 people saw the post and "thanked" the poster. The second post (figure, 10 in Appendix B), was made in response to the realization of the gap between the supply and demand of information, and focuses more on enticing suppliers of information to interact with the website. This post received no "thanks".

4 Results

As mentioned earlier, there is a substantial gap between demand and supply of information in this market. We divide the analysis into two parts. In the first part, we provide quantitative evidence that there is a substantial gap between demand and supply of information. In the second part, we discuss qualitative evaluations of our web-page from the users and shed some light on why we see such a huge gap.

4.1 Quantitative Results

Figure 1 shows the number of visits to our web page. The blue line corresponds number of users who viewed data (demand side) and the green line presents the number of users who contributed data (supply side). The maximum number of contributors per day was 13, with average of ≈ 4 (median 3) users.[6] The high demand shows that supply shortage is not because people do not know about our web page. Instead, as we show from social media comments discussed in the next section, the main problem is that people expect to see data before they start contributing or they do not understand how the data presented on the web page is generated (i.e. through their contributions or the contributions of people like them).

[5]Nextdoor is a neighborhood-based social media site, in which people can connect and communicate with those in their neighborhood or surrounding neighborhoods. This is different from social media sites like Facebook and Twitter in that posts are distributed to other users based on geography, rather than who is "friends", as in Facebook, or "followers", as in Twitter.

[6]These numbers include views and contributions of the research team.

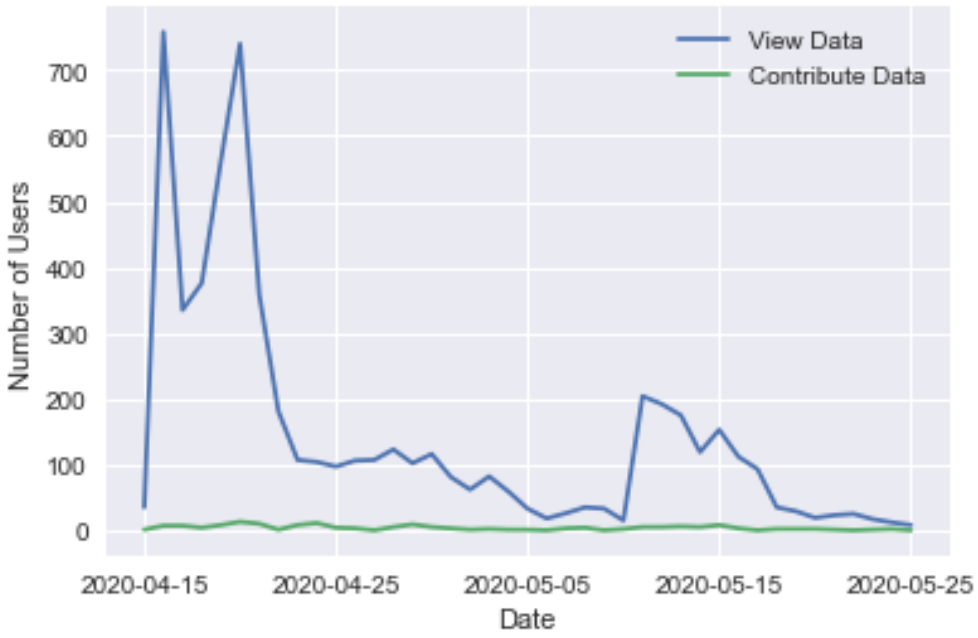


Figure 1: Demand and supply of information.

Figure 2 shows that Facebook and Google are the main referring sites for our web page. Unfortunately, both sources were active only during advertisement campaigns. An absolute majority of visits from Facebook and Google occurred during the time when the advertisement campaign was ongoing. Figure 3 shows the number of referrals with highlighted sections representing the advertisement periods for both Facebook and Google. We have two spikes from Facebook and both were during advertisement campaigns. The first advertisement campaign on Facebook was active for three days and the number of visitors immediately dropped after the campaign was over. Figure 3a shows that even though the second advertisement campaign did not cause as big jump as the first one, it still had more lasting effect then the first one. Trends are different for google referrals. Instead of sudden jumps, we see gradual increase and sudden drop after the advertisement was over.

4.2 Qualitative Results

In this section we describe the Facebook comments we received in response to our promoted Facebook post in order to understand, qualitatively, how people responded to our website in terms of demand and supply. These comments, in chronological order, are figures 11-18 in Appendix B. In each figure, different colored blocks represent different commentators. However, these colors do not represent different people across figures.

These comments present qualitative evidence of how people responded to the introduction

