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Can Technology Be Leveraged to Improve Child Independent Mobility?

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Can Technology Be Leveraged to Improve Child Independent Mobility?

by

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Can Technology Be Leveraged to Improve Child Independent Mobility?

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Spend enough time in a suburban community and you might notice the lack of children moving around freely as was once common. Child independent mobility (CIM) refers to that freedom of children to be away from constant direct adult supervision as they move about their own community. CIM has a positive impact on a child's physical, social, and emotional development and there seems to have been a considerable decline in its prevalence in communities today. We believe that technology can be developed to help increase CIM through both hardware and software solutions. This paper presents a survey that was done of parents about their thoughts and experience with their children and the amount of independence they have. The survey focuses on how their children get to school and their thoughts on how technology could be used to help increase independence.

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Chapter 1

Introduction

Parents place limits on child independent mobility (CIM) for many reasons, including concerns about traffic [9]; these concerns justify the US DOT's Safe Routes to School program [26]. Past studies have found that 31% of parents cite "stranger danger" as the primary reason for driving children to school [16]. Statistics showing overall declining crime rates seem to do little to ease parents' fears. In areas where CIM is more accepted, integration and engagement of children with the community directly promotes CIM [1]. Child independence, which is important for social and emotional development, is fostered by a child's *mobility* and social interactions in the neighborhood [19]. Increased social engagement is not just good for kids; it also fosters parents' comfort with CIM [18]. *Walking buses* and *bicycle trains* [21], in which groups of students are accompanied to school by one or more adults, address several of these concerns: students are socially connected and group movement eases parental concerns [25]. Further, providing limited adult supervision in the neighborhood during students' transit to and from school increases CIM more generally (even outside of school transit hours), as both parent and child comfort levels are bolstered [22].

This survey is part of a larger project to improve CIM. The goal is to develop technology that can be used to children to move about independently more frequently while still providing peace of mind for parents. We believe that by utilizing mobile technology and smart communities we can increase CIM rates while still keeping children safe. Before we could begin doing too much work into development we needed to better understand the views of parents when it came to CIM. We performed a survey of parents with elementary-aged children to determine how their children get to school and how they feel about technology for their children. Looking at school transit, we define "independent" transport as any form of transportation without direct adult supervision and "sustainable" as any form of transportation that is not by car. When it comes to children, safety is a very important factor so we needed to get insight into what reasons there may be for or against CIM from parents. In this paper we will present the results of our survey and a few observations made about noticeable relationships. We will also present how this data can be used to support future work in leveraging pervasive computing to increase CIM in communities.

In Chapter 2 we will discuss a few items of related work to the area of CIM and the motivations for conducting this survey. Chapter 3 discusses how we conducted the survey, who we were trying to reach, and some of the possible threats to validity for the results. Chapter 4 will list some of the basic results from the survey and answers to specific questions that will form the foundation for the other chapters. Chapter 5 will begin to go over some

of the relationships seen in the responses and possible important statistics. Chapter 6 will then look at what the results mean for our future work and how we will use these results to develop technology that improves CIM.

Chapter 2

Related Work and Motivation

A significant amount of work has measured child independent mobility and its benefits, largely through surveys and questionnaires [8, 12, 20, 22, 24, 27]; some projects take only limited advantage of sensing capabilities, specifically in measuring mobility, e.g., via accelerometers [14, 17]. There have also been efforts to create interventions to increase child mobility [7, 11], focusing on journeys between home and school. While several studies show the potential for these benefits to extend beyond home-to-school trips, such interventions are limited [4, 14, 22]. Further, one takeaway from several studies is that *independence* increases the amount of time that children are active, yet existing work focuses almost exclusively on metrics associated with increasing movement, rather than independence and agency.

Technologies available to help parents keep a close watch on children are vast. Solutions range from very simple and inexpensive proximity detecting devices to cellular-based trackers costing over $100 and requiring monthly contracts. The former only detect disconnection of the device from the parents smart-phone (basically allowing no independent movement); the latter, in addition to being expensive, are effectively digital collars that enable parents to

directly track children all of the time (thereby allowing a semblance of independent movement without true independence). A further major disadvantage of all of these solutions is their reliance on a third party to maintain information about children. Not only does this have potential serious privacy implications, but it is inflexible because it limits the parent to application capabilities provided by the device manufacturer. The third party service must be active for monitoring to work (i.e., if there is a transient failure, there is a disruption in the reliability of monitoring). Furthermore, if the manufacturer fails permanently, the required third party service will most likely also disappear[6]. Most importantly, however, these solutions just extend helicopter parenting to the digital world instead of promoting more actual independence in child mobility. These challenges motivate CPS technology for supporting CIM that is open, independent, community based, and safely provides increased autonomy to children.

Pervasive computing has developed considerably to allow for new and exciting applications of technology. Existing empirical work has demonstrated that gamification, the use of game design elements in non-game contexts [5], can have a positive impact on health and well-being [10]. Games like Pokemon GO have been shown to increase children's activity levels [13]; this work also demonstrated that "cooperation conquers competition." The Beat the Street game used a wearable accelerometer to measure and gamify active movement to school [3]; results of a pilot study in the UK showed moderate gains in "active travel" among students who used the sensor. These prior efforts show

that gamification and pervasive computing have significant potential; however, what has not been explored are the social, emotional, and technological dimensions that lead to success and how this success relates to dynamic interactions between children, their peers, parents, and the community.

Prior to the work of this survey we begun looking at data in the internet-of-things (IoT) and how it can be made more contextually relevant [15]. Datalets showed how games that depend on contextual information (e.g. time, location) like Pokemon GO can be written where the valuable data controls access to itself. One of the motivating narratives of that work as well as this survey is enabling children to participate in a walking bus on the way to school and datalets showed how the location of a child can be represented as a datalet.

Chapter 3

Methodology

The survey was written to specifically gain insights into the current situation of CIM in communities and to understand the views of parents concerning technology. The ultimate goal is to investigate how pervasive computing technologies can support efforts to increase CIM in neighborhoods. To understand the survey we will explain the overall structure, the target participants, how we collected data, and how our methodology could bias the results.

3.1 Survey Structure

We surveyed 119 different parents with 87 of them finishing the entire survey. The survey was broken into the following five sections, where each section focused on one main goal.

