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# Crowd Dynamics of Athletic Events

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**Crowd Dynamics of Athletic Events**

by

**Kelvin Andrew Kosbab**

B.S., University of St. Thomas (MN), 2012

M.S., University of Colorado-Boulder, 2014

A thesis submitted to the  
Faculty of the Graduate School of the  
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2014

This thesis entitled:  
Crowd Dynamics of Athletic Events  
written by Kelvin Andrew Kosbab  
has been approved for the Department of Computer Science

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Date \_\_\_\_\_

The final copy of this thesis has been examined by the signatories, and we  
Find that both the content and the form meet acceptable presentation standards  
Of scholarly work in the above mentioned discipline.

Kosbab, Kelvin Andrew (M.S. Computer Science)

Crowd Dynamics of Athletic Events

Thesis directed by Prof. Kenneth M. Anderson

This thesis will research crowd dynamics of athletic events. Specifically, this thesis will test the effectiveness of a crowdsourced scoring system of volleyball matches. To aid in the research of this thesis, I am using the TallyBok app that I have developed over the past year. TallyBok is a crowd sourced score alert mobile application developed for iOS and Android that targets the parents of volleyball players. TallyBok's primary goal is to keep family and friends engaged with multiple matches at once, able to follow the scores of their favorite teams even when they are attending another physically-separated match. In addition, TallyBok allows its users to share photos and comments with others viewing a match. The users themselves are responsible for scoring the matches they are watching. For testing, I will use high school volleyball matches. For each match, a test group of parents will be directed to download the TallyBok app and follow the match. In one test group, I will do all the match scoring and the test subjects will only follow the match. In another test group, I will begin to score the match but at a certain point will not update the match, forcing one of the members from the test group to score the match. In the final test group, I will not participate, forcing the test users to score the match themselves. These test will give insight into the dynamics of allowing match scores to be crowd sourced, as well as provide insight into how user friendly and intuitive the TallyBok app is for following live matches.

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# Chapter 1

## Introduction

### 1.1 Definition of Crowdsourcing

*Crowdsourcing* was first coined by Jeff Howe in 2006 in an article in Wired Magazine. The *crowd* in his article refers to some group of people drawn from members of the public that from the perspective of a company might do a task for you as opposed to the company's employees. In many ways, crowdsourcing is a form of outsourcing, where individuals and organizations outsource their tasks to a larger group of volunteers (the crowd) [5, 8, 9].

Crowdsourcing typically involves three types of actors: customers, workers, and platforms. *Customers*, also known as *requestors*, are individuals or organizations who have tasks to be completed. *Workers* are the individuals who actually perform the work that is outsourced by the customers. In many crowdsourced projects, little is known about whom the workers actually are or their qualifications. A *platform* provides an online marketplace for workers and customers to meet. For example, the largest platform for crowdsourcing software development is TopCoder, with a development community of more than 600,000 as of January 2014. The crowdsourcing platform also provides a model for participation. TopCoder, for instance, uses a competition-based model in which the winner gets paid a certain prize, and the runner-up receives half this prize [5, 8, 11].

In his article, Howe left no doubt that crowdsourcing would be a disruptive and potentially destructive force for various professions and industries. For example, Howe pointed out that iStockphoto, which is a crowdsourced stock image service, brought down the price of stock photos by an order of magnitude [5, 8, 9].

### 1.2 Challenges Faced by Crowdsourcing

Although different types of crowdsourcing face their own unique obstacles and challenges, there are many generic issues that customers face when managing a crowdsourced project. First and foremost is how to make the crowd as a whole



aware of something. The success of all crowdsourced initiatives depends on the participation of a large group of people in order to realize its maximum potential. Well-known brands and organizations do not face this issue as much but projects belonging to new or less known organizations have trouble grabbing the attention of the crowd. It is rather hard to create and maintain *engagement* if no one has heard about the initiative seeking that engagement [9, 10, 11, 12].

The next challenge faced by crowdsourced initiatives is gaining the necessary crowd participation. How can you get the crowd to contribute? According to Antikainen [1], “it is already challenging to create collaboration between strangers in face-to-face situations, and the Internet environment can make this even more difficult.” Rewarding a group for their mutual collective work is anything but easy and, taking into account the challenges of scheduling and managing time, may lead to less willingness to cooperate between members. One possible solution is significant monetary rewards, but doubts remain if that approach is viable. The key to participation is that the project *needs to provide something important to the participant*, and, depending on the project, monetary rewards may not be at the top of the list. If a participant cannot identify why a crowdsourced project is valuable to them, they will lack the commitment and engagement needed to contribute, and the probability of them dropping the project increases. A lack of importance in the participant’s life may also skew the input received for the initiative. Users who are interested in a project may be more truthful and helpful as opposed to a user who is not as engaged [9, 10, 11, 12].

Once the crowd has joined a crowdsourcing initiative, the next challenge is keeping the crowd engaged. There is a need for users to engage and for a certain critical mass to emerge before a crowdsourced project can work. Often times, crowdsourcing sites are competing with each other for available “crowd resources,” which ultimately means that not all the projects will be able to maintain a sufficient amount of contributors in order to survive. The obvious dilemma is the resources, i.e. the crowd, cannot be managed because there is no contractual relationship in place. User interest may also fade after the first initial excitement has disappeared from a crowdsourced initiative [9, 10, 12].

## Chapter 2

### Motivations of Trust on the Internet

#### 2.1 Definition of Trust

Trust is a highly complex and multi-dimensional phenomenon. In any industry, trust is the cornerstone to interpersonal and commercial relationships. Wherever risk, uncertainty, or interdependence exist, trust is crucial. As conditions become more complex in a system and more people are integrated in a system, trust grows as well [1, 2, 13].

If a service is often unavailable, it is simply not useful and its users will stop using it due to the service's lack of dependability. The same thing occurs if a service has been subverted by an attacker, which leads people to believe the service is insecure and cannot be trusted. In order for a service to be successful and grow its user base, it must be dependable, reliable, and trustworthy [1, 3, 7, 13].

For an Internet service to succeed, it is paramount that the service maintain a good reputation with its users. A good relationship facilitates trust and minimizes risks throughout the application [3, 7, 13].

#### 2.2 Trust as it Relates to Crowdsourcing

As it relates to crowdsourcing, it is vital that an application develop a good relationship and reputation with its users (in this case, "the crowd"). If the application fails to do this, there is a high chance people will be less honest when using the application and the people may choose to not use the application. As such, crowdsourced applications must make every effort to maintain an environment that is valuable to its users [3, 4, 6, 7, 10, 11, 13].

Crowdsourced applications must be able to manage users who maliciously infiltrate the application. Users acting against the goals of the project may corrupt the application's integrity by using the application in an improper way or by simply being present in the application's environment [3, 4, 6, 7, 10, 11, 13].

Crowdsourced applications must be able to maintain each and every user's privacy. In many social networks and crowdsourced applications, user profile

information is often a few clicks away. The application needs to insure that only non-private information about a particular user is available to the public [3, 4, 6, 7, 13].

### **2.3 Developing Crowdsourced Trust**

In order to develop a good relationship with the users, a crowdsourced application must incorporate personalized user feedback and track user activity to understand user behaviors.

Relationships in the crowdsourced network provide a basis for trust aggregation. It is important to update the quality of the trust assessments based on how well each user in the network behaves, so a feedback loop must be created. A feedback loop allows for trust assessments to be dynamically updated as the crowdsourced application network evolves and as the user-base changes over time. Updating the application according to the feedback will keep the crowd happy and engaged in the crowdsourced application [1, 12, 13].

However, maintaining good relationships may require some level of tracking user behavior. It is important to research and discover the user's behavior in the application without invading a user's privacy. Researching user behavior may uncover useful ways to improve the crowdsourced application and may also uncover malicious users who are using the application inappropriately [1, 12, 13].

## Chapter 3

### Crowdsourcing and Athletics

#### 3.1 Can Crowdsourcing Succeed in Athletics?

Crowdsourced applications have succeeded in countless industries and application domains. However, one such application domain that remains largely untested is whether the crowd can be an effective tool at athletic events for sharing sensitive event data. Currently, many athletic events only utilize the crowd for comments, polls, and other tasks that are solely for spectators. What if the crowd was responsible for reporting the progress of a match or game?