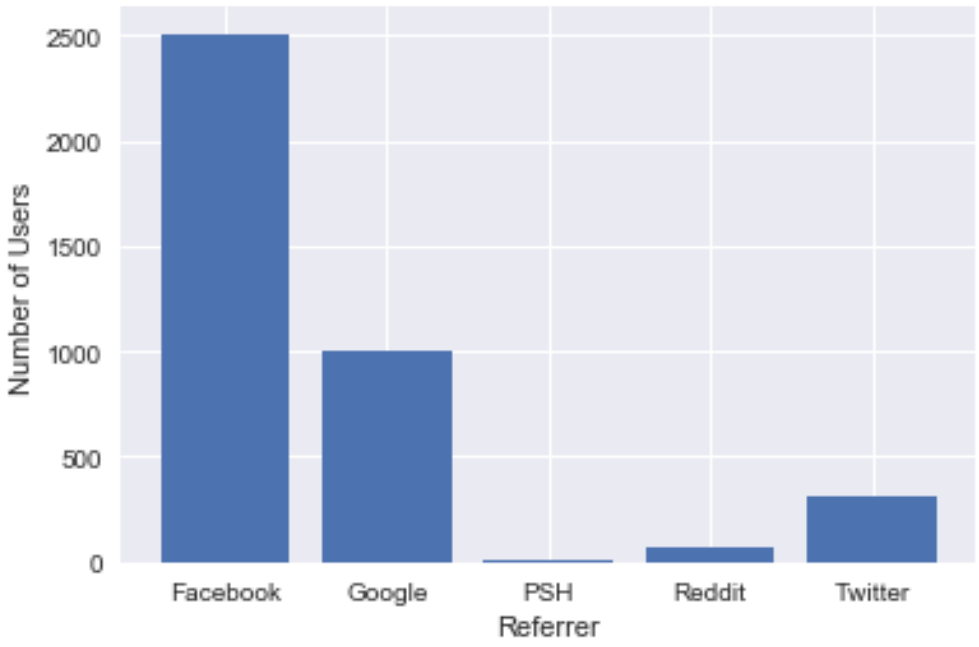


Figure 2: Referrers to our web-page (PSH refers to Pitt Shopping Helper).

of this website. There are three main takeaways from this comment data. The first is that people find this website useful, in theory. In figure 14, we have a person thanking the creators; in figure 16 we have someone stating that it is a "really good idea"; and in figure 17 stating that it is "a fantastic idea". However, the second takeaway is that many comments also note a lack of data and there is some frustration about this lack of data, particularly about product data. Some of these comments are requesting different types of data, such as more stores or products (figures 12, 13, 14, 17, 18). However, numerous comments point out the lack of product availability data on the website; in figure 15 we can see a person commenting on how they would love the website if there was any data reported; figure 16 presents a similar comment about how there is no recent data, calling the website "useless", and proceeding to comment about their difficulties with toilet paper shortage. In both of these comments, the focus is on a lack of data and both present a certain level of frustration or anger about the lack of data. The third takeaway is that there is a trajectory in the comments from inquiry and excitement, to suggestions about more products and stores, to frustration about lack of data.

These comments strongly indicate demand for the information the website could provide, to the extent of frustration and anger about a lack of supply to meet that demand. However, there are remarkably few comments about supply in terms of providing information; the most notable exception is the comment in figure 15, in which an individual, responding about a complaint about lack of data, says "It can't work until we all start contributing

(a) Facebook Referrals

(b) Google Referrals

Figure 3: User Referrals and ads. intervention.

information. It's information technology, not magic". Also in this same figure, a later comment says "This is a fantastic idea! It's like the WAZE app, but for groceries (sic)". The first comment explicitly outlines the supply-side requirements of the market to work, namely everyone contributing data to ensure data continues to be available to others, and the second comment suggests a similar understanding, although the Waze app also uses other data sources to provide information in addition to individual contributors. Such a comparison may indicate a lack of understanding that the supply of this data is dependent on voluntary, individual contributions. Notably, nobody comments on having contributed data, while many comments indicate having viewed, or attempting to have viewed, data. Overall, the strong skew of comments towards demand-side topics and away from supply-side topics indicates that people see themselves as consumers, rather than as producers, of information and that they may not understand how such information markets work, namely in requiring "normal" people to act as both suppliers and demanders of information.

References

Agrawal, A. and Chhatre, A. (2006). Explaining success on the commons: Community forest governance in the indian himalaya. *World development*, 34(1):149–166.

Chamberlin, J. (1974). Provision of collective goods as a function of group size. *American political science review*, 68(2):707–716.

Chaudhuri, A. (2011). Sustaining cooperation in laboratory public goods experiments: a selective survey of the literature. *Experimental economics*, 14(1):47–83.

Dawes, R. M., McTavish, J., and Shaklee, H. (1977). Behavior, communication, and assumptions about other people's behavior in a commons dilemma situation. *Journal of personality and social psychology*, 35(1):1.

Gautam, A. P. (2007). Group size, heterogeneity and collective action outcomes: Evidence from community forestry in nepal. *International Journal of Sustainable Development & World Ecology*, 14(6):574–583.

Isaac, R. M., Walker, J. M., and Williams, A. W. (1994). Group size and the voluntary provision of public goods: Experimental evidence utilizing large groups. *Journal of public Economics*, 54(1):1–36.

Ledyard, O. (1995). Public goods: some experimental results. *Handbook of experimental economics*, 1.

Liu, H. K. (2017). Crowdsourcing design: A synthesis of literatures. In *Proceedings of the 50th Hawaii International Conference on System Sciences*.

Mao, A., Mason, W., Suri, S., and Watts, D. J. (2016). An experimental study of team size and performance on a complex task. *PloS one*, 11(4).

Masel, J. (2007). A bayesian model of quasi-magical thinking can explain observed cooperation in the public good game. *Journal of Economic Behavior & Organization*, 64(2):216–231.

McGuire, M. (1974). Group size, group homogeneity, and the aggregate provision of a pure public good under cournot behavior. *Public Choice*, pages 107–126.

Nosenzo, D., Quercia, S., and Sefton, M. (2015). Cooperation in small groups: the effect of group size. *Experimental Economics*, 18(1):4–14.

Olson, M. (1965). The logic of collective action, cambridge, mass. *Harvard Univ. Pr.*

Pecorino, P. and Temimi, A. (2008). The group size paradox revisited. *Journal of Public Economic Theory*, 10(5):785–799.

Rustagi, D., Engel, S., and Kosfeld, M. (2010). Conditional cooperation and costly monitoring explain success in forest commons management. *science*, 330(6006):961–965.

Wheelan, S. A. (2009). Group size, group development, and group productivity. *Small group research*, 40(2):247–262.

Zhang, X. M. and Zhu, F. (2011). Group size and incentives to contribute: A natural experiment at chinese wikipedia. *American Economic Review*, 101(4):1601–15.