1. **Personal and Family Background:** We asked the participants some information about themselves and their family. This included basic demographics as well as how comfortable they feel with technology. They were also asked about their children like how old they were, how they get to school, and even whether their children have mobile devices.

2. **Community Background:** We asked the participants things about the community they lived in like how far they are away from schools and parks, how safe the community is, and ages they might allow their children to perform certain activities in their community.

3. **Software for Child Independent Mobility:** The participants were shown various short simulations of rules they might want their children to follow and asked to evaluate the effectiveness of the rules and how they felt about them. This was with the purpose of identifying how software and hardware solutions can be used to improve CIM.

4. **Technology and Children:** We asked the participants how they felt about giving smartphones or simpler mobile devices to their children and reasons why they would or would not do so.

5. **Technology for Child Independent Mobility:** We asked the participants to imagine that a simpler mobile device existed for their children and asked what kind of features might be important to have and what they would prioritize in such a device. This included features like battery life, communication technologies, etc.

At the end of the survey participants were asked if they would be interested in receiving more information and would be available for follow up studies as necessary. The full survey can be found in Appendix A.

3.2 Target Participants

The inclusion criteria for our study was to be a parent with at least one elementary-aged child. This included those with elementary, middle, and high school age children. Although we were interested in elementary-aged children, many parents had older (and younger) children as well that they provided data for. Our particular interest in this work is with those that lived within walking or biking distance to school and this is more commonly found in suburban and urban neighborhoods. The survey was available to both mothers and fathers and includes those that might have one child or more than one child. When respondents stated that they had more than one child, they were given the opportunity to answer some of the background questions for each one of their children. Where a specific question might pertain to a single child, respondents were simply asked to clarify which of their children they had in mind when responding to the question.

3.3 Data Collection

We recruited survey participants through social media and parent forums in the Austin area. The survey was performed using Qualtrics [23], which allowed for all respondents to respond to the survey on any computer or mobile device with internet access. We decided to use an online survey to increase the number of participants we could reach and we could still show the simulations in small videos. As part of the distribution we asked that individuals only take the survey if 1) they were a parent and 2) had a child that was old

enough to attend some form of school from elementary to high school. As part of the survey, the first 100 participants were offered a $20 Amazon gift card as compensation for their participation. We felt that as the survey was quite long this would result in a higher response rate than a smaller reward. They were not required to finish the survey in one sitting but we encouraged them to finish any section they started before pausing. As each of the questions in any particular section were heavily related we wanted to ensure there was consistency through the whole section. Although we did not require that any particular individual completely finish the survey after having started we did distribute the survey multiple times to potentially receive new participants and remind others to finish the survey. The first survey response was collected in the beginning of December 2017 and the last response was received in the middle of January 2018.

3.4 Threats to Validity

As with many opt-in surveys, there is an inherent risk that our study may be specific to the area it was distributed and the demographics of those that responded. Although the respondents were not restricted to live in Austin, the way in which the survey was distributed resulted in most, if not all, participants being residents in the Austin area. In particular the schools that would have been reached by the particular forums and media used are in areas with low levels of poverty and crime. This could affect the percentages associated with the various modes of transport for the children en route to school. It

might also have an effect on the views of technology for children and the priorities of features in mobile devices to help their children. In areas with more crime or potential dangers the results might be very different when it comes to what activities the child might be allowed to participate in independently.

The survey was open to all parents but as more mothers might have been active in the various forums, we had a higher number of mothers participate than fathers. Also, although it would be expected that within a single partnership the answers would not vary greatly, that cannot be guaranteed. We did not have many cases where both parents responded to the survey so our data might be biased by this point.

In addition to the group of individuals that responded to the survey there is the possibility that our questions were written or arranged in a way so as to encourage positive views of technology for their children. As the survey showed possible scenarios for the kids that could benefit from technology prior to asking respondents if they would want their child to carry a mobile device, this could have biased their responses in Section 4 of the survey.

Still, we urge the readers to focus more on the overall trends and the implications than the absolute numbers.

Chapter 4

Results

In this chapter we will look at the basic results of the survey. Specifically, we will address the demographics of the respondents, the characteristics of the communities they live in, statistics about how their children get to school, and results relating to what kinds of devices are already being used by the children.

4.1 Demographics

In total we had 87 participants finish the entire survey with the total amount of children landing at 172. Of these 87 participants, most of them are female (86%) with a much smaller group of male participants (14%). The majority of respondents had two children (55%), with the next largest group having only one child (20%) which was closely followed by those that had three children (17%). Most of the children were younger than 12 (83%) with 40% of the children being 5-7 years old and 43% being 8-11 years old. When asked how comfortable they are with technology when compared to their peers most of the participants the responses were split pretty evenly with only 52% responding they felt "Above Average" and the rest responding they were "Average". Of

the 172 children that we received data for we eliminated 33 of them due to them being too young to attend school or being older than 18.

4.2 Communities

Most of the participants described the community they live in as either suburban (52%) or urban (46%). When asked how close they lived to the nearest park 45% responded that they lived within half a mile, 82% lived within a mile, and the rest lived more than a mile. A large group of the participants lived within half a mile of their children's elementary school (32%) and 70% of all participants lived within one mile.

We asked each parent a few questions about how safe their communities or and what things might dangers to their children. Table 4.1 shows the percentages of parents that agreed or disagreed with the different statements about dangers. Most questions were pretty polarized to either agree or disagree with around 80% responding in the same way. The least polarized statement was whether their children are in danger from adult strangers in their neighborhood where only about 61% disagreed with the rest split between agreeing or feeling neutral.

We also asked the parents to specify an age for which they would let their children perform certain activities in their neighborhood with some level of independence. The percentages for these activities and the ages that the parents responded are shown in table 4.2. From their responses we can see that the most common ages for independence are nine and ten years old with

Question	Agree	Neutral	Disagree
My neighborhood or community is a safe place for children to play outdoors	93.10%	2.30%	4.60%
My neighborhood or community is a safe place for children to walk or bike	82.76%	3.45%	13.79%
In my community, automobile traffic is a threat to my child's safety	79.31%	9.20%	11.49%
In my community, my child is in danger from adult strangers	17.24%	21.84%	60.92%
In my community, my child is in danger from other children	4.60%	12.64%	82.76%

Table 4.1: Perceived levels of safety and dangers in communities

just over 40% choosing those ages for each activity.