Currently, only designated officials and organizations handle any kind of in-progress updates, and this is true for both professional and amateur sports. Having a designated official for this task works extremely well at higher levels of competition, where accurate reporting of event progress is paramount and organizations have the resources to offer sophisticated tools for fans to follow events independent of their location.

However, a crowdsourced application that reports event progress may have a better chance of success at smaller events, such as recreational, club, and high school events. These smaller events often have designated officials to score the match, but because of the smaller scale they often do not have the means to report real-time progress of the event to people not present at the event. If the crowd can be trusted to report accurate progress and results, real-time progress of athletic events can be available at any level of competition and for any athletic event.

#### 3.2 Finding a Suitable Athletic Event

One sport that has a lot of promise for a crowdsourced application is volleyball. USA Volleyball, the organization that oversees all of the tournaments nationwide in the United States, has a very strong and expansive development program with thousands of teams and a large variety of age divisions. Just in Colorado there are 138 registered volleyball clubs and 394 teams spanning five age

divisions. The club volleyball season typically starts at the beginning of spring and runs to the end of summer.

High school volleyball starts when club activity ends and typically runs into the winter. Similar to USA Volleyball, there are thousands of high schools with volleyball teams in the United States. In Colorado, there are 327 varsity teams spanning five divisions. Additionally, it is common for each high school to have a junior varsity team, and a C-team.

Focusing on volleyball as a test-base for a crowdsourced application thus provides testing opportunities throughout the year.

### **3.3 Testing Tools**

To obtain data for this thesis, two testing tools will be utilized. The first is a mobile application I developed called TallyBok. TallyBok is a crowdsourced mobile alert application designed to keep volleyball parents and fans informed about the progress of a match. TallyBok is discussed in detail in Chapter 4 of this document. The second testing tool is SurveyMonkey. SurveyMonkey is the world's leading provider of web-based survey solutions allowing users to gather the insights they need to make more informed decisions.

## **Chapter 4**

### **TallyBok**

TallyBok is a mobile app available on both the iTunes App Store as well as the Google Play Store. TallyBok is a live score alert application for volleyball parents. It allows parents to automatically keep family and friends updated as well as to follow match scores of their favorite teams.

#### **4.1 Defining the Situation**

Currently for volleyball matches and tournaments, volleyball parents who are not present at the match want to keep track of their child's match results and progress. Club directors and school administrators want to keep track of their teams wherever their team is playing. Coaches want to know progress of preceding matches so they can get their teams ready on time. Referee officials need to post the scores of their matches and get to their next assigned court.

Because systems are already in place to address tournament management for officials such as AES and TM2sign, the target audience for TallyBok is the parents, club officials, and school administrators who want to track the progress of a remote match or who want to help distribute information about matches they are attending. Parents, club directors, and coaches should be able to get volleyball match results and schedules for their favorite teams wherever they are, whenever they want, and whenever it happens.

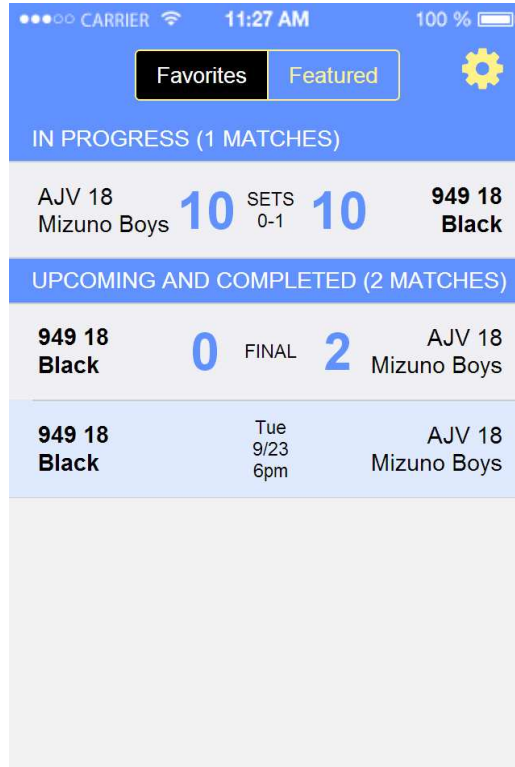
#### **4.2 What is TallyBok?**

TallyBok allows volleyball parents, club directors, and coaches to follow the match scores of their favorite teams, watch real-time scores of games in-progress, get notified when matches and sets begin and end, as well as share photos and comments with friends, family, and other parents.

## 4.3 Screens

### 4.3.1 Scoreboard

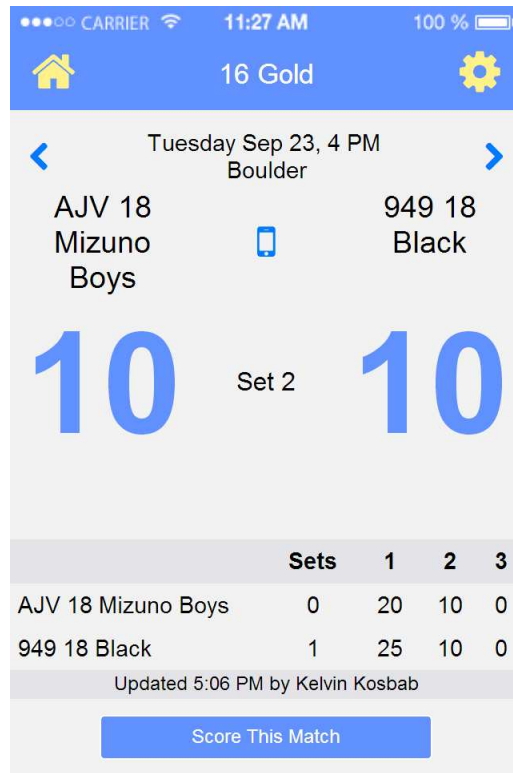
The scoreboard screen is responsible for displaying all the in-progress, completed, and upcoming matches for the user's favorite teams.



**Figure 1: Scoreboard Screen**

### 4.3.2 Match View

The match view screen is responsible for displaying the detailed information for a specific match.



**Figure 2: Match View Screen**



### 4.3.3 Scorekeeper

The scorekeeper screen is responsible for displaying the detailed information for a specific match as well as allowing the user the ability to score the match (i.e. modify the score of the match). TallyBok automatically will detect when a set is over. When a team scores the final point of the set and the scorer updates the score in TallyBok, a dialog is presented to the user asking them to confirm they wish to end the set. Confirming the dialog will either proceed to the next set or end the match if the winning team has won enough sets.

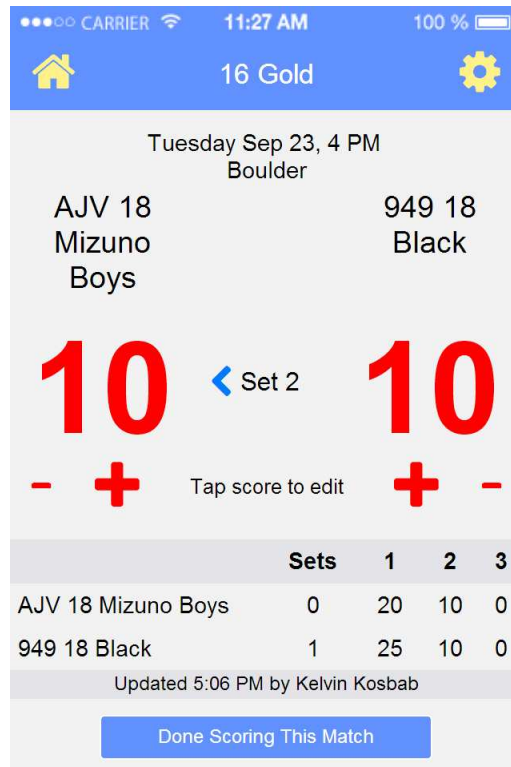
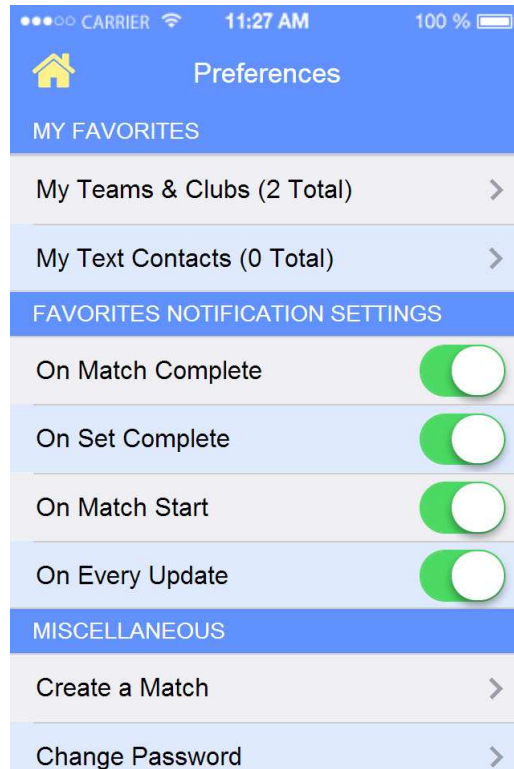