Appendix A

Proposition 1 proof:
Assume all but player i mix between reporting and not reporting with probability p. If in any period t player i strictly prefers to submit a report or not submit a report, he will do the same in any other period. Let's find utility from always submitting and never submitting a report.

$$V_{always\ report} = \frac{-c+U}{1-\delta*(1-(1-p)^N)} - U \tag{5}$$

$$V_{never\ report} = \frac{U*\delta(1-(1-p)^{N-1})(1-(1-p)^N)}{1-\delta(1-(1-p)^{N-1})(1-(1-p)^N)} \tag{6}$$

The way we show that there exists two solutions for c/U sufficiently low and *delta* close enough to 1 is the following. First, let's rewrite problem as:

$$\frac{-c+U}{1-\delta*(1-(1-p)^N)} - U - \frac{U*\delta(1-(1-p)^{N-1})(1-(1-p)^N)}{1-\delta(1-(1-p)^{N-1})(1-(1-p)^N)} = 0 \tag{7}$$

We need to show that equation 7 has two solutions in $[0,1]$. Notice that for $p=0$ the LHS of equation 7 equals to $-c<0$. Also, for $p=1$ the LHS is $\frac{-c}{1-\delta}<0$. Next we need to show that there exists $p\in(0,1)$ such that LHS of equation 7 is positive. We can rewrite LHS of equation 7>0 as:

$$1>\delta\geq\delta^* \equiv \frac{c}{U(1-p)^{N-1}(1-(1-p)^N)+c(1-(1-p)^{N-1})(1-(1-p)^N)} \tag{8}$$

For any c we can assume high enough value for U such that the RHS of 8 is less then one for any $p\in(0,1)$. Therefore, by continuity of LHS of equation 7 in $(0,1)$ interval and the facts that at $p=0$ and $p=1$ LHS of equation 7 is negative and for every c there exists U high enough such that there exists δ which satisfies equation 8, proposition 1 is proved.

Proposition 2 proof:
Let's rewrite equation 7 as:

$$(1-p)^{N-1}((U-c)(1-(1-p)^N)-c) = \frac{c-\delta c}{\delta} \tag{9}$$

The proof of proposition 1 shows that there exists two solutions in the interval $(0,1)$ for high enough δ and low enough c/U. As N increases LHS of equation 9 increases, p should decrease to keep equation 9 correct. By comparing slopes with respect to p and N one

can show that $(1-(1-p)^N)$ (probability that at least one report will be available) should decrease to keep equation 9 hold. Therefore, when number of shoppers increases in order equation 9 to hold, probability that there there is no report available increases.

Appendix B

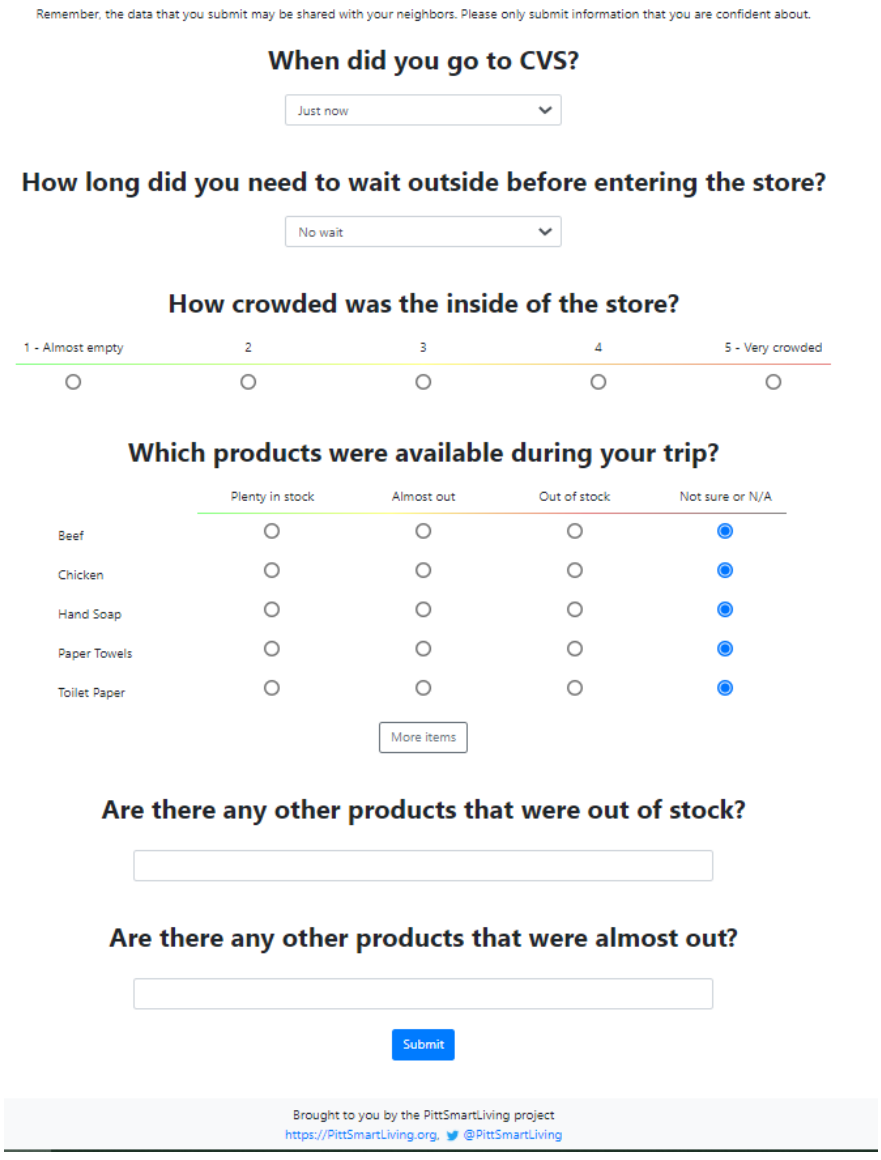
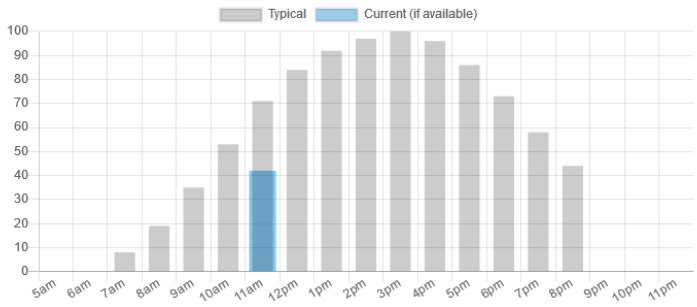


Figure 4: Contribute Data screen for one of the stores.