Question	5-6	7-8	9-10	11-12	13-14	15+	N/A
Playing in a public space in your neighborhood with no direct adult supervision.	4.60%	17.24%	43.68%	26.44%	8.05%	0.00%	0.00%
Biking or walking to school alone.	1.15%	10.34%	43.68%	25.29%	10.34%	3.45%	5.75%
Biking or walking to school with a friend or sibling.	6.90%	20.69%	44.83%	18.39%	3.45%	1.15%	4.60%
Biking or walking to a friend's house alone.	3.45%	28.74%	41.38%	20.69%	2.30%	2.30%	1.15%

Table 4.2: Ages that parents would let their children perform certain activities

4.3 How Does Your Child Get to School?

As part of the survey each participant was asked how each one of their children gets to school most frequently. Of all children more than half of them

get to school by car (57%). After that 24% walk/bike/scooter with an adult, just under 12% took a school bus, less than 6% walk without an adult, and only about 2% bike or scooter without an adult. These numbers include children from all ages and from the three distance groups from the school. Many high-school age children drive themselves to school so we want to focus on the ages that have the best opportunity to change. When focusing on just elementary and middle-school age children we get the percentages that are shown in figure 4.1.

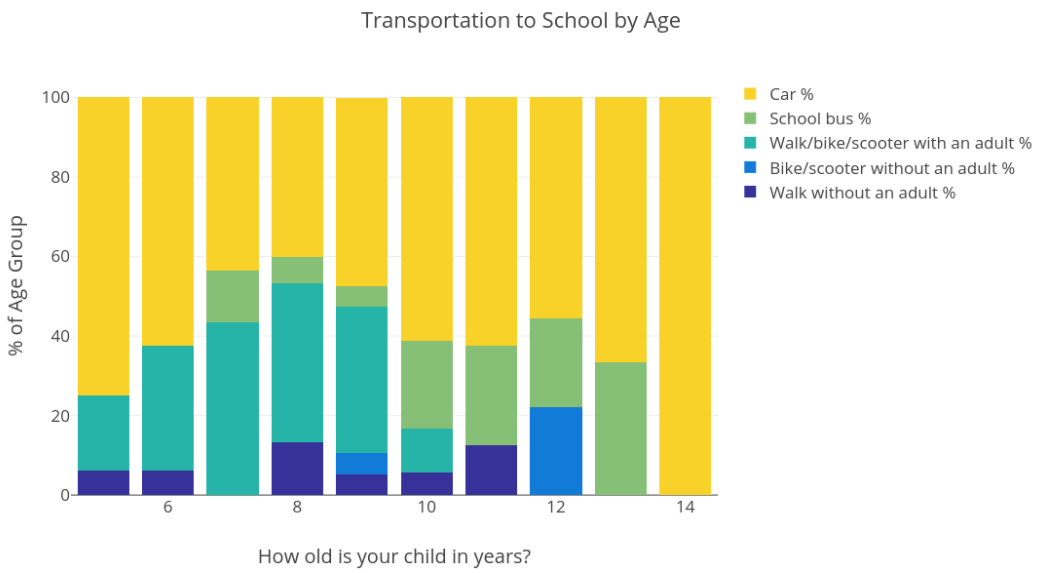

Figure 4.1: Transportation methods for elementary age children

4.4 Does Your Child Have a Mobile Device?

The participants were asked if their children owned some sort of mobile device that they carry on a regular basis. This included devices like smart-

phones, activity trackers, smart watches, etc. If the child did carry a device they were then asked what kind of device they have. The majority of children do not carry any form of a mobile device on a regular basis with only 29% responding that they do. Of those devices the most common device being carried was a smartphone (68%) followed by activity trackers (28%).

Chapter 5

Observations

5.1 Independent and Sustainable Transportation

From the results it is very clear that a large group of children are being driven to school but our work aims to improve the CIM of children. To look at independence we can look at previous transportation definitions of *independent* and *sustainable* transportation. Although sustainable transportation means the children are not necessarily independent, they are already a step closer to independence and can maybe more easily transition to independence than those driving to school.

As we might expect distance to determine whether a child is driven to school or not, it would make sense to see that percentages of sustainable transportation are fairly consistent across the age groups. Also as children get older we might expect the independent transportation percentages to increase. As our work focuses on improving CIM to support positive child development, we are most interested in elementary-aged children, as this allows us to focus on improving CIM from the earliest possible age. From the responses only 44% of the elementary children get to school using a sustainable form of transportation and the independent transportation group is considerably smaller with just

under 8% of the children. To see how distance from the school affects these numbers we have broken this down into the different distances as shown in figure 5.1. It is likely that by living more than a mile away from the school is too far to expect to see many children walking or riding bikes to school and so it is not surprising to see no children getting to school in an independent way. Living within a mile though we can see that there are about 11% of the children going to school independently with 52% traveling to school sustainably. As we shrink the distance to just half a mile those numbers increase a little more, with 62% traveling sustainably and 23% traveling without direct adult supervision.

