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College recreation programs are an ideal way for students to participate in physical activity while on campus. These programs can offer a diverse range of opportunities for individuals to participate in various sport and fitness activities. By integrating virtual reality (VR) technology these programs expand their offerings and allow students to participate in sports that may not be otherwise available or accessible. One option for virtual sports participation is cycling Esports. Cycling Esports allow individuals to participate in recreational or competitive cycling using commercial VR technology. Research indicates that numerous factors can contribute to the willingness of individuals to adopt and use specific technologies such as VR. These factors can include various aspects such as ease of use, perceived usefulness, social influence, enjoyment, and cost. Frameworks such as the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) (Venkatesh et al., 2012) can provide a structured approach to investigating these factors. Using a web-based survey and individual interviews this study aimed at understanding which factors within the UTAUT2 framework influence students to use VR technology for endurance sports such as cycling. A total of thirty students completed a survey asking about factors that influence their use of VR technology for endurance sport. Five students took part in interviews to discuss how and why these factors influenced their decisions around using this technology. The results of this study found that some factors within the UTAUT2 may significantly affect the intention of college students to adopt and use VR technology for endurance sport. Gender and age did not seem to have a moderating effect on predicting use behavior. Recreational sports programs should consider these factors when creating interventions and programs to promote cycling Esports on campus.

THE ADOPTION AND USE OF VIRTUAL REALITY TECHNOLOGY FOR ENDURANCE

SPORT PARTICIAPTON BY COLLEGE STUDENTS

by

Devin Cashman

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Approved by

Dr. Louisa Raisbeck
Committee Chair

DEDICATION

To my wife Isabel, who supported me during this journey and who has been a constant source of love and encouragement. Your patience, understanding and sacrifice has made this possible.

To my children, Ryan, and Mia, thank you for your patience and understanding over the last four years. I hope that you have learned that learning requires both success and failure. Never be afraid to take on the hard things because you are afraid to fail, take them on because you are willing to learn and grow.

To my dad, thank you for providing me with the opportunities that you never had and the personal sacrifices you made to get me where I am. To my mom, I wish you were still here, but I know you have been continually at my side and pushing me forward during this journey.

APPROVAL PAGE

This dissertation written by Devin Cashman has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair ______________________ Dr. Louisa Raisbeck

Committee Members ______________________ Dr. Omari Dyson

______________________ Dr. Christopher Rhea

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CHAPTER I: PROJECT OVERVIEW

Regular physical activity decreases the risk of chronic disease and improves physical and psychological function (HHS, 2018). However, physical activity rates among college students tend to be suboptimal, and many do not meet recommended the *2018 Physical Activity Guidelines for Americans*. According to these guidelines, only 42.3% of college students meet the recommended amount of physical activity a week, and only 33% get enough aerobic exercise (American College Health Association, 2021). This decrease in physical activity corresponds to a reduction in endurance and team sport participation by students during the transition from high school to college (Thomas et al., 2019).

Recreational sports programs are an excellent way to increase physical activity among college students. These programs differ from competitive varsity sports, as they provide opportunities for students to play or experiment with new sports for fun (Thomas et al., 2019). Participating in sports offers students a range of physical, psychological, and social benefits beyond just exercise. Sport can improve social functioning, feelings of well-being, a sense of community, and reduce feelings of distress (Eime et al., 2013). College students tend to find recreational sports more accessible because they require less time commitment, skill, and experience compared to varsity sports (Thomas et al., 2019). Therefore, this may be an ideal way to introduce students to the sport of cycling. The USA Cycling Collegiate Program actively promotes collegiate cycling to encourage widespread participation in the sport. The purpose of the program is to introduce students to recreational riding and competitive racing. More than 160 schools, organized into 11 regional conferences participate in the collegiate cycling program (USA Cycling, n.d.). Colleges can offer programs across various cycling disciplines including track, mountain biking, cyclocross, BMX, road and more recently, Esports. Recreational sport programs might be able to capitalize on the enthusiasm for Esports on campus to promote this novel form of cycling to increase physical activity (Jenny et al., 2017). Studies have shown that motivations for engaging in Eports can encompass both health and performance factors (Westmattelmann et al., 2021). One challenge that exists for cycling Esports is that it requires virtual reality technology to participate. Even though college students are usually at the forefront of rapidly evolving trends and early adopters of new technology, widespread acceptance of this technology presents a challenge. The most recent example of this was the limited participation of collegiate riders in USA Cycling's Esports National Championship (*2024 USA Cycling Esports National Championships Results*, 2024). This project addresses this issue by evaluating the factors that influence the adoption and use of virtual reality technology by college students for cycling Esports.