Market District Supermarket - 5550 Centre Avenue, Pittsburgh

Store crowding



Data collected from Google Places API

Product availability

Item	Level	Last Reported
Bread	In stock	2 days ago
Disinfecting Wipes	Out of stock	22 hours ago
Eggs	In stock	22 hours ago
Hand Sanitizer	Out of stock	2 days ago
Hand Soap	Almost out	2 days ago
Milk	In stock	22 hours ago
Paper Towels	In stock	22 hours ago
Toilet Paper	In stock	22 hours ago

Figure 5: View Data screen for one of the stores.

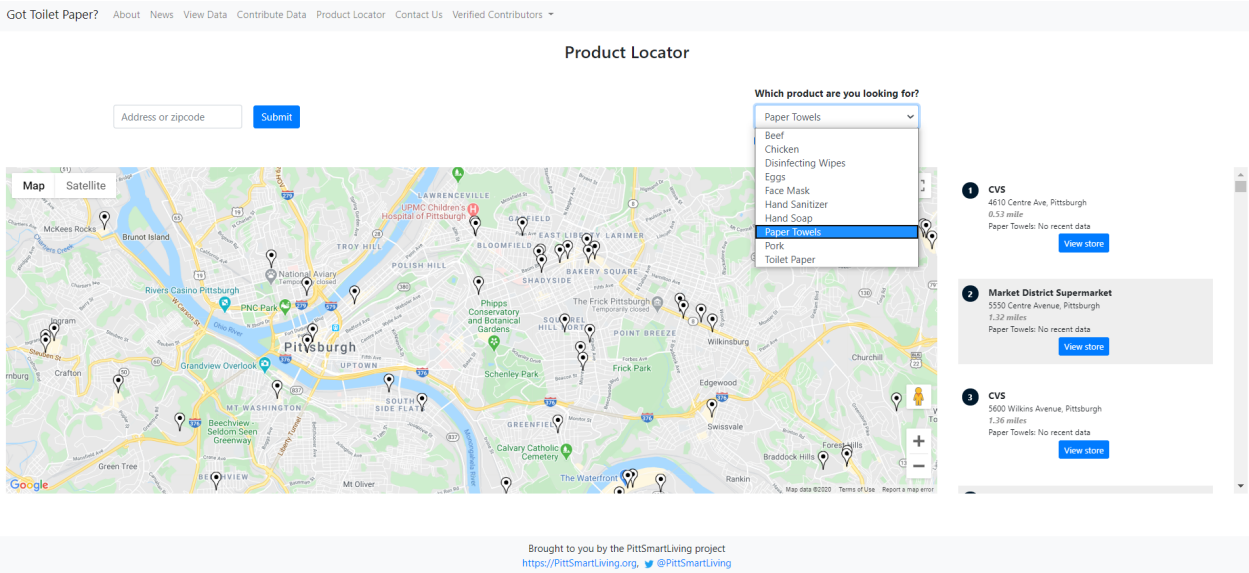


Figure 6: Product Locator screen for selected product.

