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USI Campus Trail Safety Upgrades

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MFET 491 – Senior Design
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Abstract

This project aims to increase safety on the USI biking and walking trails by evaluating potential safety hazards and implementing solutions that align with industry best practices to support the safe use of USI trails. The safety evaluation, conducted in conjunction with USI Trail Committee Members, revealed issues with ongoing trail maintenance (including trail bridges) as well as concerns for personal safety when on the trail system. The proposed solutions included the implementation of standardized signage and the integration of distance markers with scannable QR codes throughout the trail. These QR codes are linked to a Google Form where the individual can report any issues with the trail and where they are located on the trail. Once this form is submitted, members of the USI Trail Committee will be alerted. The Google Form also includes a link that will guide you to the proper emergency contact information in case of an emergency on the trail. These distance markers will be color coded on each side representing which direction on the trail you are going and how far away the entrance or exit is from that direction. This project also highlights ongoing maintenance needs for a bridge on the trail.

1.0 Introduction

The University of Southern Indian is home to many trails and nature preserves. Many members of the community here in Evansville use these trails quite often. The number one priority when creating these trails should be creating a safe environment for those who are utilizing the trail. The concern for safety on the trail that this project is covering has grown over time and needs to be addressed. Many of these trails have been exposed to harsh weather conditions and neglect in maintenance, creating an unsafe environment for those who use it. The goal for this project is to create a safe environment for the users of the various trails on campus. This will be achieved by implementing signage on both the walking and biking trails on campus. A new system will be created where the trail users will be able to report hazards on the trail as well as contact emergency services if needed by scanning QR codes that will be provided on distance markers throughout the trail.

2.0 Background

The University of Southern Indiana sits on over 1400 acres of land and is home to 11.25 miles of trails that are spread out across the entire campus. According to www.USI.edu/trails , these first trails were created by the Westwood Garden Club shortly after the University was first constructed. The Westwood Garden Club created what is known as the Bent Twig Trails which is a system of trails that is spread across 25 acres of land. The Bent Twig Trail system is located on the West side of campus and is located in proximity to Reflection Lake. Since the Bent Twig Trail system was created, there have been additional trail systems added on campus. There is now the USI-Burdette Trail, South Campus Trails, Disc Golf Trails, as well as the recent addition of the Mountain Biking Trails which can be seen in Figure 1: Disc Golf Trail Map, Figure 2: Mountain Bike Loop Trail Map, and Figure 3: Mountain Bike Flow Trail Map. These trails are part of the 1,400 acres of land at the University of Southern Indiana and lead towards the University of Southern Indiana's nature preserve. This project has been primarily focused on the Disc Golf Trails and the Mountain Biking Trails. However, the system created in this project will eventually be implemented campus wide.