Figure 3: Scorekeeper Screen

### 4.3.4 Settings

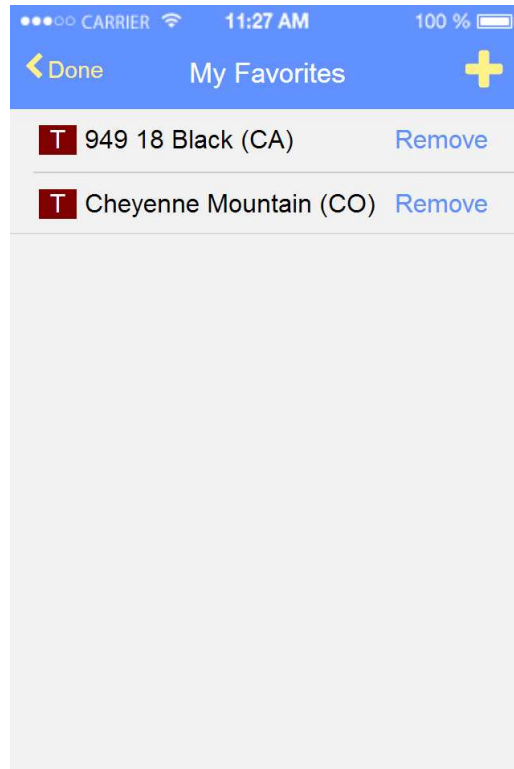
The settings screen is responsible for providing the user quick links to add favorites and create matches as well as the ability to modify their push notification settings for their favorite teams that they follow.



**Figure 4: Settings Screen**

### 4.3.5 Favorite Teams and Clubs

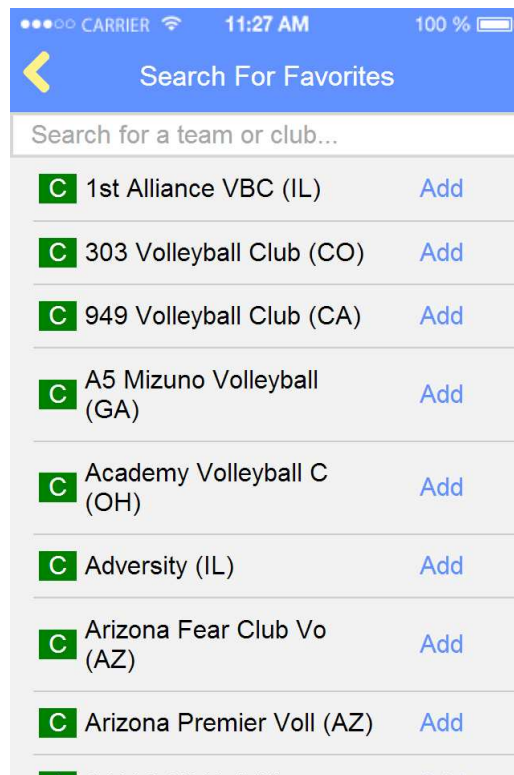
The favorite teams and clubs screen displays the list of teams and clubs that the user has specified as their favorites. This screen is also used to remove a club or team from the user's list of favorites.



**Figure 5: Favorite Teams and Clubs Screen**

### 4.3.6 Search for Favorites

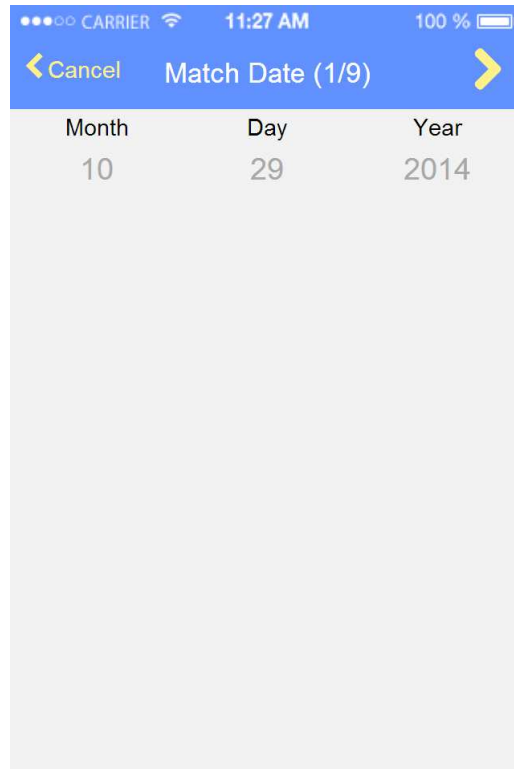
The search for favorites screen provides a way for the user to search for and add teams and clubs to their list of favorites.



**Figure 6: Search for Favorite Teams and Clubs Screen**

### 4.3.7 Create a Match

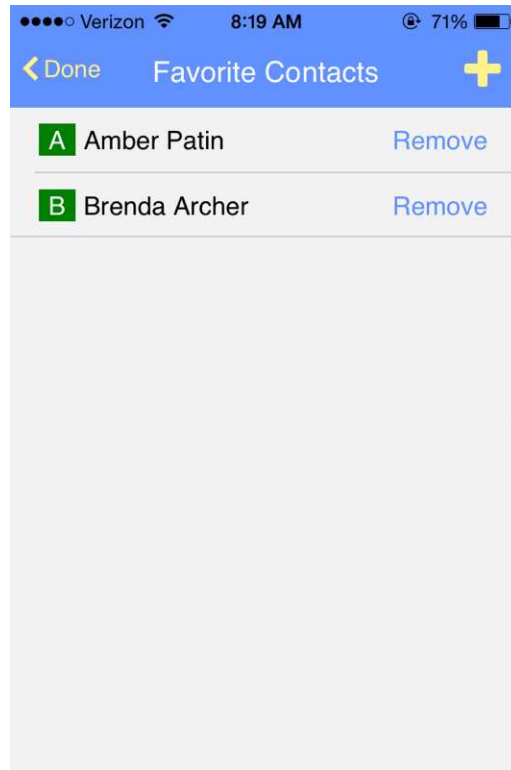
The create a match screen provides a way for the user to create a custom match. The user is limited to the teams that are already listed in the database; they do not have the ability to create new teams.



**Figure 7: Create a Match Screen**

### 4.3.8 Favorite Text Contacts

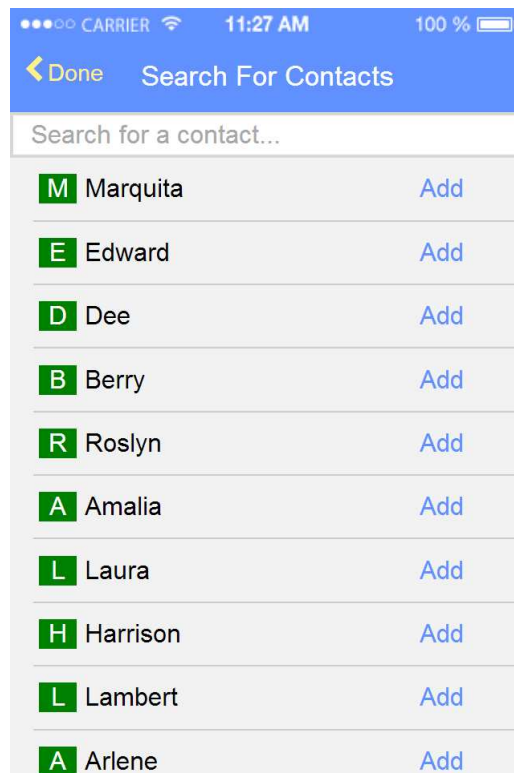
The favorite text contacts screen shows a list of contacts the user has specified as their favorites. From the match view screen, if the user taps the phone icon in the middle of the screen, this list of contacts will be pre-loaded as recipients of the text message. This screen is also used to remove a favorite contact from the list.