Background Literature

Collegiate cycling in the United States primarily exists at the recreational club or varsity sport level under the auspices of the USA Cycling Collegiate Program. The stated mission of the USA Cycling Collegiate Program is to "provide opportunities for team-oriented bicycle racing for student cyclists of all genders and abilities." While more than 160 schools currently participate at the club level, less than 30 varsity programs exist. The main differences between collegiate club cycling programs and varsity cycling programs are in the level of institutional support, funding, athlete recruitment and competitive focus. Collegiate club programs have less resources, are usually student run, open to all enrolled students, and allow athletes of varying skill levels to join. Club sport athletes can choose to participate in a range of events and competitions at the local, regional, and national level. The level of competition at these events accommodates both recreational and competitive riders across a variety of cycling disciplines

(USA Cycling, n.d.). Data from the 2022 College Recreation Survey shows that cycling classes are the second most popular form of group fitness program, suggesting there may be an interest in cycling among students (Athletic Business, 2022). However, competitive cycling programs are not widespread and there are significant barriers to entry to the sport compared with other recreational sports. Students may be hesitant to participate in cycling due to perceptions that it is too demanding. Personal barriers such as a perceived lack of skill, inexperience, fear of injury, and motivation can limit participation. In addition, factors such as peer influence, time, equipment costs, and travel requirements can create barriers for students (Eime et al., 2013; Thomas et al., 2019). One way to reduce these barriers and increase interest in cycling is for colleges and universities to build virtual cycling programs. St. Augustine's University in North Carolina used virtual cycling to launch a cycling team in 2020, the first at a Historically Black College or University (HBCU). The University found that cycling Esports were more cost effective and reduced barriers for student participation compared to traditional cycling sports (Saint Augustine's, 2021). Embracing a virtual sports approach lies in the increasing popularity of Esports among college students and the opportunities it creates for recreational sports programming.

Electronic Sport (Esports)

Electronic sport (Esports) are competitive video gaming events where players compete against each other in virtual environments. These sports are mediated by a human-computer interface that allows participants to interact with the virtual environment through various input devices such as handheld game controllers (Delello et al., 2021; Jang & Byron, 2020). Esports participants compete against other players from across the globe on a shared server in massively multiplayer online video games (Larch, 2022). Esports first became popular in the 1990s with the rise of internet-connected video games, particularly among young people (Jang & Byron, 2020). With global expenditures expected to reach $1.79 billion dollars in 2022, Esports is currently one of the fastest growing sports industries (Delello et al., 2021). While Esports competition has traditionally been through sedentary video games, the popularity of cycling and running as physical Esports has increased due to recent innovations in VR technology and the COVID-19 pandemic (Jenny et al., 2017; Loudin, 2021). During the COVID-19 pandemic there was a surge in interest in cycling Esports as an alternative form of physical activity due to social distancing restrictions. Virtual cycling applications were a convenient way for people to participate in the sport and connect with other riders without leaving their home. The ability to participate in virtual group rides, races, and training sessions made these platforms accessible to cyclists with a range of abilities from beginners to professionals (Loudin, 2021). As a result, VR applications such as ZWIFT, Rouvy, MyWhoosh, and Indievelo are popular choices for cycling Esports.

Among these applications, ZWIFT is one of the more popular platforms with approximately one million users in over 190 countries (McIlroy et al., 2021; Stenovec, 2023). Zwift combines video game-like graphics, elements of gamification, and interactivity with indoor cycling or running. In an immersive virtual environment users compete, train, and ride with other athletes from around the world. Participants use equipment, such as smart trainers, smart bikes, or power meters to generate power and speed data, which translates to the virtual world. Esports on Zwift have gained popularity as they allow cyclists to compete from the comfort of their homes without the need for physical travel or expensive equipment when compared to traditional forms of the sport (Neumann et al., 2018). The nature of Esports, combined with the immersive and interactive virtual cycling experience offered by Zwift, has led to the emergence of an active and competitive Esports community within the platform.

Structured racing events on the platform often attract hundreds of users and occur multiple times per hour, each day. A popular way for people to compete on ZWIFT is by racing in leagues and accumulating points as part of a team (Stenovec, 2023). Esports events on Zwift typically involve riders competing in various categories based on their skill level, age, or experience, and can include features such as live broadcast race commentary, virtual race marshals, and real-time data broadcast. As virtual sport becomes mainstream athletes and their coaches are using VR platforms such as ZWIFT for training regimes and competition (Neumann et al., 2018).