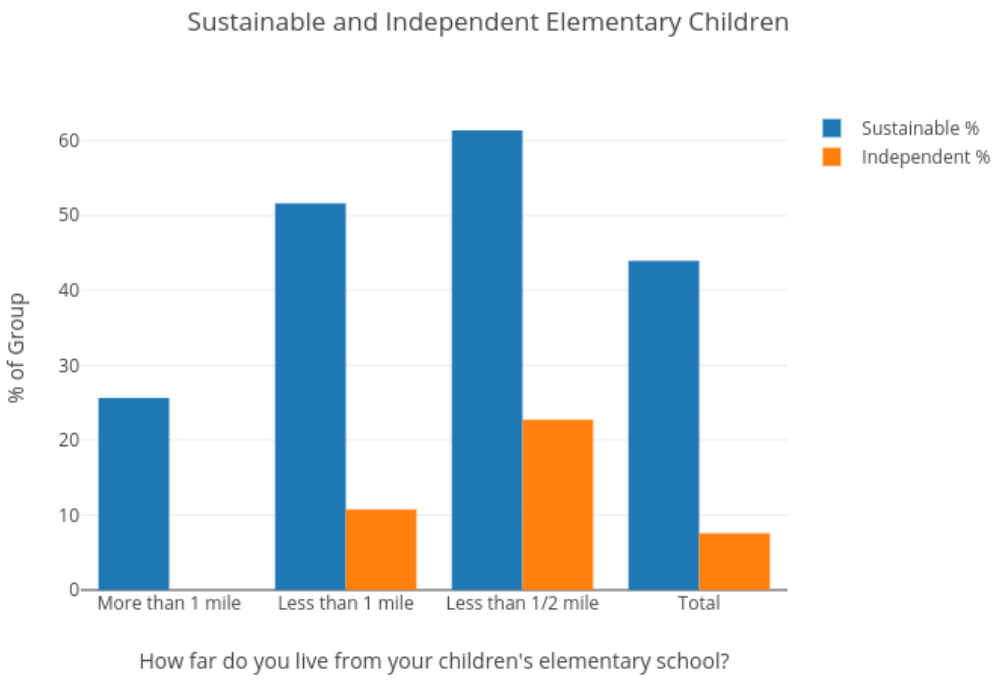

Figure 5.1: Independent and sustainable transportation groups shown by distance from school

Although the results showed that a large number of children are already getting to school sustainably, there are still 38% of the elementary children that live within a half a mile of the school being driven to school by their parents. If this many children are still being driven to school it is no surprise to see the high levels of traffic congestion around elementary schools in the morning. For people that live that close to the school it isn't unreasonable to think that it would be faster for them to walk to school than to drive due to the amount of traffic. Beyond just the time it takes, having this many people driving to school results in more opportunities for accidents to occur close to the school. These results show that there is still plenty of room for improvement.

5.2 Family and Community Influences

There might be many influencing factors on why parents might want to drive their children to school instead of choosing another option. One of the most obvious influences would be the distance that a family lives from the child's school. In addition to distance, the community itself might have a big influence on their form of transportation. If the community is dangerous or there is a lot of automobile traffic this might deter parents from wanting their children to walk, even if it is with an adult. To evaluate this we narrowed down on what might be considered "upper" elementary children (those 8-11 years old) as table 4.2 showed that over 80% of the parents consider them to be old enough to do many activities independently. We found that even within this group, of the 8-11 year old children being driven to school, more than 94%

of their parents chose “Agree” or “Strongly Agree” when asked whether their neighborhood was a safe place for children to walk or bike. This percentage shows that at, least in these communities, the safety of the neighborhood is not as strong of an influence as was intimated by prior studies. Figure 5.2 shows how the percentages break down for the different distances from schools for this target group.

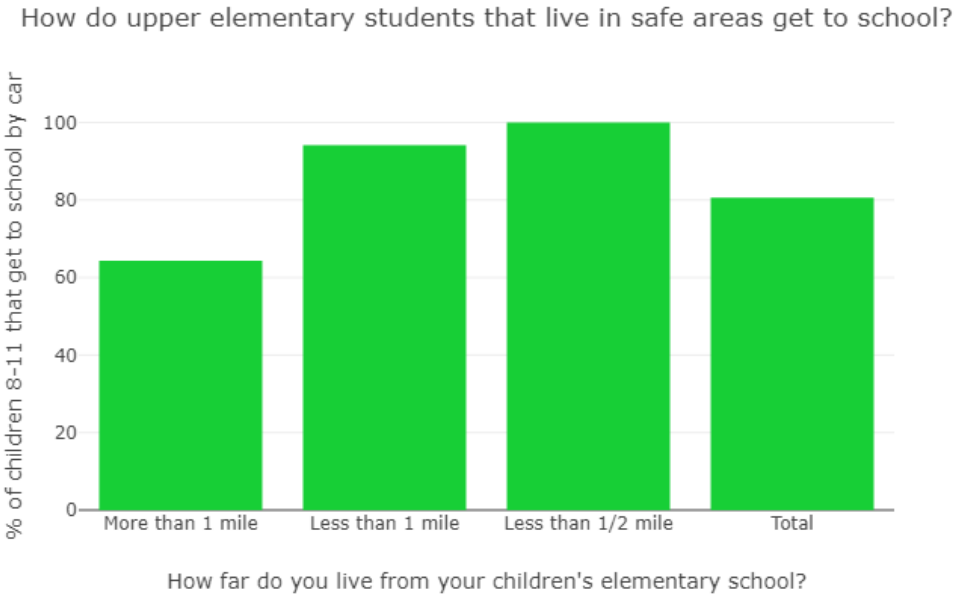

Figure 5.2: Percentages of 8-11 year old children that live in areas described as a safe place

Each participant was also asked about different factors that they perceive as dangers in their community. Specifically they were asked if their children were in danger due to automobile traffic, adult strangers, or other children. Looking at this same age group we can compare what dangers the

parents of children in different transportation groups (e.g. car, sustainable, independent) are worried about. By narrowing the group a little further to children that live within a mile of their school we get the data shown in Figure 5.1. From this graph we can see that although parents have different preferences for getting their children to school, they all have similar perceptions of the dangers in their communities. This implies that relative levels of danger in a community are not a strong influence on the mode of transport used to get to school.

Statement	Car	School bus	Walk/bike/scooter with an adult	Bike/scooter without an adult	Walk without an adult	All Children
My neighborhood or community is a safe place for children to play outdoors.	94.00%	100.00%	93.00%	100.00%	100.00%	95.00%
My neighborhood or community is a safe place for children to walk or bike.	94.00%	100.00%	80.00%	100.00%	100.00%	90.00%
In my community, automobile traffic is a threat to my child's safety.	88.00%	100.00%	87.00%	100.00%	20.00%	80.00%
In my community, my child is in danger from adult strangers.	41.00%	0.00%	27.00%	0.00%	20.00%	30.00%
In my community, my child is in danger from other children.	0.00%	0.00%	13.00%	0.00%	0.00%	5.00%

Table 5.1: Percentages of parents of "upper" elementary children within one mile of schools that agree with statements about their community

Many of the parents we surveyed had more than one child so there is the possibility that having a sibling in school is also affecting their mode of transport. For most of the children with a sibling that attends the same school the siblings get to school in the same way, but 25% get to school using

different modes of transportation. By looking at all children with and without siblings we see that for children with siblings it is much more likely that they are driven to school. Almost 70% of children with siblings at different schools are driven to school as opposed to the 43% of children without siblings that are driven to school. The second most common method of transportation for children without siblings is biking with an adult with 36% of them doing so. Figure 5.3 shows the modes of transportation for children with and without siblings.