**Figure 8: Favorite Text Contacts Screen**

### 4.3.9 Search for Contacts

The search for contacts screen provides a way for the user to search for and add contacts to their favorite list of contacts.



**Figure 9: Search for Text Contacts Screen**

## 4.4 Features

The following features are currently available in TallyBok.

### 4.4.1 Track Favorite Teams and Clubs

TallyBok allows its users to search for and add the teams and clubs they care about the most. After adding a team to their list of favorites and returning to the home scoreboard screen, all the relevant matches to that team or club will be displayed to them. The user can get results of their favorite teams' in-progress, completed, and upcoming matches.

### 4.4.2 Track Live Match Scores

TallyBok allows parents, coaches, and club directors to track live match scores in real-time from their mobile phones. Scores are updated by others who are present at the match via the scorekeeper screen. Additionally, all users have the ability to score a match themselves.

#### 4.4.3 Push Notifications

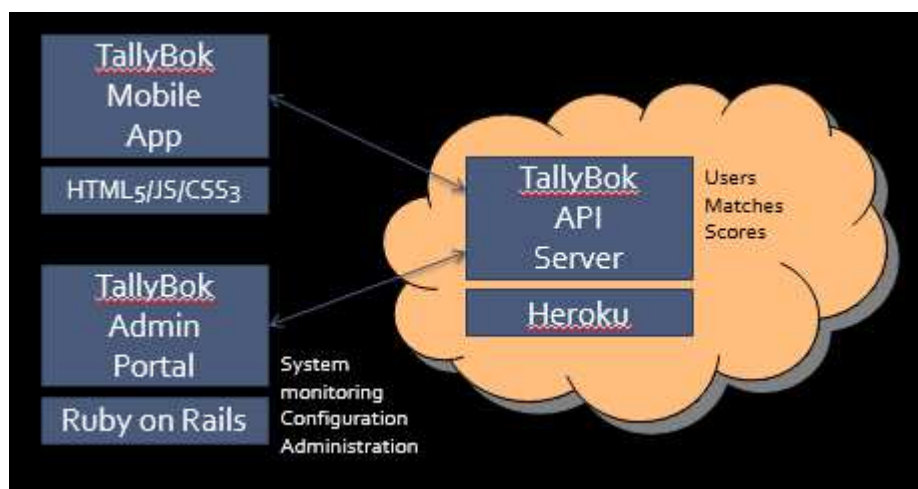
TallyBok users can receive match event notifications on their smart phones. The TallyBok app need not be open to receive these notifications. Notifications can be enabled, disabled, and customized via the settings screen.

#### 4.4.4 Text Messaging

TallyBok allows users to share results via text messaging with friends who do not have smart phones. Message content specific to the match is automatically filled in as well as any favorite contact recipients.

#### 4.5 TallyBok Architecture and Technology

TallyBok is available on both the Apple App Store and the Google Play Store. It was developed using HTML5/CSS3 with the jQuery and KendoUI JavaScript libraries. The user, volleyball match, and other data that TallyBok queries for displays is stored on a back end TallyBok API Server located as a Ruby on Rails application running on an Heroku instance in the cloud. The back end TallyBok server also can be accessed via the TallyBok Admin Portal, which provides system monitoring, configuration, and administration. See Figure 10 below for a graphical representation of TallyBok's architecture.



**Figure 10: TallyBok Architecture Diagram**

#### 4.6 The Future of TallyBok

There are several features that would help make TallyBok more user-friendly and more useful to volleyball parents, coaches, and club directors, including the ability to share photos, videos, and comments within the app, as well as automatic



match scheduling, thus eliminating the need for users to manually create a team's matches.

## **Chapter 5**

### **Evaluation**

#### **5.1 Overview**

This thesis will research the effectiveness of a crowdsourced application for athletic events as well as research the attitudes potential users have towards this use of crowdsourcing. This study will consist of two parts. The first is to get users to download the TallyBok app and have them follow and score an actual match. The second is to send out a survey to people who are or have been involved in volleyball events to determine if they are interested in an application like TallyBok and if they would trust the crowdsourced aspect of TallyBok.

For the first part of the study, a local high school, Cheyenne Mountain High School in Colorado Springs, was selected to help in the study. After connecting with some of the parents at Cheyenne Mountain, they agreed to use TallyBok in three of the matches they had scheduled over a two week period. Throughout the match, I observed the actual match, as well as the status displayed by TallyBok.

The second part of the study consisted of a survey and did not include the TallyBok application. Various players, parents, coaches, and officials were contacted to fill out a survey. The survey inquired about how each person feels and how much they would trust a crowdsourced-based scoring mobile application that would display real-time status of volleyball matches.

#### **5.2 Scope of Study**

This thesis is limited to the Fall of 2014. Only high school volleyball teams and matches were available for participation in this study due to the time of year. All of the voluntary participants surveyed for this thesis have had some experience or connection with organized volleyball in the past.

#### **5.3 Purpose of the Two Studies**

Early into the first study, I realized the results from only using the TallyBok application as a testing platform for this thesis may not provide comprehensive results. Although TallyBok would be able to provide a proof of concept there were

several factors that would limit its effectiveness in providing useful data as to whether people would use and trust the crowdsourced application.

First of all the sample size is small. There are only a few matches per week and organizing user test groups for matches proved to be difficult. Asking parents and observers to take time away from observing a match they were interested in to test a prototype application was unfair for the testers because they were forced to distract themselves from their loved ones to give updates to an application that not many users were following. If there were more people following that match, better results may have been collected. Also, some of the parents had other team responsibilities to manage, which made updating TallyBok a lower priority. Additionally, since most of the study participants were present at the match, it didn't make too much sense for them to follow along live on their phone while the match is going on in front of them.

TallyBok, second of all, is a prototype that has not been extensively tested even though it is a functional application. For the final match in the study, the user had a poor Internet connection, which in turn made TallyBok an ineffective tool. Further development needs to take place on TallyBok to resolve these issues.

Finally, comparing the final match score with the score reported by TallyBok may not give an accurate representation as to whether users would be open to scoring and following a crowdsourced app like TallyBok. Scoring a volleyball match does not answer the question as to whether users would be trustworthy when scoring a match and whether users would trust the match status from a crowdsourced application.

Adding the survey portion directly addressed the unanswered questions for the study. Also, it provided a much easier and more efficient means to query a larger crowd. Utilizing an online survey to get user feedback was less taxing on the subject, because instead of being responsible with constantly updating an application on their phone they could simply fill out a short survey. Less stress on the subject and a simpler study led to better results in the end.

## **5.4 Findings**

### **5.4.1 TallyBok Study**

The TallyBok portion of the study consisted of a total of three matches. One regular season match and two weekend tournament play matches. The first match involved Cheyenne Mountain High School versus Coronado High School on October 21, 2014. The match started at 7:00 PM local time in Cheyenne Mountain High School's primary gym. The second match featured Cheyenne Mountain High School against Lakewood High School on October 24, 2014. It started at 1:15 PM in Cheyenne Mountain High School's primary gym. The third match was between Cheyenne Mountain and Valor Christian High School in Cheyenne Mountain High School's secondary gym. That match started at...

In total there were nine users who took part in the study, all belonging to the same high school. Finding schools who agreed to participate in the study proved to be more difficult than initially planned, as a vast majority of the schools never replied back to the invitation. Participation in the study was completely voluntary. The head parent at Cheyenne Mountain was contacted and agreed to help out in the study. She then contacted other parents to download TallyBok and follow along at the match.

For all three matches the user of the TallyBok application was not instructed or influenced whatsoever. It was the user's responsibility to figure out how to add their favorite team, find the correct match, and then score the correct match. This simulated the actual process any user would have to follow when using TallyBok.