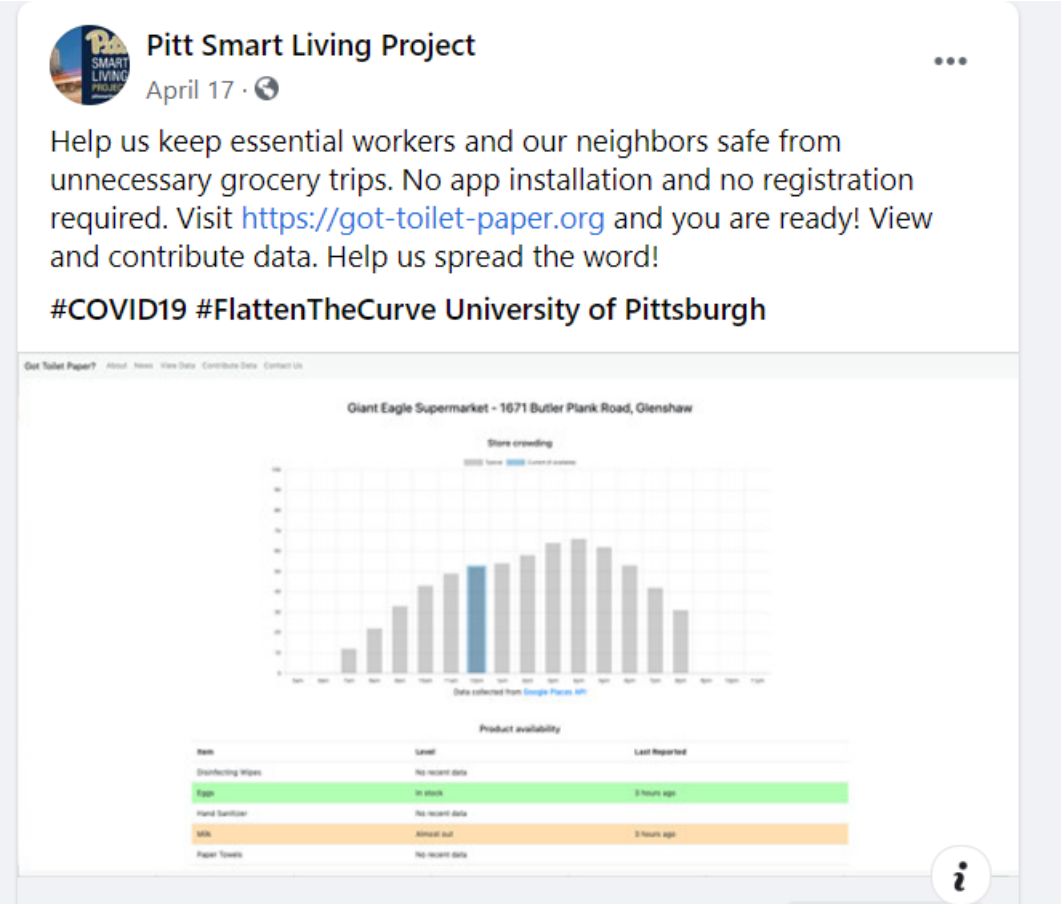


Figure 7: Promoted Facebook Post Content

Sera Linardi @seralinardi
Wonder how crowded your grocery store is right now? Does it has the eggs and **#toiletpaper** you're looking for? Check https://got-toilet-paper.org/ and report lines or shortages after your visit. Project of **@PittSmartLiving @SciPitt @GSPIA**. **#GiantEagle #cvspharmacy #TraderJoes #Aldi** pic.twitter.com/Wk5T1P984I

Figure 8: Twitter Post Content

M **Mallory Avery**
Friendship • 16 Apr

Want toilet paper? Here's how to find it! In order to help with the pandemic response, the Pitt Smart Living team at the University of Pittsburgh has built a mobile-friendly web site to help Pittsburghers know:
(a) whether items are out of stock at different grocery stores (crowdsourced), and
(b) how busy each store is at any given time, to help people choose a time to visit when stores would be less crowded (using Google data).

The website can be accessed at https://www.got-toilet-paper.org/

No download or registration is required.

Additional information is available at https://pittsmartliving.org/2020/04/15/got-toilet-paper-website/