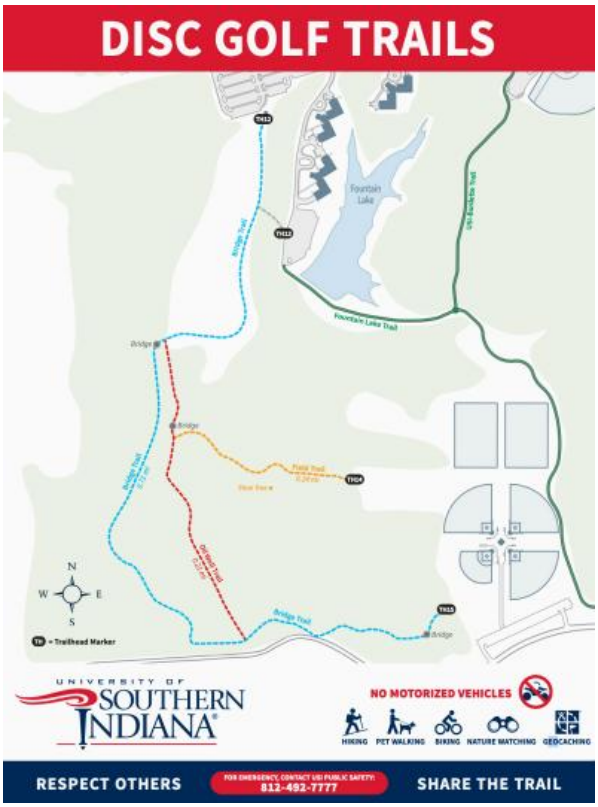

Figure 1: Disc Golf Trail Map

Figure 2: Mountain Bike Loop Trail Map

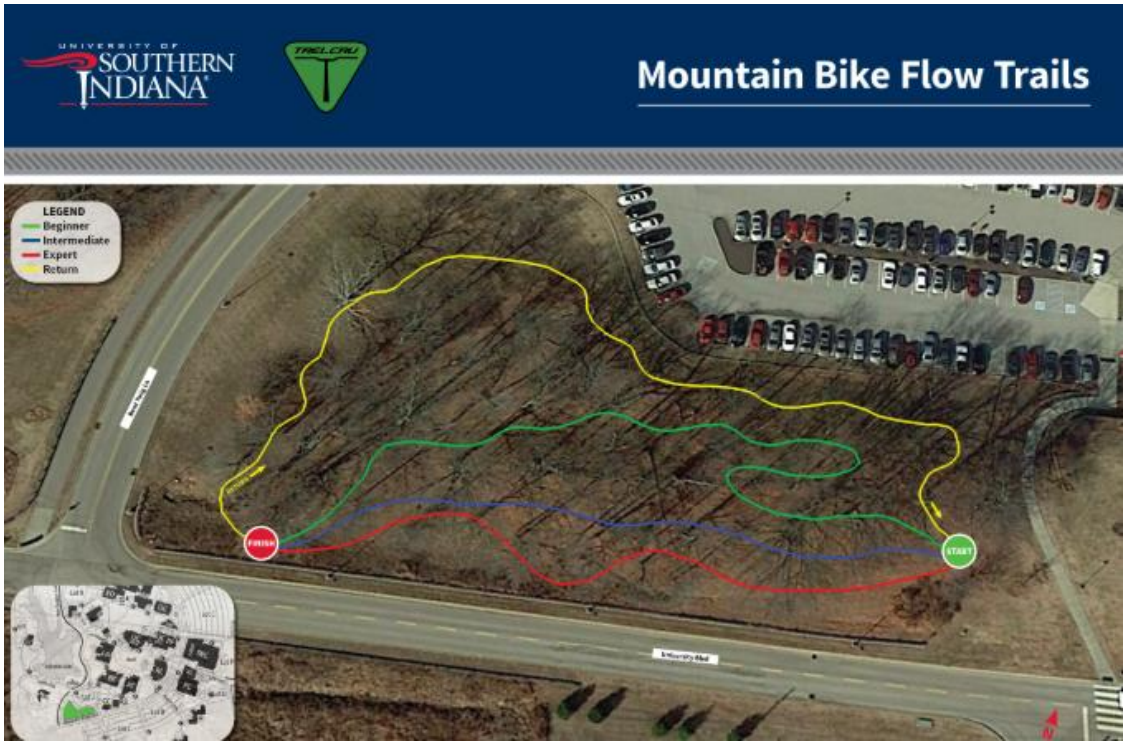

Figure 3: Mountain Bike Flow Trail Map

2.1 Ongoing Maintenance Concerns

There are a variety of ongoing maintenance concerns that need to be closely monitored on the trails. These maintenance concerns span from signage to bridges on the trail and are very important to monitor. The trails have several problems within them which include:

- Lack of signage in the trails
- No distance markers within the trails
- Lack of a system for checking and reporting trail hazards
- Lack of a system for getting help in the event of an emergency

Trail signs need to be implemented not only at the entrance of the trail but also within the trail. There are no signs within the trail that show navigation of the trail. This means that it is very easy to lose track of where you are on the trail and get lost. These signs need to be placed at various locations on the trail to prevent this from happening. The trail also lacks distance markers to show where you are on the trail. This means that it is very hard to locate where you are and it is very hard to find someone if they need help. Lastly, there is no system in place to quickly report any hazards on the trail or contact public safety in the event of an emergency. All of these problems lead to the problem of safety. All of the emergency poles that were once on campus have also been removed which further decreases the safety levels of the trails considering that they are in a remote area. There are also no current procedures in place that check the status of the trails. A system will be implemented where the users on the trail will be able to report hazards or contact public safety in the event of an emergency by scanning a QR code. These QR codes will be located on the distance markers that will be placed throughout the trail. By improving all of these aspects within the trail, the overall safety of the users of the trail will improve. Bridges on these trails also need to be closely monitored for any maintenance issues. An example of this is a bridge on the South Campus Trail that has been exposed to harsh weather conditions and neglect in maintenance, creating an unsafe

environment for those who use it. The problems with the bridge include:

- Boards on the surface of the bridge are rotting
- One support for the bridge is washing away
- One support for the bridge is missing

The boards on the bridge are not spaced out far enough to allow water and mud to wash through the boards. This results in water, mud, and other debris getting washed onto the bridge and having nowhere to go. The boards are covered with mud and debris which in turn is creating a rotting problem with several of the boards on the bridge. One of the supports for the bridge is also being washed away. This is due to the rushing water that comes through the stream that the bridge is over. When there is a significant amount of rainfall, the water rushes through the stream at a significant rate creating a harsh environment for the supports. This has also slowly eroded the bank of the stream and caused the original support to come out of the ground. This needs to be revisited and improved, as well as the other side of the bridge where a support is completely missing. There are numerous bridges on other trails around campus where these problems can also occur. This is another aspect of the trails that need to be closely monitored.