Match logs indicate that the first match between Cheyenne Mountain and Coronado was started 27 minutes early. The purpose of this may have been to give the user familiarity of the scorekeeping screen before the match. Then at 7:00 PM, when the actual match began, TallyBok match updates progressed as expected. Throughout the match, two different users updated the score on TallyBok. As the match progressed, the status given by TallyBok accurately represented the actual score of the match until the match completed. For complete logs of the first match see appendix A.

For the second match between Cheyenne Mountain and Lakewood, two users updated the match progress on TallyBok. Different from the first match, the logs indicate the match was started on TallyBok just as the actual match began. Just as with the first, the scores were accurately updated and reported by TallyBok as they happened in real-time. For complete logs of the second match see appendix B.

The third match between Cheyenne Mountain and Valor Christian was played in a different gymnasium that had Internet connectivity issues, thus rendering TallyBok effectively useless for the study.

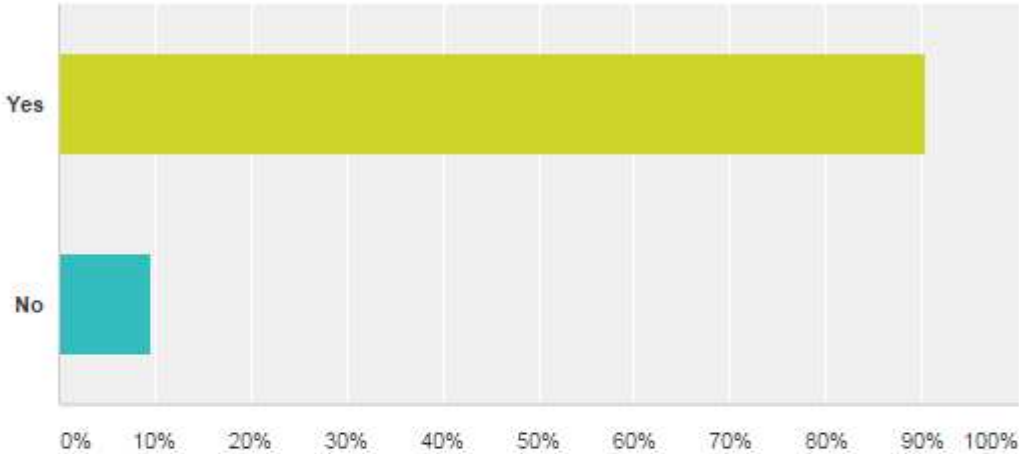
In general TallyBok performed well over the duration of the study. The users successfully created accounts, added their favorite teams, and accurately kept score for the matches in question. Additionally, the users reported they were satisfied with the application and were excited about future development especially in a club tournament setting, where it is considerably more chaotic and more difficult to follow matches.

#### **5.4.2 Survey Study**

The survey portion of the study consisted of a single survey with nine questions. Three of the nine questions were yes/no questions. Four of the questions were based on a ratings system. One of the questions was a multi-part ratings-based question. The final question was an open-ended free response question.

Each question in the survey, except the multi-part rating question, was asked to explore how the user felt about the crowd scoring a match as well as the level of interest each user would have to score a match. The purpose of the multi-part rating question was to determine what could make TallyBok a more usable and more enjoyable application for the user. See appendix C for all questions on the survey. In total, 62 subjects responded to the survey.

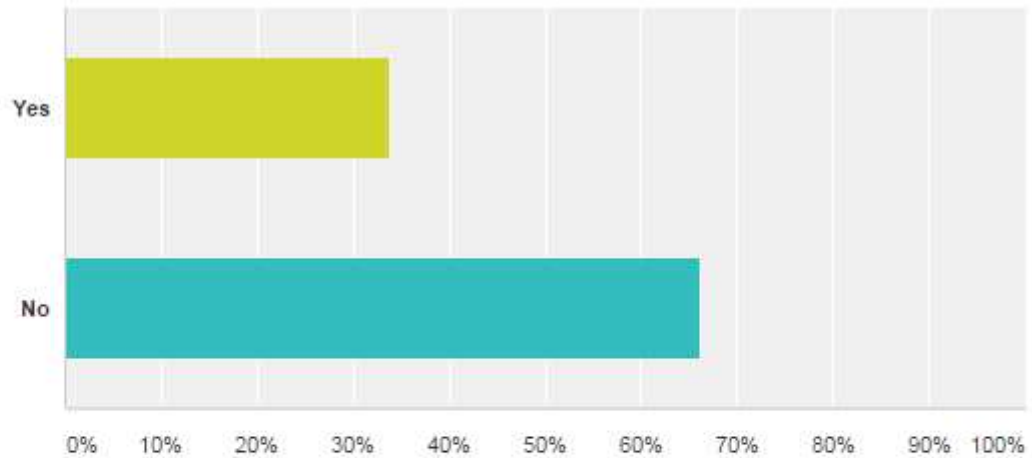
The first question of the survey was a yes/no question asking if the subject would be interested in an application that followed the real-time status of a volleyball match if they were not able to attend the match in person. An overwhelming majority, 90.32% of the subjects, answered that they would be interested in following match progress remotely from their phone.



Answer Choices	Responses	
Yes	90.32%	56
No	9.68%	6
Total		62

**Figure 11: Survey Question 1 Results**

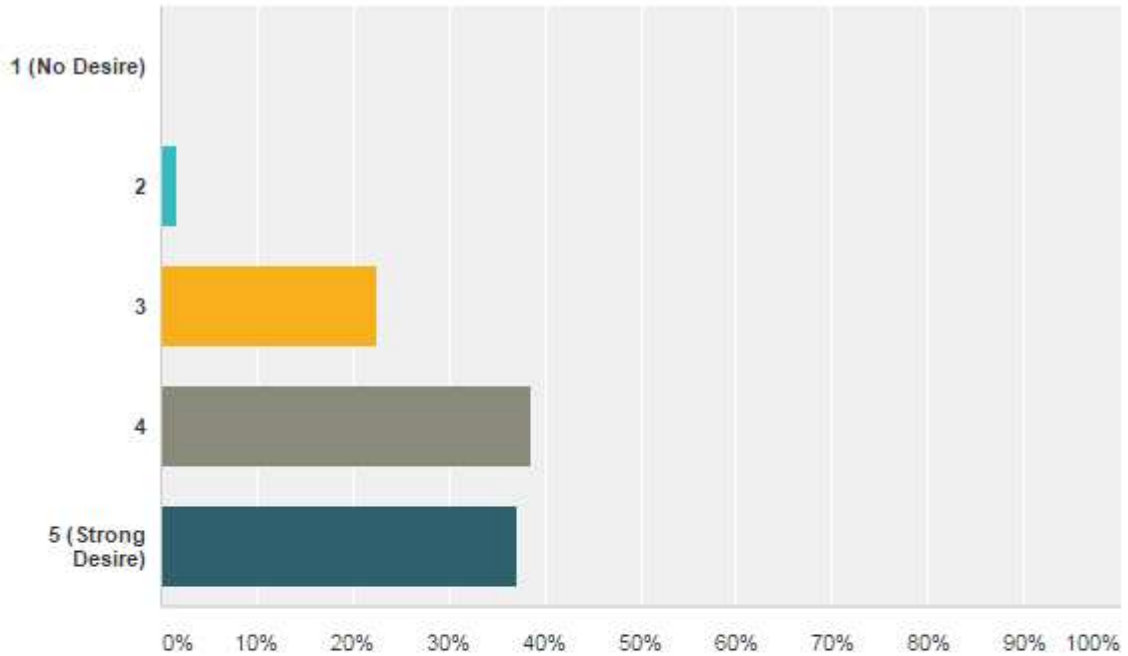
The second question was a yes/no question that asked the subject if they felt it was necessary on a mobile application to have a designated official or person whose job it was to score the match. The results to this question were more divided, with 66.13% of the subject believing that it was not necessary to have a designated official to score a match and 33.87% believing an official was necessary.



Answer Choices	Responses	
Yes	33.87%	21
No	66.13%	41
Total		62

**Figure 12: Survey Question 2 Results**

The third question asked the subject to rate their desire to follow a volleyball match they had some affiliation with (a connection with team members, coaches, fans, or friends) in some fashion but were unable to attend in person. Similar to the first question, 75.81% of the subjects reported at least some desire to follow their favorite team, with 37.10% of subjects having a strong desire to do so.