Esports are an increasingly popular activity on college campuses. Over 160 colleges and universities currently belong to the National Association of Collegiate Esports which oversees varsity Esports programs in the United States (*NACE*, 2020). Additionally, around six hundred universities are reported to have Esports clubs on their campuses (Delello et al., 2021). The growth in Esports indicates a shift in student interest toward virtual gaming and provides an opportunity to incorporate this type of programming as an alternative form physical activity or entry point into the sport of cycling. The appeal of cycling Esports lies in the features of VR technology that make it different than simply playing a video game or riding a stationary bicycle as well as its ability to make the sport more accessible to a wide range of participants.

Virtual Reality Technology

Virtual reality (VR) technology creates a computer-generated environment that senses and responds to the user’s actions, making it feel real (Neumann et al., 2018; Sherman & Craig, 2019). Four key elements of virtual reality; virtual worlds, immersion, sensory feedback, and interactivity work together to create a sense of being mentally and physically present in a virtual sports environment (Sherman & Craig, 2019). Specialized displays and controllers create these elements for physical Esports such as cycling.

The most common type of commercial cycling Esports applications use semi-immersive VR systems. This type of system projects a virtual environment onto a large flat or curved screen while the user remains in their physical surroundings (Akbaş et al., 2019). Depending on the application the virtual world can be either imaginary or simulate real-world landscapes and have varying degrees of realism. The goal of the virtual world is to create a sense of immersion or to make the user feel that the virtual world is real. Both the type of display and nature of the virtual world contribute to the level of immersion. The interactivity of virtual reality and how users interact with the virtual environment is one of the most essential elements of sport VR systems (Sherman & Craig, 2019). Users interact with the virtual environment in cycling Esports using sensors or smart bikes/trainers that translate physical effort to speed and simultaneously respond to the virtual environment. For example, as a cyclist approaches a feature in the virtual world such as a hill, the physical effort required to pedal increases to simulate the virtual gradient. Advanced systems integrate newer technology that can create sensory feedback through vibrations that recreate uneven surfaces, incline systems that raise the bike up and down, and fans that respond to changes in the environment. Esports riders interact with the virtual world through avatars which are digital representations of themselves (Sherman & Craig, 2019). In cycling Esports, the speed and position of the avatar responds to the rider's real-time physical effort on the bike. Cyclists in the virtual world can see each other and communicate with other participants creating a shared virtual experience. This enables users to ride together as a group or compete against each other in real-time on various courses. Despite the benefits VR technology for cycling Esports, it also presents challenges for potential users.

One issue with VR systems and the equipment needed to use it is the high upfront cost which can prevent people from adopting the technology. Users must also integrate various hardware, software and peripherals which presents a challenge for people who are not technologically savvy. Lack of space, lack of internet connectivity, or poor instructional guides can create additional infrastructure barriers that limit VR use. Individuals may ultimately perceive this technology as useful, not useful, uninteresting, or too difficult to use for cycling Esports (Mahalil et al., 2020). Understanding the reasons behind decisions to use or not use VR technology is important for developing successful cycling Esports programs.

Technology Adoption and Use

Different frameworks for technology adoption can play a role in understanding the factors that influence consumers to use VR for cycling Esports. Models such as the Technology Assistance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) and Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) offer approaches to evaluating consumer desire to use of VR technology in the sports sector (Angosto et al., 2023). These frameworks are valuable because they examine broad factors that could be relevant and predictive of the behavioral intention to adopt and use VR technology for cycling Esports.

The TAM uses six factors to assess an individuals' attitude toward end use of technology and builds on psychological theories of planned behavior and reasoned action. Among the six factors considered are perceived usefulness (PU), perceived ease of use (PEOU), attitude toward using, behavioral intention to use, external factors and actual use of the technology (Mahalil et al., 2020). Previous studies using the TAM have identified PU and PEOU as important factors in individual decision to use sports technology (Angosto et al., 2023; Kim et al., 2017). Models incorporating these two factors and other factors such as peer influence and structural resources that influence college student recreational sport participation may offer greater utility in evaluating cycling Esports technology. One such model which has an expanded set of factors making it more suitable for cycling Esports is the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) (Angosto et al., 2023).

The UTAUT2 (Venkatesh et al., 2012) identifies seven main factors that influence individuals' acceptance and use of technology: performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price/value, and habit. In this model performance expectancy and effort expectancy are like PU and PEOU that are part of the TAM.