2.2 Existing Solutions

When looking at making signage for the trails on campus, there are a lot of criteria to consider. The following need to be considered when producing signage for the trails on campus:

- Material
- Durability
- Visibility
- Reflectiveness
- Simplicity

The first thing to consider when looking at existing solutions is the material that should be used for signage. This material must be able to withstand the elements of nature which include strong winds, rain, and exposure to sunlight. The best and most common materials to use for trail signage include plastic, wood, and aluminum. These materials withstand the elements of nature best and are very durable. The next aspect that needs to be considered is visibility and reflectiveness. This means that the material used needs to be reflective and easily seen. The most common material used is reflective vinyl which can easily be seen both at night and during the day. The signs must be readable from at least 5 feet both at night and during the day. This means that reflective vinyl would be the perfect material to use on the signage around campus. The signs also need to be 1.5 – 3 feet from the edge of the trail and the information on the signs need to be placed at a height of 4 – 6 feet. This makes sure that the information can easily be seen but it's also not in the way of the users when they are on the trail. The distance markers also need to be placed at least every 0.5 miles and need to be color coded for directional markings. This means that each side of the markers needs to be different colors so that the users know which direction they are walking on the trail. These standards can be found from www.osha.gov (OSHA) and www.americantrails.org (Trails). Lastly, the signage needs to be as simplistic as possible. Existing signage on trails around the nation include as many pictures as possible and the least amount of wording as possible. Individuals using the trail may not speak English or could also be

illiterate. This means that the signs need to be simple so that individuals of any background are able to comprehend what is on the sign. There are also ongoing maintenance issues that need to be addressed within these trails. One example of these issues is the bridges on the trails. These bridges are vulnerable to the elements of nature. This means it is common for the bridges to deuterate. In order to keep these bridges in top shape we need to look at existing solutions of these bridges. When looking at existing solutions, many examples of trail bridges from around the country and even the world can be looked at. There are six main types of designs for trail bridges which include:

- Deck girder and deck truss bridges
- Single-unit bridges
- Side girder and side truss (pony truss) bridges
- Arch bridges (deck or suspended)
- Cable bridges
- Covered bridges

According to fs.usda.gov , deck girder and deck truss bridges generally are made from timber and can span anywhere from 10 to 120 feet long. These bridges are designed to have two or more trusses which support the main deck where individuals will be walking on. Single unit bridges are generally made from laminated timber or concrete and can span anywhere from 10 to 120 feet long as well. These bridges are a single, self-supported unit with a very simple design. Side girder and side truss bridges are generally made from timber and can span anywhere from 40 to 240 feet long. These bridges use two girders or trusses with floor beams or ledger beams attached to them. The girders and trusses generally serve as the handrails in these bridges. The floor beams and ledger beams serve as the support for the deck planks. Arch bridges are generally made out of timber, concrete, or steal and can span anywhere from 20 to 200 feet. These bridges utilize two arches underneath the deck that serve as the supports for the bridge. These bridges can also be suspended which means the arches will be above the deck. There are two beams that span across the bridge with cables or steel

rods that support the deck. Cable bridges can span anywhere from 40 to 400 feet and are generally made using timber and steel cables. Two main steel cables serve as the supports for the bridge with a truss running underneath the deck. There are also steel cables that will run above the deck that serve as handrails for the bridge. The last type of trail bridge is the covered trail bridge. Covered trail bridges are side truss bridges and will also utilize side girders or deck girders. There is then a covering that is added over the top of them to protect the bridge from the harmful effects of nature. When looking at this project, it is important to know what different types of existing solutions there are for trail bridges around the world. The trails on the USI campus use a variety of bridges. The bridge that will be focused on within the trail for this project is a deck girder bridge. This bridge is made of lumber and is approximately 15 feet in length.

2.3 System Hierarchy

When looking at the system hierarchy of this project, it starts at the level of the USI property and can then be divided into the biking trails and the walking trails. There are four different walking trails located here on campus. These trails are the Bent Twig Trails, the Disc Golf Trails, the USI-Burdette Trail and the South Trails. There are also 3 different biking trails located here on campus. These trails are known as the Mountain Bike Loop Trail, the Mountain Bike Connector Trail, and the Mountain Bike Flow Trails. This system hierarchy can be found in Figure 4: System Hierarchy.

Figure 4: System Hierarchy

2.4 Subsystem Hierarchy

When looking at the subsystem hierarchy of this project, there will be two different subsystem hierarchies. There will be one subsystem hierarchy for the walking trails and one subsystem hierarchy for the biking trails.

2.4.1 Walking Trail Subsystem Hierarchy

The first subsystem hierarchy will be for the walking trails on the campus. The hierarchy will start with the walking trails and then break down into the four groups of walking trails on campus. These walking trails are the Disc Golf Trails, the Bent Twig Trails, the USI-Burdette Trail, and the South Trails. This subsystem hierarchy can be found in Figure 5: Walking Trails Subsystem Hierarchy.