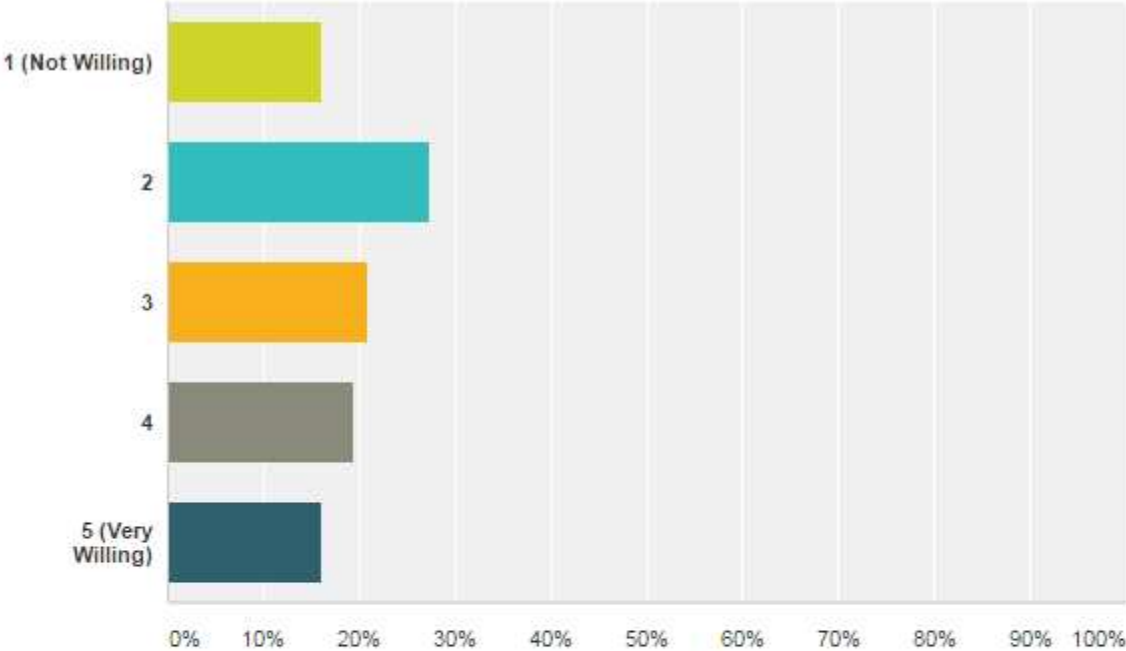


Answer Choices	Responses
1 (No Desire)	0.00% 0
2	1.61% 1
3	22.58% 14
4	38.71% 24
5 (Strong Desire)	37.10% 23
Total	62

**Figure 13: Survey Question 3 Results**



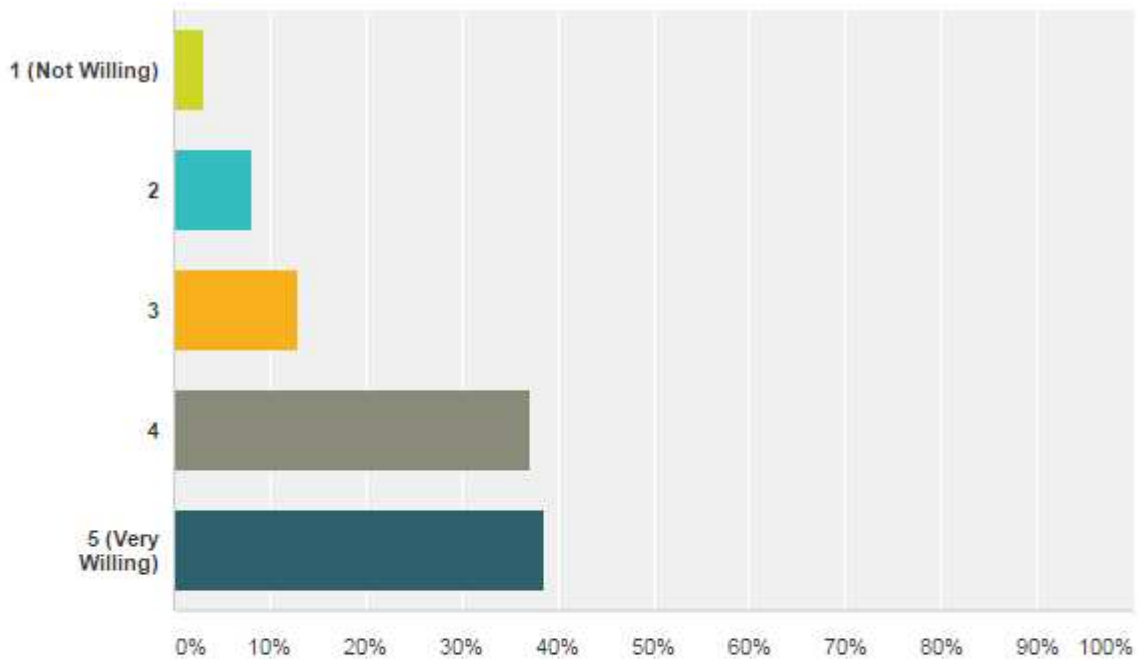
The fourth question asked the subject to rate their willingness to score a match using a mobile application that they were present at but had no affiliation with. The results to this question were very balanced, with 16.13% of respondents strongly willing to score the match, 19.35% somewhat willing to score the match, 20.97% neither willing or unwilling to score the match, 27.42% of respondents somewhat unwilling to score the match, and 16.13% of respondents strongly unwilling to score the match.



Answer Choices	Responses
1 (Not Willing)	16.13% 10
2	27.42% 17
3	20.97% 13
4	19.35% 12
5 (Very Willing)	16.13% 10
Total	62

**Figure 14: Survey Question 4 Results**

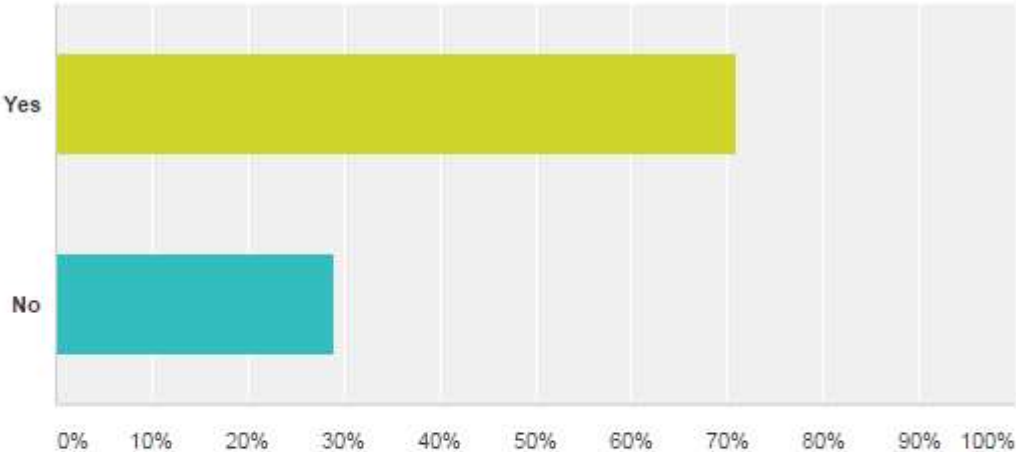
The fifth question asked the subject to rate their willingness to score a match using a mobile application that they were present at and had an affiliation with and friends who desired to follow the match live from home. If a user had friends or family following the match, a strong majority of respondents reported they would be willing to score the match with 38.71% strongly willing and 37.10% somewhat willing to score the match.