Performance expectancy refers to the extent to which individuals believe that using a particular technology will improve their performance or effectiveness in a specific task or activity. Effort expectancy reflects how simple a technology is to use and the amount of effort needed to use it. Social influence encompasses opinions, recommendations, and social pressure from peers, teammates, or communities on an individual's decision to adopt and use specific technologies. Facilitating conditions reflect the perception that the necessary resources and support are available to help them use a particular technology. Hedonic motivation suggests that individuals will adopt and use technology that offers enjoyable and satisfying VR sport experiences. Price/Value is the perceived cost of adopting and using a technology compared to the potential benefits. Habit creates a sense of familiarity and comfort with using technology. For example, if an individual becomes accustomed to using a particular technology to perform a task, they may be more likely to keep using it (Jang & Byron, 2020; Venkatesh et al., 2012). The UTAT2 also integrates moderators such as sex, age, gender and experience with technology that have been shown to influence technology use and adoption (Venkatesh et al., 2012). Physical activity professionals and organizations can use the UTAUT2 in practical ways to guide the design, implementation, and evaluation of technology adoption initiatives for cycling Esports programs.

Identifying which factors will encourage students to use VR technology for cycling Esports can help promote it as a form of physical activity (Tamilmani et al., 2021). For example, creating enjoyable Esports experiences that foster social connections and allow students to ride together in virtual worlds with different challenges can enhance adoption. Additionally, if social influence plays a significant role, targeted media campaigns and events can promote recreational sport, club cycling, or group activities using VR technology for endurance sports.

The purpose of this study is to investigate the adoption and use of VR technology for participation in endurance Esports by college students. The specific aims of this research include:

Specific Aim #1: Determine which factors within the UTAUT2 framework explain behavioral intention to adopt and use VR technology for endurance sport by college students.

Specific Aim #2: To understand individual motivations that explain the influence of factors within the UTAUT2 framework on their adoption and use of VR for endurance sport participation.

Specific Aim #3: Develop effective strategies to create a recreational cycling Esports program at Regis College and increase physical activity among the student population.

Participants

College students (undergraduate and graduate) who identified as cyclists were recruited for this study. A total of sixty-three participants completed a survey distributed via email, including 23 female (av age 22.09 SD 2.09) and 40 male (av age 23.30 SD 4.36).

The Institutional Review Board at the University of North Carolina Greensboro approved this research project.

Methods

Emails were sent to 160 collegiate cycling clubs listed as active in the USA Cycling Collegiate Program database as of 2021, inviting members to participate in the survey. The email included a brief overview of the research project, a link to a Qualtrics based survey, and the IRB information. Recreational sport program directors of schools in New England that had active cycling clubs were sent emails asking them to forward the recruitment materials to their club cycling team. Recruitment information was posted via social media (Facebook and Instagram) to target active cycling and cycling Esports groups. Due to an initial low response rate, new recruitment materials were created and posted through Instagram with a direct link to the survey. Paid advertisements on Instagram targeted collegiate cycling clubs, triathlon clubs, and cycling Esports participants asking them to participate in the study. To recruit more participants a blog post with the survey link was posted on an online news site that is popular within the cycling Esports community.

The survey received 125 total responses. Out of those that responded to the survey, sixty-two opened it but completed no information. Of the sixty-three remaining surveys, the response rate to each question varied among participants. Thirty-four of the respondents reported that they had used VR technology to participate in cycling and 28 did not. Thirty participants answered all questions, while others responded to only a limited number of questions.

Thirteen participants provided their contact information and expressed a willingness to participate in an individual interview. To reduce selection bias and ensure confidentiality contact information was removed from the surveys. Ten participants, with an equal number of men and women, were invited to participate in an interview with the researcher. Five respondents, three women and two men responded to the invitation to participate in individual interviews. At the time of the interview all the students were enrolled at colleges in the United States. Each student interviewed had experience using VR technology for cycling, with all but one continuing to use it at the time of the interview. The students had a range of cycling backgrounds. Three of the students currently competed for either a club cycling or triathlon program at their school. The remaining two participants described their interest in cycling as primarily focused on fitness and recreation. Participants predominantly described using the ZWIFT VR system for cycling sports.