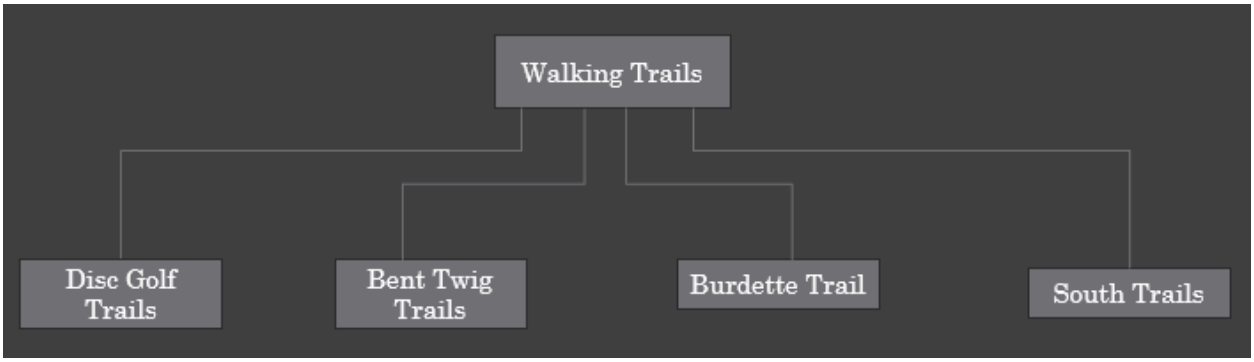

Figure 5: Walking Trails Subsystem Hierarchy

2.4.2 Biking Trail Subsystem Hierarchy

The biking trail subsystem hierarchy will start with the biking trails and then be broken down into the three biking trails on campus. These three trails are the Mountain Bike Loop Trail, the Mountain Bike Flow Trail, and the Broadway Connector Trail. This subsystem hierarchy can be found in Figure 6:Biking Trail Subsystem Hierarchy.

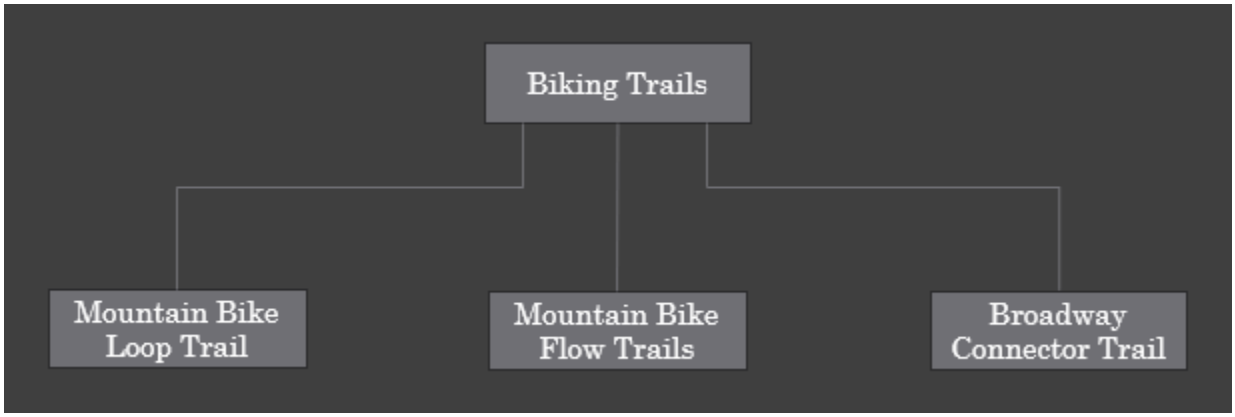

Figure 6:Biking Trail Subsystem Hierarchy

3.0 Conceptual Design

3.1 Requirement Specifications

When looking at the requirement specifications for this project, it is important to look at what the necessary specifications are for signage on the trail. There are many aspects that go into the trail signage in this project. Each of these aspects needs to meet specific requirement specifications in order for the project to be a success. The requirement specifications for this project consist of the following:

- Trail signs must be readable from at least 5 feet away both at night and during the day
- Trail signs must be comprehendible for individuals of any background
- Reflective material for high visibility in all conditions
- Weatherproof materials to prevent degradation due to the natural elements including UV radiation, wind damage and exposure
- Placement no less than every 0.5 miles
- Positioned so that information is at a height of 4 – 6 feet
- Positioned between 1.5 – 3 feet from the side of the trail
- Have directional markings on both sides of the sign

The trail signs being visible and easy to follow must comply with OSHA standards which means that they have to be readable from at least 5 feet away. The trail signs must also be as simplistic as possible, making sure that individuals with any background are able to comprehend what is on the sign. Next, the signs need to have high visibility in all conditions. This means that users need to clearly see the signs in any conditions including rain, fog, or darkness. The signage also needs to be weatherproof so that it can withstand all natural elements including UV radiation, wind damage, and exposure. Next, the signage needs to be placed no less than every 0.5 miles. In this project distance markers will be placed every 0.25 miles. The signage will also need to have the information listed at the top. This makes sure that the information is very easy to see

and the users will not miss it. Next, the signage will also need to be placed between 1.5 – 3 feet from the trail. This ensures that the signage is visible but also not in the way of the user. Lastly, the signage needs to have directional markings. The distance markers on the trails on campus will be blue on one side and red on the other side. This will indicate which direction you are traveling in the trail. These requirements can be found from www.osha.gov (OSHA) and www.americantrails.org (Trails). There will be several evaluation criteria in order to meet each of the requirement specifications listed. The criteria include the following:

- Trail signs must be readable from at least 5 feet both at night and during the day
- Trails signs must be comprehendible by individuals of any background
- Positioned so that information is at a height of 4 – 6 feet
- Positioned between 1.5 – 3 feet from the side of the trail
- Placement no less than every 0.5 miles

The first evaluation criterion is that the signage must be readable from at least 5 feet away both at night and during the day. This means that bright and reflective material must be used in order to meet this criterion. The next criterion is that signs must be comprehendible for individuals of any background. This means including the least amount of wordage possible in order to meet these needs. The next criterion is that the information needs to be placed at a height of 4-6 feet. This is approximately at head height, which makes it much harder to miss the information. The signage also must be placed between 1.5 – 3 feet away from the side of the trail. This is in order to make it visible but also not too far from the trail where the user may miss it. Lastly, the signage must be placed no less than every 0.5 miles. In this project the signage will be placed every 0.25 miles. These evaluation criteria were created based off of OSHA standards, www.osha.gov (OSHA) and www.americantrails.org (Trails).

3.3 Trail Concerns

In order to get to the root of these problems, discussions had to be made with various sources. The first source that I contacted was Bryan Morrison who is part of the USI Trail Committee and Public Safety. The first item that needed to be determined was the stakeholders for the trails here on campus. The stakeholders are:

- USI students
- USI employees
- Pet owners
- Athletes (USI and local high schools)
- Cyclists/Trail Riders
- Community members and family

These stakeholders would be using the trails for various reasons and these reasons needed to be considered as well. The stakeholders would be using the trails for many reasons including:

- Getting exercise
- Walking their dog
- Practicing for cross-country or track
- Riding their bikes

When working on this project the stakeholders above needed to be considered as well as the uses of the trail listed above. These stakeholders and uses for the trail were made in collaboration with Bryan Morrison and Bob Gober who are both very involved with the trails here at the USI campus. The only work that had already been done on the trails was implementing signs at the trailheads of each trail. The biggest concerns when going into this project were maintenance and safety. The key to this project was to make sure that all users were safe on the trail and could feel comfortable using it. Members of the community using these trails have not always felt safe before and the goal of this project is to change that.

3.4 Design Framework

When looking at the project, some of the designs that will need to be included in the project will be the following:

- The trail signage to provide navigation throughout the trail
- The distance markers that provide your exact location on the trail
- QR codes placed on each distance marker
- These QR codes will have the following:
    - GPS coordinates
    - Distance marker they scanned
    - A link to the USI Public Safety page
    - A link to the USI Public Safety emergency hotline
    - A map of where they are located on the trail

When looking at signage, the trail in its current state does not have any signage at all. An entirely new design will be created for the implementation of a system of signs throughout the trail. These signs will be strategically placed in order to properly navigate an individual through the trail. An entirely new system will be implemented for distance markers throughout the trail as well. The trail lacks any distance markers, which makes it very difficult to locate an individual on the trail if they need to be found or rescued. The designs of these signs and distance markers will also be looked at as well in order to make them as easy to comprehend as possible. Lastly, QR codes will be placed on each distance marker which when scanned will enable users to report trail hazards or contact USI Public Safety in the event of an emergency. There will be two QR codes will take the user to a google form when scanned. The first QR code will be for reporting hazards and their GPS coordinates will be given, the distance marker they are at, a map of where they are on the trail, a place to type what the hazard is, and a place to insert a photo or video of the hazard. The second QR code will have their GPS coordinates listed when scanned, the distance marker they are at, a map of where they are on the

trail, a link to the USI Public Safety page, and the USI Public Safety emergency number. This will be a brand-new system that will be implemented and will be much easier for users on the trails to report problems.

Various meetings were held with the USI trail committee to help with the design of these stakes and QR codes. Based off of these meetings a prototype for both the Google forms and the stakes were made. The first prototype for the Google forms was to only have one form, however, after a meeting with the USI Trail Committee it was determined that there needed to be two separate QR codes. One QR code would be for safety and the other would be for reporting hazards. These meetings were held at various times throughout the project schedule which can be seen in Figure 8: Project Schedule. The FMEA was also used to help determine what needed to be addressed in the project. The FMEA was used in this project to make sure that the design would not fail. After analyzing the FMEA it was determined that this project would be successful and meet all of the necessary requirements. This can be found in Figure 7: FMEA.