Answer Choices	Responses
1 (Not Willing)	3.23% 2
2	8.06% 5
3	12.90% 8
4	37.10% 23
5 (Very Willing)	38.71% 24
Total	62

**Figure 15: Survey Question 5 Results**

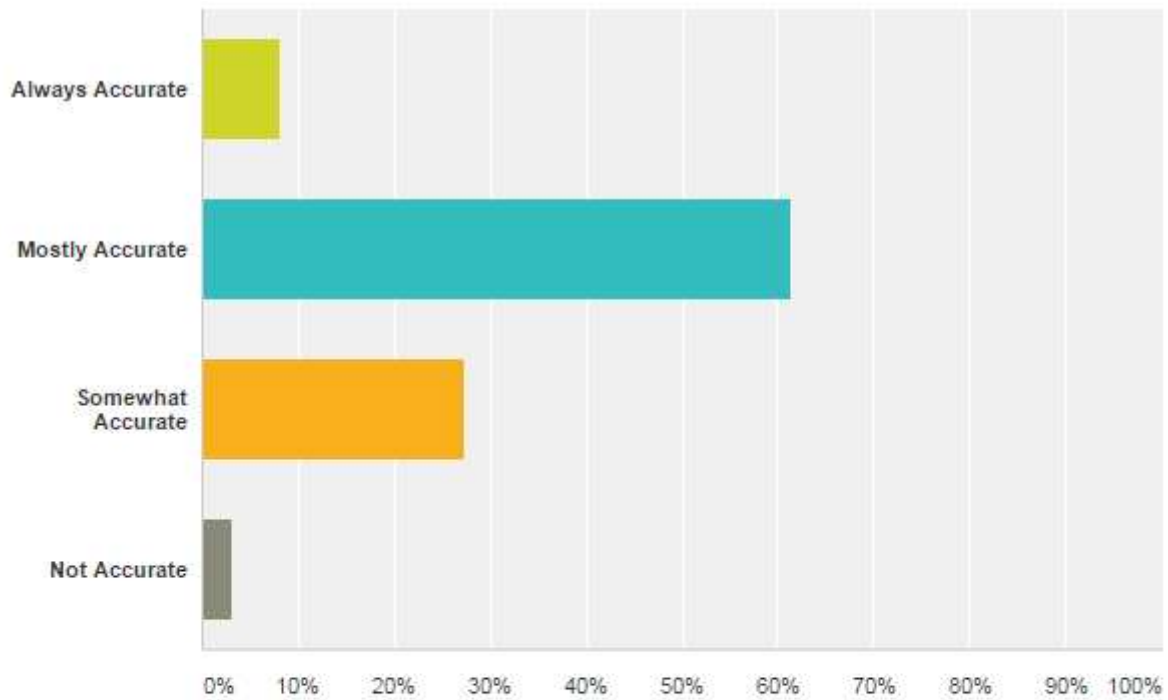
The sixth question was a yes/no question that asked the subject if they trusted the crowd’s input on a mobile application that followed the status of a volleyball match in real-time. The results to this question indicated respondents would for the most part trust the crowd to score a match correctly with 70.97% of respondents answering ‘yes’.



Answer Choices	Responses	
Yes	70.97%	44
No	29.03%	18
Total		62

**Figure 16: Survey Question 6 Results**

The seventh question asked the user to rate how accurate they believe the crowd would be when scoring a volleyball match. The results to this question were more random, but indicated that for the most part users would trust match progress scored by the crowd would be more trustworthy than not. 61.29% of respondents reported they believe the reported match progress would be mostly accurate and 27.42% of respondents believing the match progress would be somewhat accurate.



Answer Choices	Responses
Always Accurate	8.06% 5
Mostly Accurate	61.29% 38
Somewhat Accurate	27.42% 17
Not Accurate	3.23% 2
Total	62

**Figure 17: Survey Question 7 Results**

The eighth question asked the question to rate their desire to see certain features (match comments, photo sharing, Facebook connectivity, and so on) in a mobile application that allowed them to follow their favorite volleyball teams in real-time. Overall, the users responded that each feature listed probably needed to be included in the application. The features that had the strongest desire to be included in the application were the ability to follow matches from a desktop or laptop, the ability to follow matches from a tablet device, creating a custom match, creating a custom team, and the ability to share match photos and videos.

	Not Needed	Probably Not Needed	No Opinion	Probably Needed	Definitely Needed	Total
Automated Scheduling	0.00% 0	14.75% 9	29.51% 18	44.26% 27	11.48% 7	61
Create Custom Match	1.61% 1	17.74% 11	30.65% 19	33.87% 21	16.13% 10	62
Create Team/Club	3.28% 2	6.56% 4	19.67% 12	50.82% 31	19.67% 12	61
Share Comments About a Match	4.92% 3	19.67% 12	29.51% 18	44.26% 27	1.64% 1	61
Share Match Photos	4.84% 3	6.45% 4	19.35% 12	54.84% 34	14.52% 9	62
Share Match Videos	1.61% 1	4.84% 3	20.97% 13	53.23% 33	19.35% 12	62
Follow Match with a Tablet Device	0.00% 0	3.23% 2	9.68% 6	45.16% 28	41.94% 26	62
Follow Match Using a Desktop/Laptop	1.61% 1	11.29% 7	3.23% 2	46.77% 29	37.10% 23	62
Share Match Updates and Content on Facebook	4.92% 3	1.64% 1	19.67% 12	60.66% 37	13.11% 8	61
Share Match Updates and Content on Instagram	6.45% 4	12.90% 8	22.58% 14	48.39% 30	9.68% 6	62
Share Match Updates and Content on Twitter	6.45% 4	9.68% 6	24.19% 15	46.77% 29	12.90% 8	62

**Figure 18: Survey Question 8 Results**

The final question of the survey was an optional open ended comment question that asked the user to state any further concerns or comments about a crowdsourced application with the purpose of following volleyball matches in real-time. See appendix D for a complete listing of responses to this question. The

responses to this open ended question varied quite a bit. A couple respondents were concerned over the timeliness of the updates, bringing up experiences they have had following matches on other applications where the scorer simply forgot to update the match consistently. Others voiced their concerns about malicious users and suggested having a scorer rating system to evaluate how accurate each user is when scoring a match. One response stated there was an app that already performed this task called Game Tracker. Game Tracker is a website that displays match progress and detailed statistics for volleyball matches. However, it is not a mobile app, the web page is not supported by mobile devices, and it is not crowdsourced. Additionally, Game Tracker is utilized only for college-level volleyball matches and not for club or high school level volleyball, which means it does not cover all the features of a mobile crowdsourced score alert application for volleyball parents, club directors and fans.

#### **5.4.3 Overall Findings**

The results from the TallyBok test as well as the survey suggest that a crowdsourced scoring application for volleyball could be successful, which may also apply to other athletic events. From the survey, a majority of the respondents believed that the crowd would at least do an acceptable job scoring a match. Furthermore the respondents indicated that they would be willing to score the match using a mobile application if they had family or friends who wanted to follow the match but were unable to attend in person (question 5). If they were not present at the match, a majority of the respondents indicated they would strongly desire to follow the match in some fashion in real-time (question 3). The results from questions 3 and 5 indicate that if enough people would use the crowdsourced mobile application for following volleyball matches then there would always be people who wanted to follow the match and there would always be people willing to score the match for the users who were not present.

Even the concerns voiced by the respondents about the accuracy of the match may indicate that a crowdsourced volleyball application may be successful. A majority of the respondents would want to report an accurate score to their friends and family. Because of this, any malicious user would have a difficult time

sabotaging the match due to the majority of the users willing to correct the score for their friends and family away from the match.

The results from the TallyBok study further indicate that a crowdsourced scoring application in volleyball would be successful. In the two matches tested, the users correctly started and scored the matches as the match progressed. If there were users following along at home, they would have seen accurate match progress in real-time. In both matches, two users updated the match. If one user missed an update, the other user would in turn update the match correctly.

## Chapter 6

### Future Work

In order to obtain the best results and the best answer as to whether a crowdsourced application can succeed at athletic events, large scale testing using TallyBok over a large amount of matches would be the next step. Crowdsourced applications by definition require a crowd of users to use them effectively. If the crowd is small, the results obtained in turn will not reflect the bigger picture of whether crowdsourced applications can or cannot succeed in athletics.

In the study, more volleyball teams must be involved. It may also benefit the study if instead of covering high school teams, club volleyball teams were used. Compared to high school, club schedules are often more chaotic with more tournaments, more travelling, and days where each team plays more than a single match. All these factors make it more difficult for fans to follow the team in person, which is where mobile real-time match progress updates may be extremely useful.

Furthermore, bugs within TallyBok need to be sorted out. Some volleyball venues do not have a quality Internet connection. Thus it is important to have some kind of offline mode that allows users to cache match progress until their phone finds a good connection. Also, the app needs to be clearer to the user when there is a bad connection. Alerting the user may give the user the opportunity to find and connect to a WiFi network. If another connection cannot be established, the user can simply wait to input the match progress until after the match is completed. Although waiting eliminates real-time following of the match, it at least relieves some stress from those who are trying to score the match using TallyBok. Also, it would be helpful to have automatic scheduling built into the application. Creating each match by hand is tedious and not scalable. If the match schedules could be queried automatically, the application would have a much greater chance of success.