Got Toilet Paper?
got-toilet-paper.org

Posted in **General** to **9 neighborhoods**

Thank Comment 6

Figure 9: Nextdoor Post Content 1

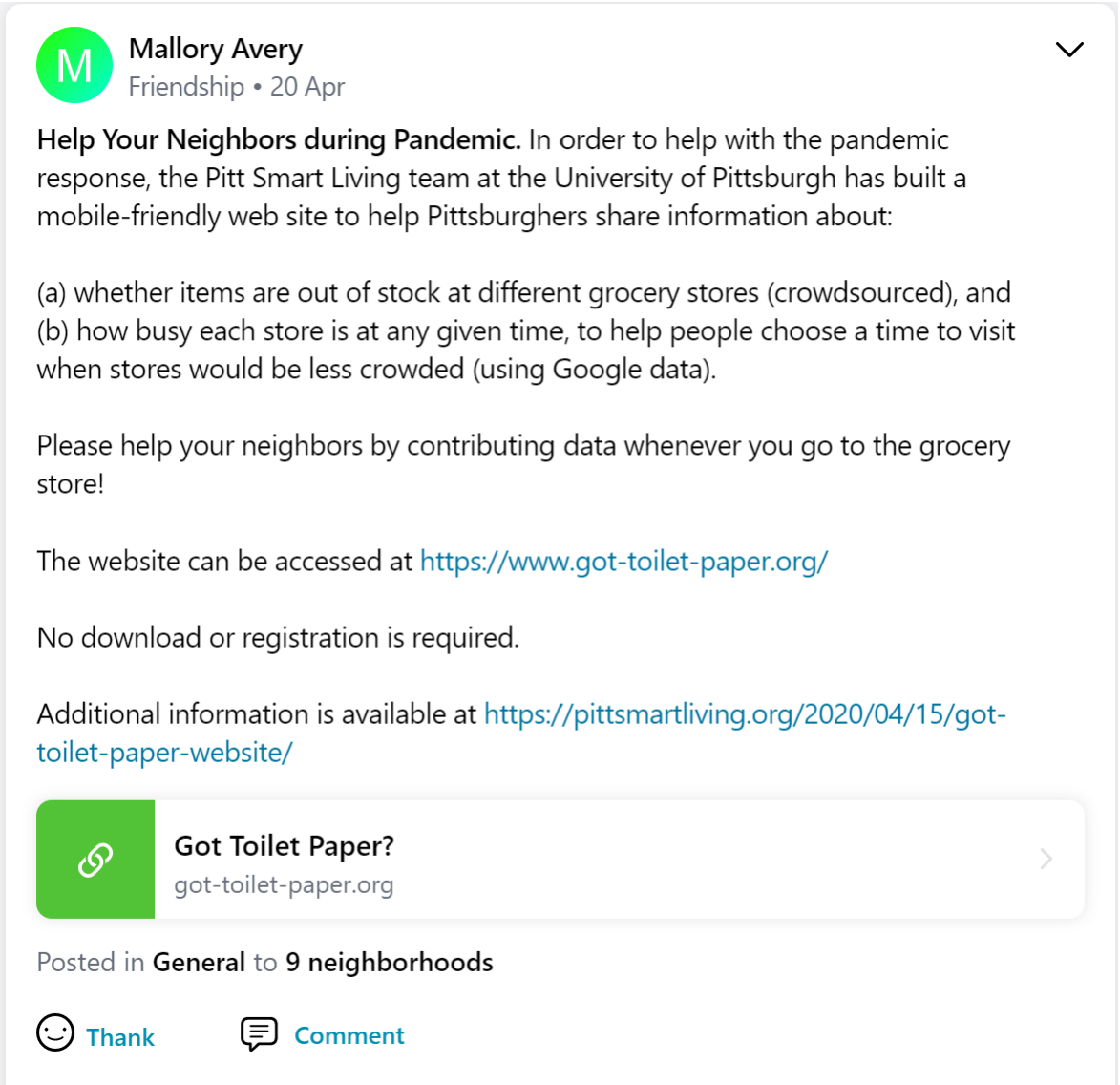


Figure 10: Nextdoor Post Content 2

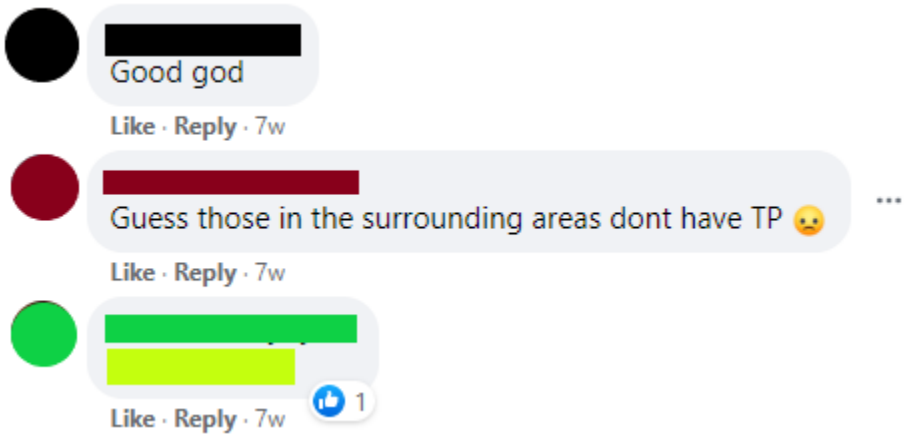