FAILURE MODE AND EFFECTS ANALYSIS

Item: Trail & Trail Bridge | Responsibility: | FMEA number:
Model: | Prepared by: Isaac Hoesli | Page : 1 of 1
Core Team: Isaac Hoesli | FMEA Date (Orig): | Rev: 1

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)	Responsibility and Target Completion Date	Action Results				
											Actions Taken	Sev	Occ	Det	RPN
Supports holding up bridge	Bridge supports giving out	Bridge collapsing	10	Base washing away	1	none	7	70	Implement periodic inspections of the bridge		design modified	10	1	2	20
			10	Wood rotting	1		7	70							0
Trail signage assisting in navigate the trail	Trail signs are damaged	Signage is no longer visible or eligible	5	Broken sign post	3	none	5	75	Implement periodic inspections of the trail		design modified	6	3	2	36
			5	Damage to sign	3		5	75							0
Water and mud drain in between boards on bridge surface	Mud and debris accumulation on bridge surface	Wood planks rotting	6	Damage to wood planks	6	none	3	108	Implement periodic inspections of the bridge		design modified	6	6	1	36

Figure 7: FMEA

Activity	Due
Project Selection	9/2/2024
Initial Design Specs	9/16/2024
Conceptual Design	9/23/2024
Draft 1	10/11/2024
Usability Assessment	10/21/2024
Draft 2	11/11/2024
Oral Presentation	12/2/2024
Pre-Senior Final Report	12/9/2024
Prepare items for proposal	1/29/2025
Waiting for approval	3/1/2025
Implement approved signage	4/1/2025
Final Presentation	4/25/2025
Final Report	5/2/2025

Figure 8: Project Schedule

4.0 System Design

4.1 Distance Marker Design

During the design process of these distance markers, many different materials were considered. The two biggest aspects of the design were the stakes and the vinyl for the stickers that were going onto the stakes. A decision matrix was used for both the stakes and the vinyl to help decide which options to choose. In the stake decision matrix cost, availability and durability were chosen as the criteria. A 6’ square signpost and a 66” marking post were both considered however, the 66” marking post came out with a higher score. As a result, the 66” marking post was picked as the material for the stake. In the vinyl decision matrix variety, cost, durability, and availability were chosen as the criteria. “Sticker App” weatherproof stickers and a 6-color pack of weatherproof vinyl were both considered for this project. The 6-color pack of weatherproof vinyl came out with a higher score and was chosen for this project. Both of these decision matrixes can be found below in Figure 9: Stake Decision Matrix and Figure 10: Vinyl Decision Matrix.

Weighting	0.4	0.3	0.3
Stake	Cost	Durability	Usability
6' Square Sign Post	2	3	1
66" Marking Post	3	3	3

Figure 9: Stake Decision Matrix

Weighting	0.25	0.15	0.3	0.3
Vinyl	Variety	Cost	Durability	Availability
Sticker App Weatherproof Stickers	1	2	3	2
6 color pack of weather proof vinyl	3	3	2	3

Figure 10: Vinyl Decision Matrix

4.1.1 Original Distance Marker Design

The original distance marker design included the QR code sticker at the top of the stake followed by the distance sticker below it. This distance marker also only had one QR code on it since it was designed before the idea of two separate QR codes was implemented. The old distance marker is pictured in the image below. This distance marker had the QR code at the top and the distance would go below it however it was not finished due to the design being changed while making it.

Figure 11: Old Distance Marker Design

4.1.2 New Distance Marker Design

The new distance marker design featured the distance at the top of the stake followed by the two QR codes beneath that. The stickers would be blue on one side and red on the other side indicating which direction the user is traveling in the trail. The emergency QR code will also always be printed in blue since that is the universal color for safety markings on campus. The new distance marker is pictured in the images below.

Figure 12: Red Side of New Distance Marker

Figure 13: Blue Side of New Distance Marker

4.2 Google Form Design

When the idea to first create a QR code system was introduced, a Qualtrics form was going to be where the QR codes took the user when scanned. However, when making the Qualtrics form, there were various obstacles that prevented Qualtrics form from being a possibility. The main problem was that users would have a tough time using the form if they were not a part of USI. It was determined that a Google Form would be much more appropriate for a project like this. The design also only included one QR code that led the user to one Google Form. However, after meeting with members from the USI Trail Committee it was decided that there needed to be two separate QR codes and Google forms. One QR code would be used for trail hazards and non-emergencies. The other code would be strictly for emergencies only so that the user could quickly contact USI Public Safety.

4.2.1 Original Google Form Design

The original idea for this system was to create a QR code that took you to a google form where the GPS coordinates will be given, the distance marker they are at, a link to the USI Public Safety page, the USI Public Safety Number, a map of where they are on the trail, a place to type what the hazard is, and a place to insert a photo or video of the hazard. It was later decided that there needed to be two separate forms created. One form for emergencies only and one form where the user could report trail hazards.