Another aspect that could be studied further is whether the specific sport has an impact on if crowdsourced applications can succeed. Maybe volleyball events are not very efficient and on the other hand lacrosse events turn out to perform better.



Different mobile apps could be written from the basic backbone of TallyBok to test the other sports.

Finally, once a crowdsourced app has a proven and a dependable crowd-base established, how would a payment model affect user's impressions of the application? Building and maintaining an application is not free and at some point there needs to be a return on investment for the developers. What kind of payment structure would be most effective? Would an annual subscription service be best or an advertisement-based model?

## Chapter 7

### Conclusion

The future is bright for crowdsourced applications. Thus far they have found their way into just about every industry and application around the world. Although some challenge the effectiveness and trust of utilizing such applications, countless individuals and organizations continue to utilize the crowd as a means to do work. Developing a successful crowdsourced application requires something that is attractive to new users, engaging, and has the ability to keep users interested for the duration of the project. If one of these conditions is broken, the application may fail to meet its desired or potential goal.

In athletics, crowdsourcing has only succeeded as a tool that involves only spectator aspects of an event, such as voting, reviews, or comments. There is no successful app available today that allows every one of its users to score an event. An app with this feature would allow users to follow the progress of an event in real-time regardless of the match being a college event or a recreational event.

One such sport that shows enormous potential for a mobile match progress application is volleyball. Volleyball has a large base of users that want to keep track of how their favorite teams are doing. The need is especially true in the lower levels of the sport, where institutions and organization do not have the technology in place to provide live match tracking.

TallyBok, developed by Kozinga, is an app that provides real-time volleyball match tracking for parents and friends. TallyBok allows users to follow their favorite teams, score their team's matches, and keep those who are not present at the match informed on the match progress.

A survey of people familiar with volleyball events indicated that users would be willing to use a mobile application that kept their friends and family informed on volleyball match progress. The survey indicated if somebody was unable to attend the match they would want to get some kind of real-time updates. The survey also indicated that if users knew friends and family members who could not attend the

match but wanted to follow the match progress, those present would be willing to update the match progress using a mobile application.

At volleyball matches, as well as any athletic event, people want to stay informed. People want to feel that they are connected with what is happening on the playing field. Crowdsourced applications may provide the opportunity people desire to stay connected at athletic events

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## Appendix A

### Match 1 Log: Cheyenne Mountain versus Coronado

**October 21, 2014**

Time	Active User	Log Description
6:33 PM	user1@domain.com	Start match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:54 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:55 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:57 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:57 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:57 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:57 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:57 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:58 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:58 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:58 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:58 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:58 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:59 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:59 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
6:59 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:00 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:00 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:00 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:01 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:01 PM	user1@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:01 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600











7:53 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600
7:54 PM	user2@domain.com	Update score of match highcoronado:highcheymtn:2014-10-21 18:30:00 -0600

## Appendix B

### Match 2 Log: Cheyenne Mountain versus Lakewood

October 24, 2014

Time	Active User	Log Description
1:15 PM	user1@domain.com	Start match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:16 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:17 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:17 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:17 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:18 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:18 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:18 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:19 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:19 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:20 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:21 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:21 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:21 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:22 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:22 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:23 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:23 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:23 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:24 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:25 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
1:25 PM	user1@domain.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600





10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600
10:28 PM	janice@kosbab.com	Update score of match highcheymtn:highlakewood:2014-10-25 13:30:00 -0600

## Appendix C

### Crowdsourced Application in Volleyball Survey

Consider a mobile application that allowed users to remotely follow the real-time score of a volleyball match. Updates would be sent to each user's phone thus allowing the user to follow the progress of the match. The only requirement is the match would have to be scored by a person at the match itself. For each of the questions below, consider your feelings as to who is scoring the match as well as how important it is for you to get updates out to others wishing to get scores from the match but are unable to attend in person.

- 1) If you knew somebody who played volleyball but were unable to be present at one of their matches would you be interested in being able to follow the match progress live as it happened from your phone?
  - Yes
  - No
- 2) For a volleyball match that is being scored using a mobile application, do you believe it is necessary to have a designated official whose only job is to score the match (as opposed to a parent, fan, team manager, etc...)?
  - Yes
  - No
- 3) If there was a match in which you had an affiliation (a connection with team members, coaches, fans, or friends) but you were unable to attend the match in person, please rate (1 to 5) your desire to follow the real-time match status of that in some fashion (whether via text message, streaming video, live scores, etc...).
  - 1 (No Desire)
  - 2
  - 3



- 4
  - 5 (Strong Desire)
- 4) If there was a match in which you had no affiliation (no connections with team members, coaches, fans, or friends and you do not have a responsibility at the match) but you were present at the match, please rate (1 to 5) your willingness to score the match using a mobile application.
- 1 (Not Willing)
  - 2
  - 3
  - 4
  - 5 (Very Willing)
- 5) If you had the ability to score a match using a mobile application and you had other friends and family members interested in following the match from home using the same mobile application, please rate (1 to 5) your willingness to score the match using a mobile app.
- 1 (Not Willing)
  - 2
  - 3
  - 4
  - 5 (Very Willing)
- 6) If anybody had the ability to score a match using a mobile application, would you trust the crowd to truthfully update the match score according to the actual match progress?
- Yes
  - No
- 7) How accurate do you think the crowd would be when scoring a volleyball match using a mobile application?
- Always Accurate
  - Mostly Accurate

- Somewhat Accurate
- Not Accurate

8) For a mobile app that allowed you to follow your favorite volleyball teams and clubs, please rate (1 to 5) the following features for how much you would like that feature included in the application. (Options available for each feature: Not Needed, Probably Not Needed, No Opinion, Probably Needed, Definitely Needed)

- Automated Scheduling
- Create Custom Match
- Create Team/Club
- Share Comments About a Match
- Share Match Photos
- Share Match Videos
- Follow Match with a Tablet Device
- Follow Match Using a Desktop/Laptop
- Share Match Updates and Content on Facebook
- Share Match Updates and Content on Instagram
- Share Match Updates and Content on Twitter

9) Do you have any specific concerns about an app that allows the spectators of a match to score the match or about the app in general (optional)?

## Appendix D

### Survey Question 9 Responses

**Response 1:** If the only thing being tracked by spectators was the actual score (vs stats), concern would be timeliness of scoring, especially if there are multiple people scoring the match with their mobile device. Second concern - if the app is not extremely easy to use/document scores, it will not be utilized, as it would detract too much from actually watching the match if you had to spend too much time trying to figure out how to use the app. Final concern - in order for this to work, you'd need to be able to not only search for a match that is being scored (if you cannot attend) OR send notices to those with the app that someone is interested in having the match scored.

**Response 2:** Credibility and accuracy would be my only concern. And if there were a section for "comments" for the simple fact that some people aren't very rational when it comes to extreme sporting situations.

**Response 3:** don't see a need for such an app

**Response 4:** Even when universities provide live stats they are notorious for not staying current or completely forgetting the updates by game 2 or 3. The only problem I see is spectators forgetting to keep the info updated.....results would be accurate because it would be pointless to be deceptive.

**Response 5:** I would think you would need a "username" if just someone in the crowd was scoring the match for you instead of an SID or scorekeeper. So that you could rate the reliability of a person doing it to help keep them honest.

**Response 6:** There would have to be some type a disclaimer so that people wouldn't think that it's the official score but it would have to be a disclaimer definitely added to it

**Response 7:** none

**Response 8:** I disagree with social media if it's individuals under the age of 18.

**Response 9:** I think this would be very interesting to see how it all comes together and works

**Response 10:** If the application could be utilized by a school and accessed by parties so non-local family to have access to scores. However, could athlete numbers be attached to scoring?

**Response 11:** There is a program called game tracker that already does this.

**Response 12:** I think it is a great idea. Many colleges have live streaming and some USAV events have been providing live streaming at their junior events, so have a mobile app that helps communicate is probably great for those interested!

**Response 13:** Will they be able to enjoy the match as much?