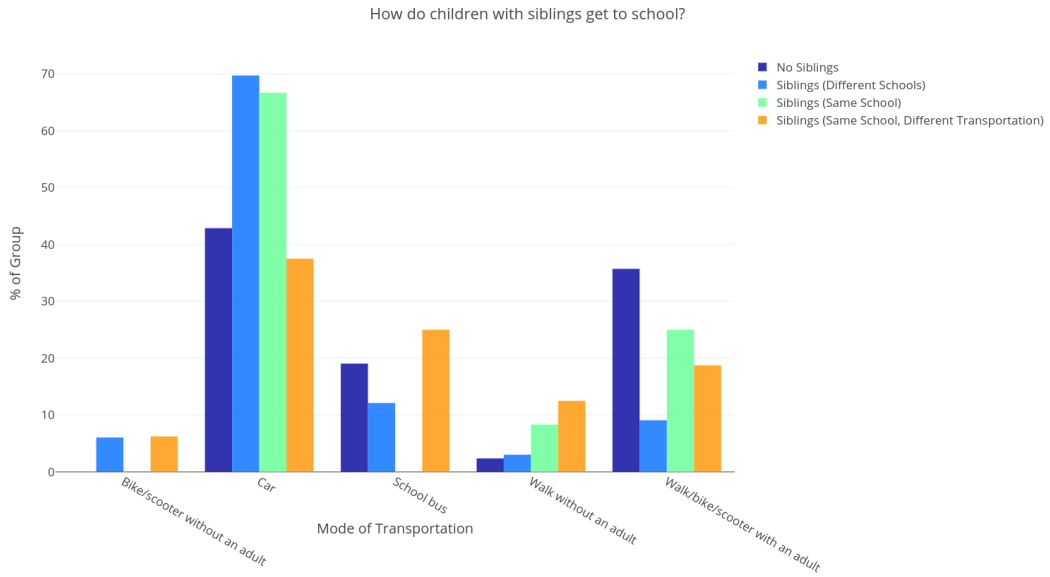

Figure 5.3: Method of transportation to school for children with and without siblings

5.3 Mobile Devices and CIM

A major focus of this study is how technology can be used to improve CIM. We wanted to see if children that are already using mobile devices of some sort are more likely to have higher levels of CIM. For all children in the survey less than 30% of them carry some sort of mobile device on a regular basis. Of the children that carry a mobile device just over 67% of them are carrying a smartphone of some type. The others are carrying entertainment devices or activity trackers without GPS or communication abilities. Surprisingly, almost 60% of the children that carry a smartphone are driven to school with and about 26% take the bus. It seems that from the data that children are not carrying devices to help them get to school independently. From table 5.4, however, we can see that for the most part, mobile devices become more prevalent as the children get older. Earlier we saw that around these older ages, parents consider their children able to me more independent so it is possible that mobile device usage is related to general independence for the children.

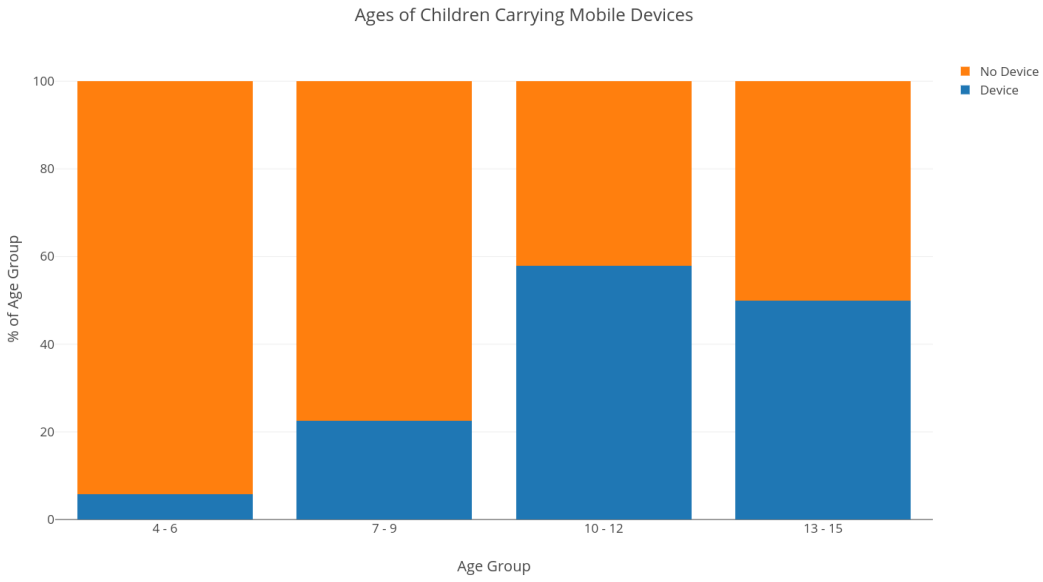

Figure 5.4: Ages of children that carry mobile devices

Chapter 6

Implications

6.1 Increasing CIM Through Gamification

There is a significant population of elementary-aged children who have little preventing them from being more independently mobile. Since proximity and safety are not significant barriers, a critical factor that may be contributing to the decline in CIM over recent decades is a lack of incentive. We will investigate the potential of incentives, with an initial focus on *gamification* to increase levels of CIM. We would like to investigate the relative benefits of games, devices used to collect data to input to the game, and the ways in which games directly target metrics associated with increased child independence and agency.