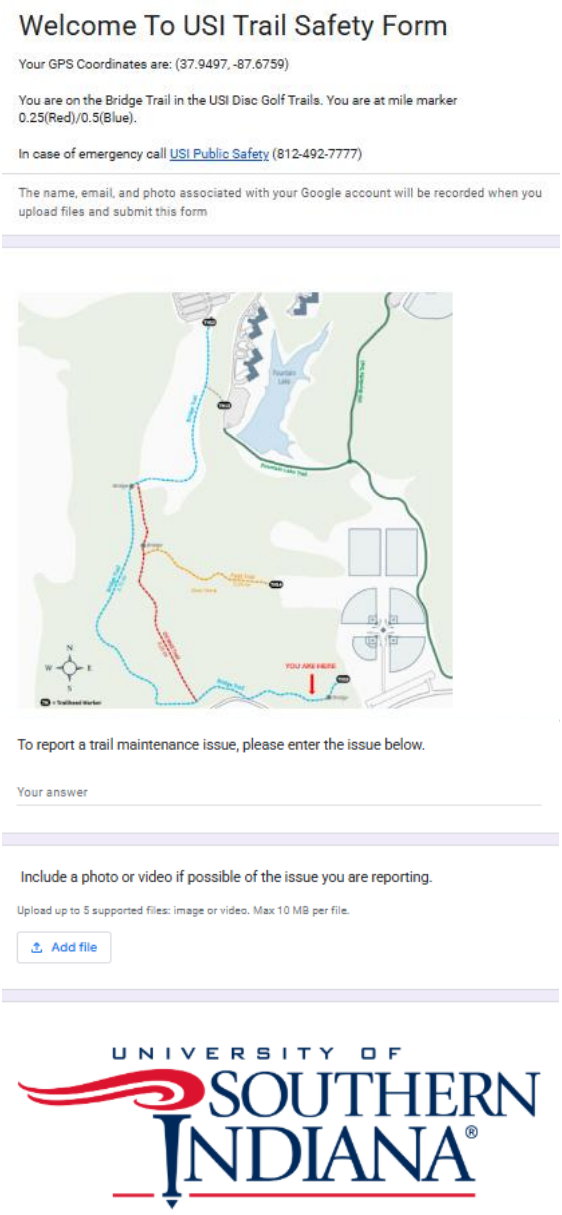

Figure 14: Original Google Form

4.2.2 Final Google Form Designs

The final version of the design for the QR codes consisted of two separate QR codes with two separate Google forms. The first QR code will be used for reporting hazards and the second QR code will be used for emergencies only so that USI Public Safety can be contacted. The first QR code will direct the user to a Google form with the GPS coordinates , the distance marker they are at, a map of where they are on the trail, a place to type what the hazard is, and a place to insert a photo or video of the hazard. The second QR code will direct the user to a Google form with the GPS coordinates, the distance marker they are at, a link to the USI Public Safety page, and a map of where they are on the trail. This change was recommended after meeting with a member of the USI Trail Committee.

Figure 15: Emergency Google Form

Welcome to USI Trail Safety Form

Your GPS Coordinates are: (37.9497, -87.6759)

You are on the Bridge Trail in the USI Disc Golf Trails. You are at mile marker 0.25(Red)/0.5(Blue).

The name, email, and photo associated with your Google account will be recorded when you upload files and submit this form

To report a trail maintenance issue, please enter the issue below.

Your answer

Include a photo or video if possible of the issue you are reporting.

Upload up to 5 supported files: image or video. Max 10 MB per file.

Add file

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Figure 16: Hazard Reporting Google Form

5.0 Next Steps

After meeting with a representative of the USI Trail Committee and USI Public Safety this project has been approved to be implemented campus wide. The USI Trail Committee is using this design, including the recommended locations for signage, the post design, the materials selected for the demonstration unit and the Google Forms. All materials developed for this project are being adopted by the USI trail committee for implementation campus wide. The USI Trail Committee will be adding USI branding to the design presented for consistency within the USI trail system. They will also be procuring the materials and coordinating the implementation campus-wide. The USI Trail committee will be creating a unique trail email address that reaches multiple members of the committee for trail maintenance and upkeep issues. All emergencies will be directed to USI Public Safety. The USI Trail Committee would like to continue working with USI Engineering to address current maintenance issues on the trails, such as dilapidated bridges and the need for switchbacks to improve drainage on parts of the walking trails.

The budgets for the project can be seen below in Table 1: Campus Wide Implementation Budget and Table 2: Single Distance Marker Budget. This design will be implemented across the entire USI campus. Calculations were made after closely looking at each trail on campus and it was determined that there needed to be 51 distance markers made. An example of how these distance markers were mapped out can be seen in Figure 17: Disc Golf Trail Distance Marker Locations Example. This came out to $2,242.47 for all of the distance markers needed for the campus trails.

Item	Cost	Quantity	Total
Distance Marker Posts	$37.99	51	$1937.49
QR Sticker	$0.66	204	$134.64
Trail Distance Label	$1.67	102	$170.34
Total			**$2242.47**

Table 1: Campus Wide Implementation Budget

Item	Cost	Quantity	Total
Distance Marker Posts	$37.99	1	$37.99
QR Sticker	$0.66	4	$2.64
Trail Distance Label	$1.67	2	$3.34
Total			**$43.97**