Figure 11: Facebook Comments 1

Figure 12: Facebook Comments 2

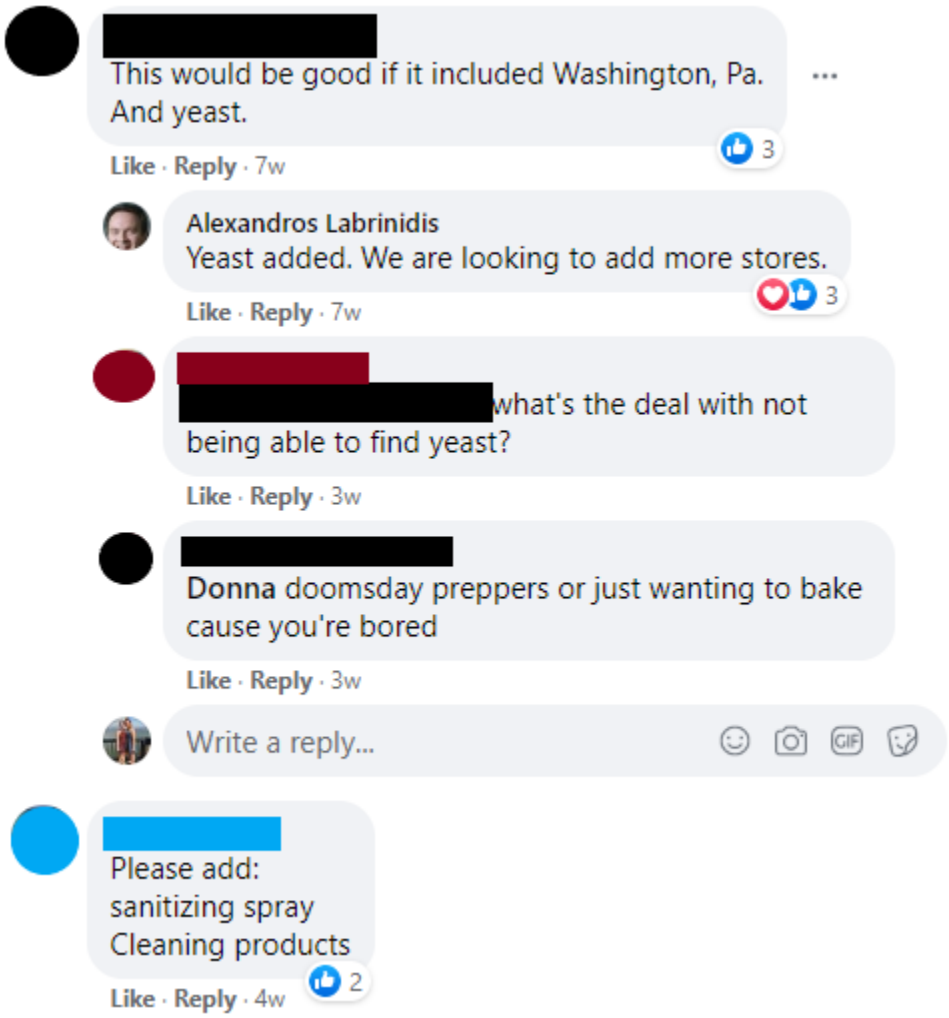


Figure 13: Facebook Comments 3

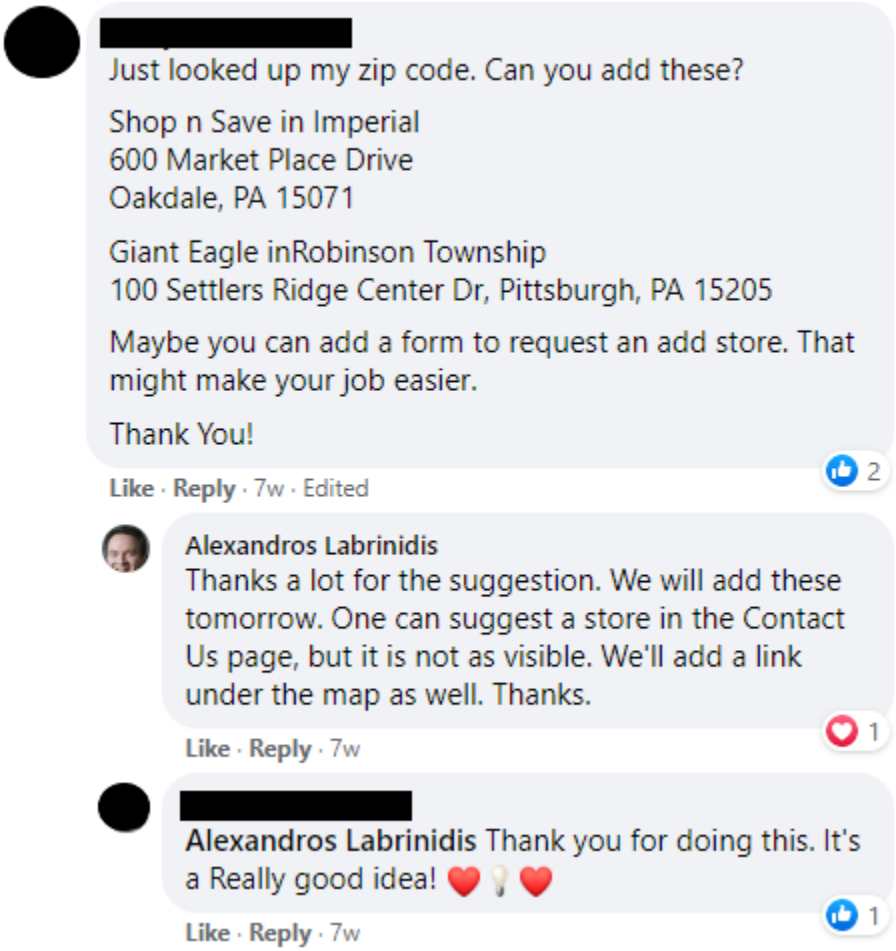


Figure 14: Facebook Comments 4