To leverage the concept of gamification we will build on KidsGoGreen [2], an interactive game developed at one of the partner institutions and played in elementary school classrooms. KidsGoGreen's goal is to raise awareness and change the behavior of children and their families with respect to active and sustainable mobility habits through gamified educational initiatives. In KidsGoGreen, sustainable travel to school contributes to the collective progress of the whole school in a virtual path mapped onto the real world. An interactive

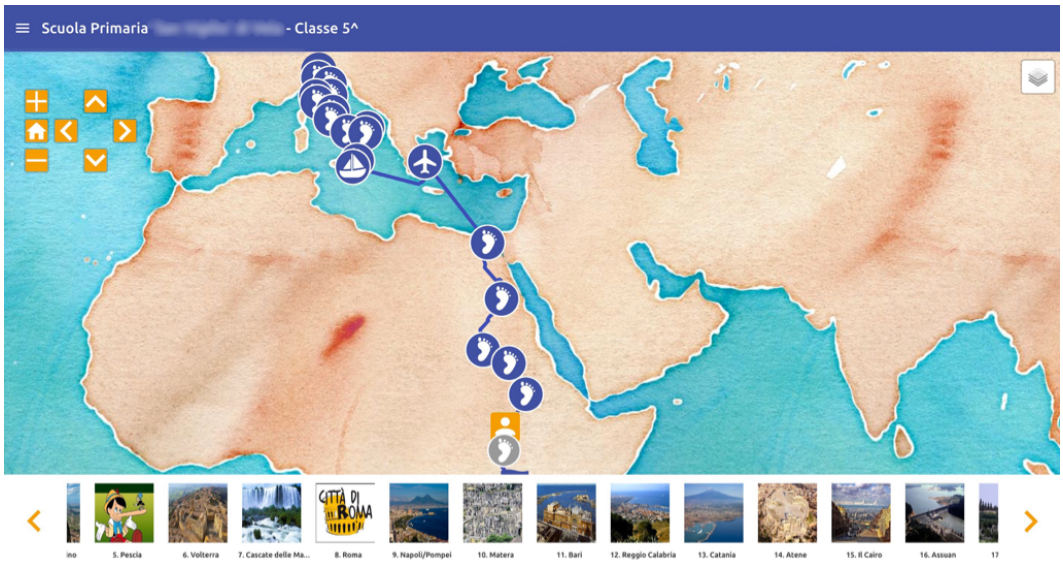

Figure 6.1: KidsGoGreen virtual journey.

digital map shows the school's journey in real time, as shown in figure 6.1, and arrival at intermediate stops unlocks multimedia educational material, making each achievement an opportunity for in-class learning. KidsGoGreen was piloted for 12-weeks in the Vela primary school in Trento, Italy, with a virtual journey from Trento to Kangole (Uganda), requiring more than 8000 Km to be sustainably travelled. Overall, 87 children took more than 4400 home-to-school trips and successfully (virtually) traveled 8538 Km. A questionnaire-based assessment showed that the game had a positive influence on home-to-school mobility habits for 68% of the children and the effects were still observable six months later.

This is also where datalets [15] can be leveraged. If we represent the information of each child as a datalet then we can control access to prevent any

breach of privacy. Datalets have already been used to show how an augmented reality could be implemented and applying to them like a game like this is not much of a stretch.

6.2 Outlook on Mobile Devices

Providing accurate rewards requires children to have some sort of technology associated with them, whether a passive proximity badge, some wearable sensor, or a smart phone. Our survey of elementary school parents also collected parent perceptions related to technology and their children. While many upper elementary aged children are starting to carry smartphones, our survey found that 61% of parents **were not** comfortable with their child carrying a smartphone. On the other hand, 69% of parents **were** comfortable with their child having a device with more limited capabilities. The top reason parents selected for having their child carry a device was that the device could give the parent peace of mind; a close second was the ability of the device to make the child feel safer. However 67% of parents also reported the ability of the device to improve their child's health as a motivator.

We want to create applications that engage children in independent activities in ways tailored to a child's mind, attitudes, and behaviors, incorporating both software and hardware (i.e., devices that children wear or carry). When evaluating hardware solutions there will be trade-offs in what features the devices have. If the device tracks activities and is constantly monitoring the surroundings then it could negatively affect the battery life of the device.

Priorities are very important to consider when designing such a device and our results have given us a brief look into a few of the things that the parents would most like to have in such a device. According to the responses the three most important set of features are: "My child can use the device to alert me in an emergency," "The device can be tracked to within a city block," and "The device has a limited set of contacts for calls and text." Giving each level of importance a point value from 1-5 allows us to view the priorities shown in figure 6.2. Although earlier we saw that two-thirds of parents would have their children carry a device to improve their health, keeping track of the child's activity levels was rated as the least important feature of the list.

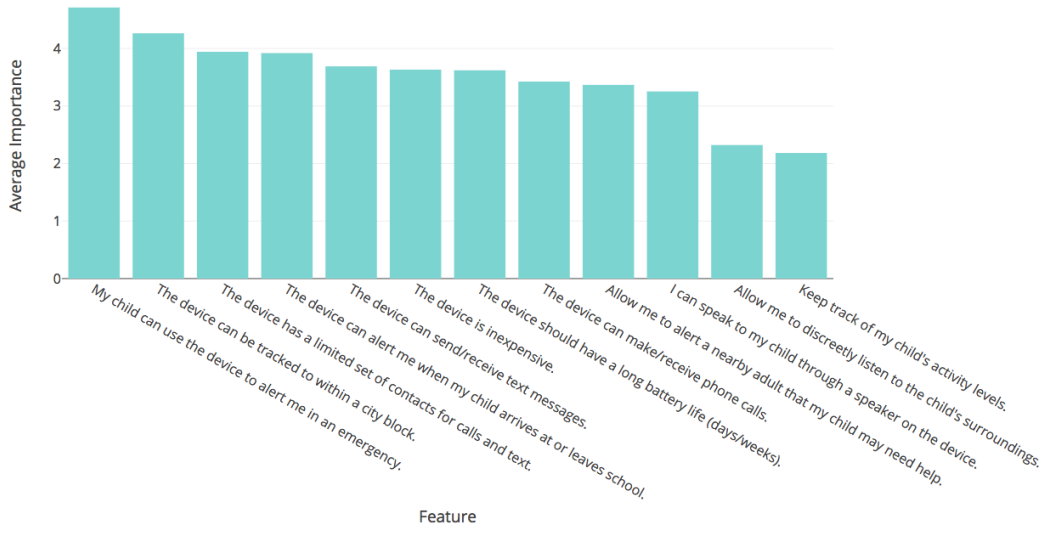

Figure 6.2: Average importance of different mobile device features to parents.