Table 2: Single Distance Marker Budget

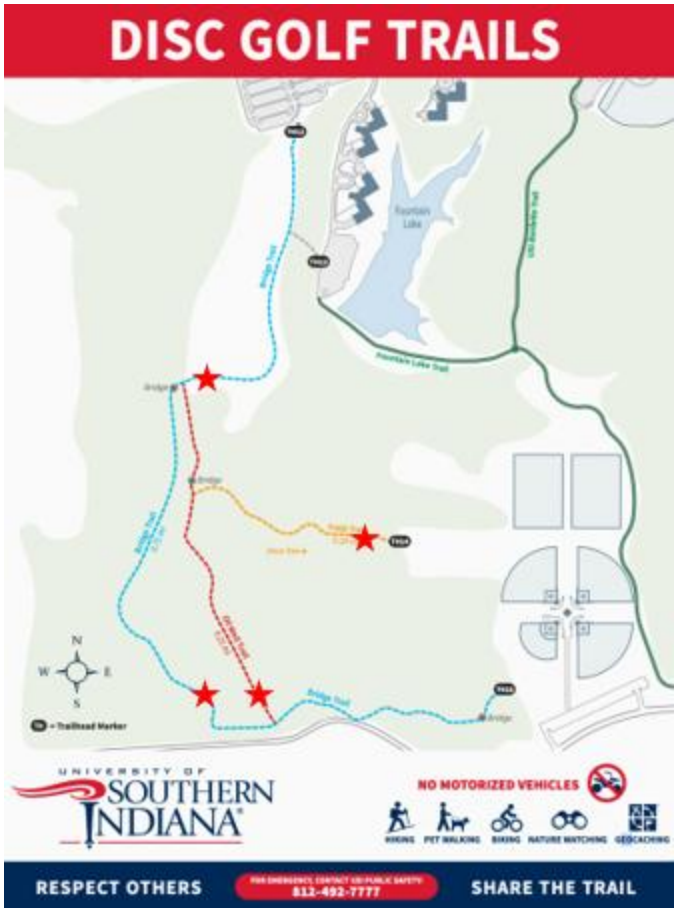

Figure 17: Disc Golf Trail Distance Marker Locations Example

6.0 Lessons Learned

In this project there were many lessons learned. The first lesson that I learned was how to take on adversity and sudden changes. The original scope of this project was to only work on the Bridge Trail on the Disc Golf Trail. There were changes to the bridge that needed to be made as well as the trail itself needing signage. However, when diving deeper into the project it was decided that the scope needed to be changed away from the bridge and just focus on signage. During winter break, signage was unexpectedly put up around the trails which led to the scope having to completely change. The idea to implement distance markers in all of the trails on campus with a system to report hazards and contact emergency services was then developed, which ultimately became the scope of this project. Another lesson that was learned was how to manage a project. This is a very important skill to learn for the future and this project helped in many ways with that. A timeline, budget, materials, and various other aspects all had to be managed. Overall, many lessons were learned in this project which will help better myself in the future.

7.0 Conclusion

In conclusion this project achieved many goals that it set out to achieve. This project evaluated the USI trails for potential safety hazards in collaboration with USI Public Safety and the USI Trail Committee. Next, this project identified appropriate locations for mile markers within all USI trails which included the mile markers being located 0.25 miles apart from each other. This project also created a QR code system that can be used within the trails to allow stakeholders to quickly reach help in case of emergency or orient themselves to the trail in case they are lost. Lastly, this project created a mechanism for providing trail maintenance needs to the USI Trail Committee to improve trail conditions. Overall, with all of these additions the trails here on USI's campus will be a much safer environment and the users on the trail should feel much more comfortable.

8.0 References

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9.0 Appendices

9.1 Project Schedule

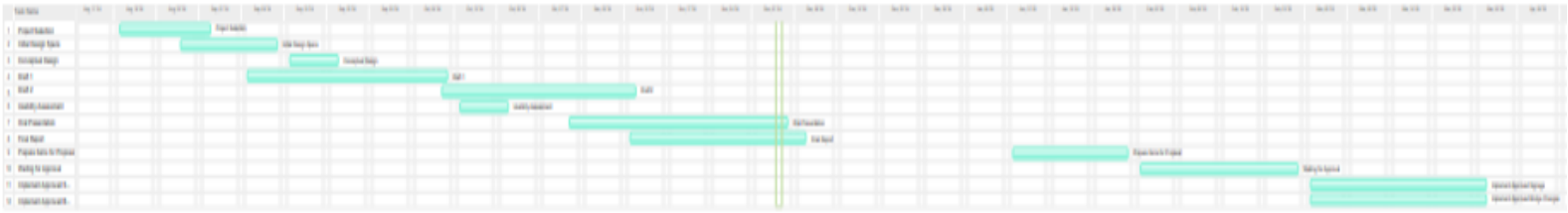

Figure 18: Project Schedule Gantt Chart

9.2 Appendix N: ABET Outcome 2, Design Factor Considerations

Design Factor	Page number, or reason not applicable
Public health safety, and welfare	11, 12, 17, 18, 25
Global	This design will only be implemented on the USI campus
Cultural	Cultural design factors were not necessary for the design in this project
Social	Signage in the trail does not require social design factors
Environmental	11, 12, 17, 18
Economic	Economic design factors do not play a role in the design for this project
Ethical & Professional	Ethical and professional design factors did not have to be considered
Reference for Standards	11, 12, 17, 18, 25

Table 3: Design Factor Considerations