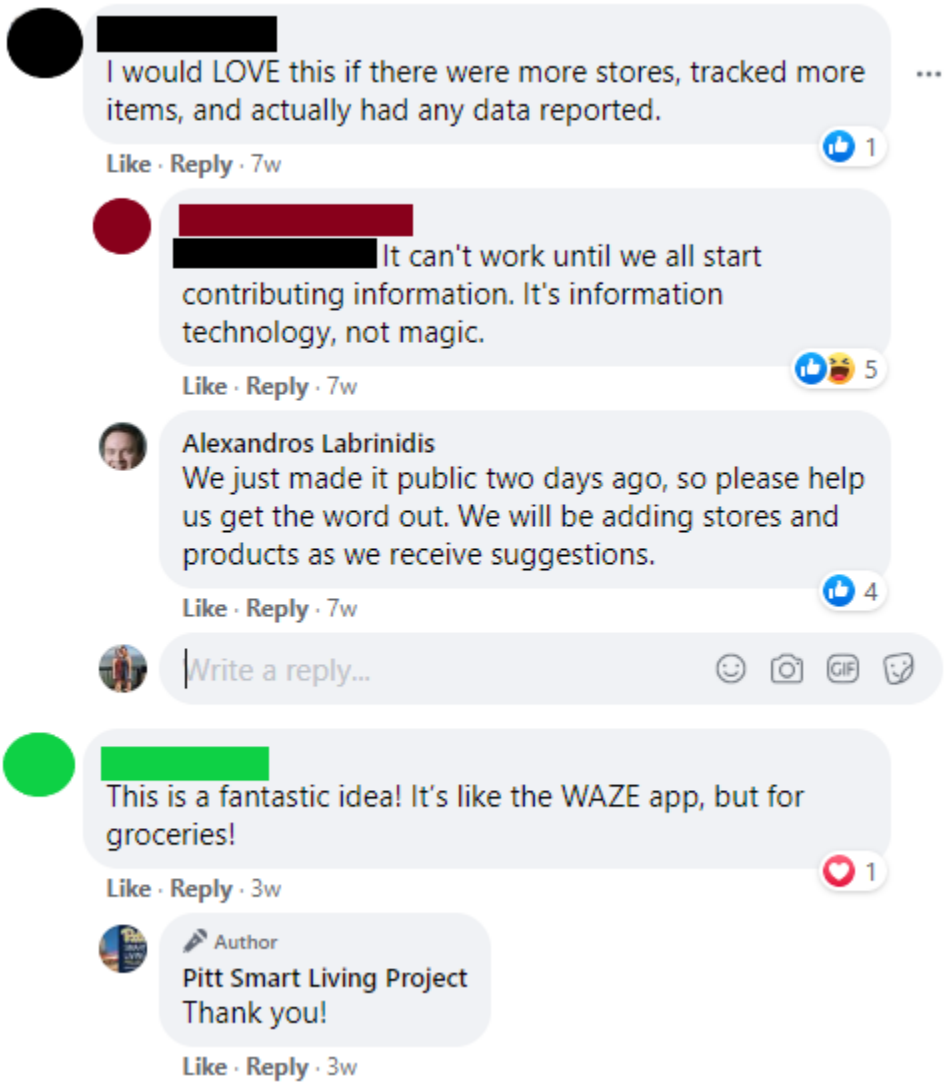


Figure 15: Facebook Comments 5

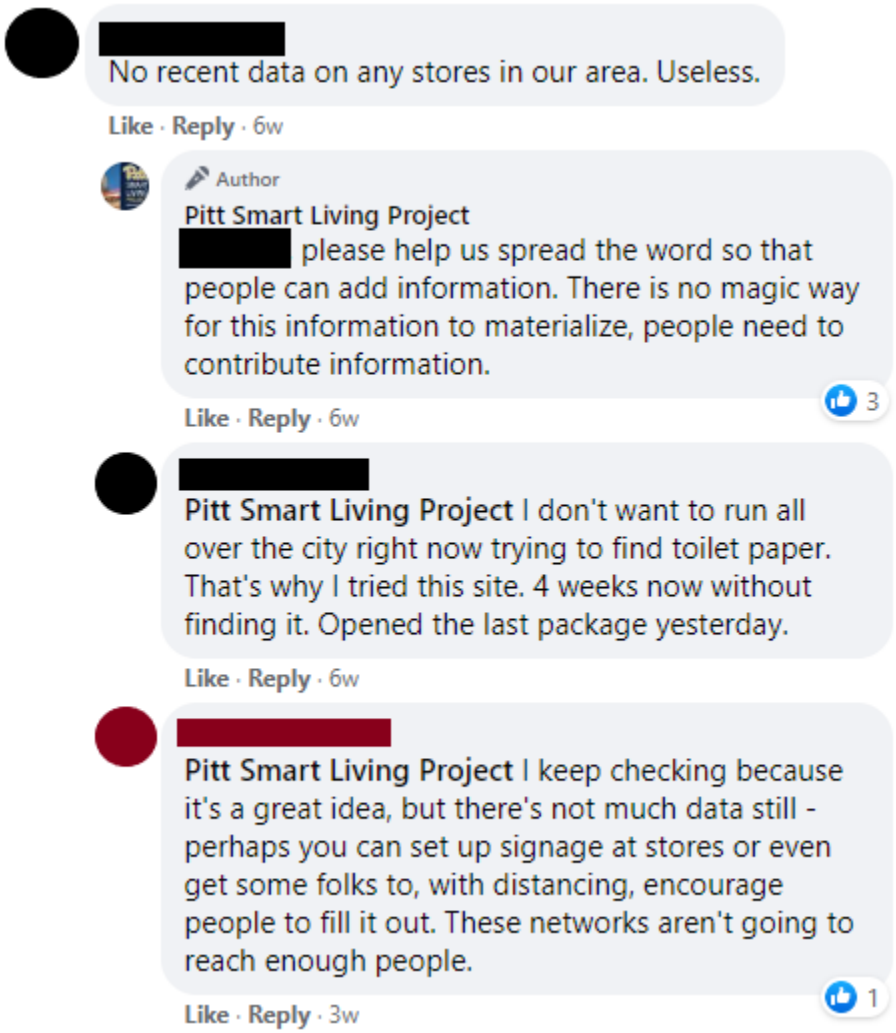


Figure 16: Facebook Comments 6

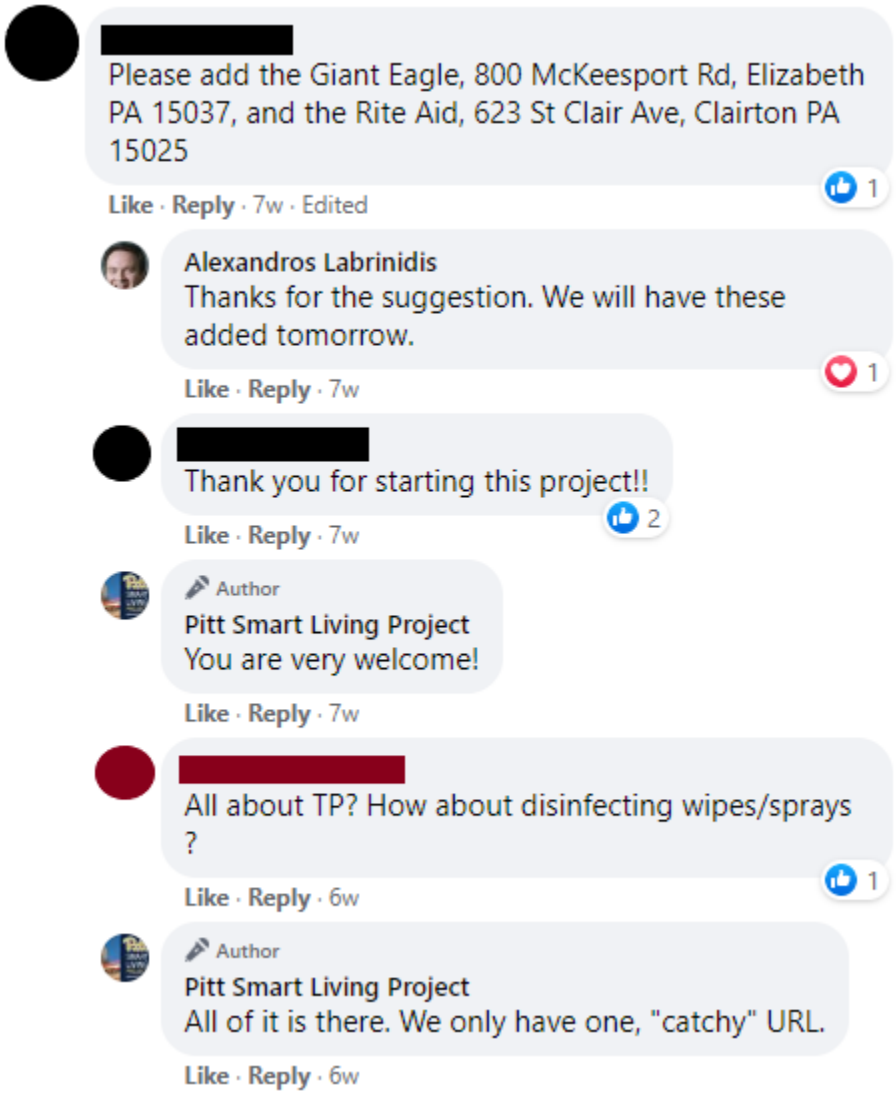


Figure 17: Facebook Comments 7

Figure 18: Facebook Comments 8