Chapter 7

Conclusion

This paper finds that safety in a neighborhood and distance from school are not as strong of influences in whether or not a parent drives their children to school as has been suggested in prior studies. Instead it found that convenience and lack of incentive might have a much stronger influence. Although our results showed that safety was not a key factor in deciding transportation type, we cannot ignore that many parents feel that safety is their primary concern as shown by related work. To satisfy their peace of mind we advocated implementing software and hardware solutions that can be used to increase CIM while still providing the necessary peace of mind to parents. We found that although most parents do not want their children to have a smartphone they are open to using more limited devices with their children. To drive incentive for CIM we also proposed using gamification as a way to foster the desire to improve CIM.

Appendices

Appendix A

Survey Appendix

A.1 Intro and Consent

This page provides some information about the research study of which this survey is a part. Your participation is entirely voluntary. You can refuse to participate without penalty or loss of benefits to which you are otherwise entitled. You can stop your participation at any time, and your refusal will not impact current or future relationships with UT Austin. To do so, simply close the survey without submitting it.

The purpose of this study is to determine (a) parental comfort in using technology to support child independent mobility (CIM) in general and (b) parental comfort with the PIs developed approaches to monitoring CIM in particular.

The study consists of this online survey. This survey should take around 20-30 minutes but not more than one hour.

The benefits to you of participating in the study include an increased understanding of the Internet of Things and of the potential benefit of using IoT technologies to support children. The benefit to society is more substantial; the impact of this research is potentially very large, as such framework

can be used for all kinds of emerging IoT systems. There are no anticipated risks of being in the study.

In addition, the first 100 completed surveys will receive a $20 Amazon gift card. You will be asked for your email address at the end of the survey for delivery of the gift card.

Confidentiality and Privacy Protections: Data from this study will be maintained indefinitely. The data resulting from your participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate you with it, or with your participation in any study.

The records of this study will be stored securely and kept confidential. Authorized persons from The University of Texas at Austin, members of the Institutional Review Board, and study sponsors have the legal right to review these research records and will protect the confidentiality of those records to the extent permitted by law. All publications will exclude any information that will make it possible to identify you as a subject.

Contacts and Questions: If you have any questions about the study please contact Dr. Christine Julien (c.julien@utexas.edu; 512-232-5671). For questions about your rights or any dissatisfaction with any part of this study, you can contact, anonymously if you wish, the Institutional Review Board by phone at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.

By continuing with this survey, you acknowledge that you have been informed about this study's purpose, procedures, possible benefits and risks. You may save a copy of this form by printing it from your browser. You have been given contact information through which you may ask questions at any time. You voluntarily agree to participate in this study. By continuing with the survey, you are not waiving any of your legal rights.

A.2 Section 1: Personal and Family Background

To help us assess demographics of the study participants and the technology comfort and background before the study, please answer the following questions truthfully. Your answers will not be used against you, and you are free to withdraw from the study at any time.

1. What is your age?
2. What is your sex?
3. Do you own a smartphone?
4. How would you rate your comfort with technology (e.g., computers, smartphones, etc.) in comparison to your peers?
    - Above average
    - Average

- Below average

5. How many children do you have?

   The rest of the questions in this section are answered once for each child

6. How old is your child in years?

7. How does your child usually get to school (choose the most frequently used method)?

   - Walk without an adult
   - Bike/scooter without an adult
   - Walk/bike/scooter with an adult
   - Car
   - School bus
   - Other (specify)

8. Does your child have any technology or devices that they wear or carry on a regular basis (e.g., a smartphone, Gizmo, smart watch, activity tracker, etc.)?

9. What kind of device does your child have?

10. What was the age in years at which your child first had this device?

A.3 Section 2: Community Background

For the questions in this section, consider the neighborhood or community in which you currently live.

11. How would you describe your community?

    - Urban
    - Suburban
    - Rural

12. How far do you live from the nearest public park?

    - Less than 1/2 mile
    - Between 1/2 mile and 1 mile
    - More than 1 mile

13. How far do you live from your children's elementary school?

    - Less than 1/2 mile
    - Between 1/2 mile and 1 mile
    - More than 1 mile

14. Rate your level of agreement or disagreement with the following statements.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
My neighborhood or community is a safe place for children to play outdoors	x	x	x	x	x
My neighborhood or community is a safe place for children to walk or bike.	x	x	x	x	x
In my community, automobile traffic is a threat to my child's safety.	x	x	x	x	x
In my community, my child is in danger from adult strangers.	x	x	x	x	x
In my community, my child is in danger from other children.	x	x	x	x	x

For each of the following questions give the youngest age at which you would allow your child to engage in the specified activity (a blank response means you would not allow that activity)

15. Playing in a public space in your neighborhood (e.g., a public park or playground) with one or more friends of the same age but no direct adult supervision.

16. Biking or walking to school alone.

17. Biking or walking to school with a friend or sibling.

18. Biking or walking to a friend's house alone.

A.4 Section 3: Software for Child Independent Mobility

Imagine your child, that is 10 years old, participates in a "walking school bus", in which a chaperone "picks up" your child outside your home and walks with your child and a group of other children to school. In the videos that follow, the adult chaperone is depicted by a larger purple circle, your child is depicted with a small green circle, and other children are depicted as small blue circles. Students are registered to the walking school bus in advance; any registered students who are within the large green shaded circle are considered "on the walking bus". In the videos there is also a phone that represents your personal phone where you can receive alerts and messages.

19. First, consider the following rule (assume that school begins shortly before 8am):

    Between the hours of 7-8am, my child should either be at my house, on the walking bus, or at school."

    Watch the video found at:

    `https://www.youtube.com/watch?v=0zKwoYGyc6E`

    Does this video show an instance of the rule being followed correctly?

20. Briefly explain why or why not.

21. In the following two videos we present a couple scenarios of the walking bus rule being violated on the way to school.

Watch the video found at:

`https://www.youtube.com/watch?v=Eoc1eCILzas`

and

`https://www.youtube.com/watch?v=jEWbdxmiU0w`

In the first case, you receive a text notification that your child has violated the rule. In the second case, the chaperone receives a notification. Which scenario do you prefer?

22. Briefly explain your choice.

23. Here is one more scenario of your child walking to school

    Watch the video found at:

    `https://www.youtube.com/watch?v=RZgNIg8AUyE`

    In this video, do you feel the rule was violated?

24. Briefly explain why or why not.

25. Given all of these scenarios, which one of the following rules best captures the intended restriction on your child's movement?

    - Between the hours of 7-8am, my child should either be at my house, on the route to school, or at school.
    - Between the hours of 7-8am, my child should either be at my house, on the walking bus, or at school.

- Between the hours of 7-8am, my child should start at my house, be picked up by the walking bus, remain on the bus until arriving at school, then remain at school.
- Other (specify)

26. If you were writing a rule to constrain your childs transit to school (with or without a walking bus), what rule might you write?

27. In this next set of videos, imagine your child, that is 12 years old, is allowed to go to a nearby neighborhood park and play as long as he or she adheres to a rule you have defined. The rule is:

    "At all times, the child must be on the way to or from the park or at the park playing with at least 3 other known children."

    Watch the video found at:

    `https://www.youtube.com/watch?v=HY41sKrFcJo`

    Do you feel this video shows an instance of the rule being followed correctly?

28. Please explain why or why not.

29. Here is a scenario where the rule is violated by children leaving the park.

    Watch the video found at:

    `https://www.youtube.com/watch?v=xFrsyI8rrwQ`

For all of the following possible actions that could occur after the violation, rank them in order of priority to you (1 indicates the thing you would most want to have happen)

- You (the parent) receives a text notification immediately
- You (the parent) receives a text notification within 5 minutes
- The device alerts the child (e.g., makes a noise, vibrates, etc.)
- Other nearby trusted adults (e.g., those also in the park) are notified immediately
- The event is recorded in a log that you can review later at your leisure

30. Here is one last video of a slightly different scenario at the park from the previous two.

    Watch the video found at:

    `https://www.youtube.com/watch?v=4x7Ot61HbaU`

    In this video, do you feel the rule was violated?

31. Please explain why or why not.

32. If you were writing rules to constrain your child in a situation in which he or she is allowed to go to a park by him or herself, what rule might you write?

33. The two rules we showed were:

(a) *"Between the hours of 7-8am, my child should either be at my house, on the walking bus, or at school."*

(b) *"At all times, the child must be on the way to or from the park or at the park playing with at least 3 other known children."*

Given your exposure to these rules, what kinds of rules would you be interested in writing related to your child(ren) and their independent mobility in and around your neighborhood or community? Feel free to write multiple rules, just put each one on its own line.

A.5 Section 4: Technology and Children

For the following questions, consider just one of your elementary aged children if you have more than one child.

34. First, how old is the child in years?

35. For each statement in the table, rate your level of agreement with the statement, considering your views regarding your elementary aged children. Consider instances when your child may be separated from you either intentionally or accidentally. "Carrying" refers to having a device on the child, whether in a pocket, worn on the wrist, or attached to a backpack or article of clothing.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I am comfortable with my child carrying a smartphone when he/she is not with me.	x	x	x	x	x
I am comfortable with my child carrying a simple device that can make and receive phone calls and texts to a limited set of contacts.	x	x	x	x	x
I am comfortable with my child carrying a simple device that allows only me (or other designated adults) to track the device's position.	x	x	x	x	x

36. For the next set of questions, consider a "device" to be any piece of technology that your child carries or wears on a regular basis. For each reason in the following table, rate how important the reason is in a decision to allow your child to have such a device.

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
It gives me peace of mind.	x	x	x	x	x
It makes my child feel safer.	x	x	x	x	x
It makes my child happy.	x	x	x	x	x
It gives my child independence.	x	x	x	x	x
It is more convenient for me.	x	x	x	x	x
It is fun.	x	x	x	x	x
It can be used to improve my child's health.	x	x	x	x	x

37. For each of the previous reasons marked as "Extremely important", please put them in order from most important to least important.

38. For each of the previous reasons marked as "Very important", please put them in order from most important to least important.

39. For the next set of statements, consider a "device" to be any piece of technology that your child carries or wears on a regular basis. For each reason in the following table, rate how important the reason is in a decision to **not** allow your child to have such a device.

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
I'm afraid my child will lose or break the device.	x	x	x	x	x
It is inconvenient for me and/or my child to remember to charge the battery of the device.	x	x	x	x	x
I do not trust the technology to work properly all the time.	x	x	x	x	x
I do not trust the privacy promised by the device, e.g., others may be able to track my child, even if the device claims that they can't.	x	x	x	x	x
I am afraid the technology might not be safe for my child.	x	x	x	x	x
I think my child would resist wearing or carrying the device.	x	x	x	x	x
I'm afraid my child would routinely forget to wear or carry the device.	x	x	x	x	x
I'm concerned the device would distract my child.	x	x	x	x	x

40. For each of the previous reasons marked as “Extremely important”, please put them in order from most important to least important.

41. For each of the previous reasons marked as “Very important”, please put them in order from most important to least important.

A.6 Section 5: Technology for Child Independent Mobility

For the following questions, imagine your child, that is 12 years old, is allowed to move about your local neighborhood without direct adult supervision and answer the questions with that in mind.

40. Now imagine you could design a device for your child to have at any time that he/she is unattended in your local neighborhood. For each of the features in the following table, rate how important that feature is to you in this imagined device.

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
The device can make/receive phone calls.	x	x	x	x	x
The device can send/receive text messages.	x	x	x	x	x
The device has a limited set of contacts for calls and text.	x	x	x	x	x
The device can be tracked to within a city block.	x	x	x	x	x
My child can use the device to alert me in an emergency.	x	x	x	x	x
The device can alert me when my child arrives at or leaves school.	x	x	x	x	x
The device is inexpensive.	x	x	x	x	x
The device should have a long battery life (days/weeks).	x	x	x	x	x
The device can keep track of my child's activity levels (e.g., counting steps or active minutes).	x	x	x	x	x
The device can allow me to discreetly listen to the child's surroundings.	x	x	x	x	x
The device can allow me to sound a buzzer to alert a nearby adult that my child may need help.	x	x	x	x	x
I can speak to my child through a speaker on the device.	x	x	x	x	x

41. For each of the previous capabilities marked as "Extremely important", please put them in order from most important to least important.

42. For each of the previous capabilities marked as "Very important", please put them in order from most important to least important.

43. The final question in this section asks you to rank the relative importance

of non-technical characteristics of the device. Put the following in order from most important to least important. If they do not matter to you, mark them so.

- Long battery lifetime
- Low cost
- Waterproof/drop-proof/etc.
- Wearable
- Small size
- Reliable

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Vita

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