Surveys

A survey tool was developed and administered through Qualtrics. Previous studies assessing the adoption and use of technology for Esports served as a guide in developing survey questions (Angosto et al., 2023; Jang & Byron, 2020; Westmattelmann et al., 2021). The survey began with the IRB information sheet and a question seeking consent to participate. Pre-screening questions asked if the participant was a student at college or university in the United States, if they participate in the sport of cycling and receive monetary support, and if they have used VR to participate in cycling. Additional questions asked about age, gender, and frequency of VR use to participate in endurance sports since these serve as moderators of technology use (Venkatesh et al., 2012). The remainder of the survey questions asked about the seven factors related to VR technology adoption and use identified by the UTAUT2 framework (performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price/value, habit) and behavioral intention to adopt and use VR technology for endurance sport (Venkatesh et al., 2012). The wording of the questions was adapted from the UTAU2 framework applied to Esports and extended to VR endurance sport technology (Jang & Byron, 2020). For example, social influence ("people who are important to me think that I should play the esport game") was adapted to "people who are important to me think that I should use VR endurance sport technology." Questions used a ten-point Likert-type scale ranging from 0 = "strongly disagree" to 10 = "strongly agree" to assess the strength of participants' feelings or attitudes toward the statements presented (Appendix A).

Interviews

The primary researcher conducted individual interviews with participants and transcribed using Microsoft Teams and Zoom. A semi-structured interview centered around the UTAUT2 framework. The researcher asked each participant about their sport experience, if they had used VR technology and the following questions:

Table 1: Interview Questions

Questions
• Can you describe an experience where VR technology enhanced your sport experience?
• Could you share and example of how the opinions or recommendations of family, friends, peers, or others influenced your decision you use VR sport technology?
• Can you describe how using VR technology contributes to your enjoyment of your sport or physical activity experience?
• How do you perceive the cost relationship to the benefit of using this technology? Can you give an example? *Follow-up: What resources or support might make it easier to integrate VR technology into your sport experience?*
• How has using this technology influenced your motivation to participate in sport activities? *Follow-up: Can you describe situations where you see yourself regularly using this technology for sport?*

Each interview transcription was reviewed by the researcher for errors in the transcription and sent to the participant for member checking before coding.

Analysis

A mixed methods research design was employed. A cross sectional, explanatory sequential approach examines factors that contribute to college students adopting VR technology platforms for cycling Esports. This design approach addresses both the first and second aims of this study. To achieve the first aim, a survey instrument captures objective data related to adoption and use of VR for endurance sports. To fulfill the second aim, individual semi-structured interviews with participants explain or elaborate on the survey findings.

This study took a deductive, qualitative research approach. This design establishes a structured approach to examine how individuals describe the factors of the UTAUT2 framework that influence their decision to use VR technology. Deductive methods enable the researcher to start with a theory, such as the UTAUT2 and design questions to test this theory (Creswell, 2013). Each interview uses constructs within the UTAUT2 framework, while subcodes help identify patterns and themes that would provide insight into how each construct contributes to participants' adoption and use of VR technology for endurance sport. These subcodes referred to events, attitudes, or topics that were relevant to the main constructs of the UTAUT2 framework. During the coding process, understanding the "how" or "why" around the code helped identify constructs that the sub-codes were indicating (Corbin & Strauss, 2014). Patterns and themes within the codes provide insight into the ways each construct influences decisions to adopt and use VR technology for endurance sport.

The quantitative survey data was analyzed using Statistical Package for Social Sciences (SPSS) (IBM Corp, 2021). Responses from multiple Likert-scale questions in the survey were combined to form a single variable defined by the UTAU2. The single variable was calculated from the mean score across all the selected Likert-scale questions that related to the variable for each participant. Descriptive statistics including mean, standard deviation, mode, and range were computed for all composite measures. Data was assessed for normality through graphical assessment and statistical testing (Ghasemi & Zahediasl, 2012). Non-parametric correlation analysis examined relationships between each of variables in the UTAUT2. Non-parametric General linear regression models helped determine how each of the seven UTAUT2 factors predicted the adoption and use of VR technology for endurance sport including age and gender moderators.

Results

Cronbach's Alpha analysis was employed to assess the reliability of the survey tool. Reliability measures the internal consistency of the constructs within a survey. A construct is generally reliable in research if the Alpha (α) value is greater than 0.65 with values between 0.80 and 0.90 considered very good (DeVellis, 2016). The results show that for the Perceived Use scale with three items (α = 0.91), the Perceived Effort scale with four items (α = 0.81), the Social Influence scale with four items (α = .95), the Facilitating Conditions Scale with four items (α = 0.71), the Hedonic Motivation scale with three items (α = 0.88), the Price/Value scale with three items (α = 0.85), the Habit scale with two items (α = 0.65), and the Adoption/Use scale with three items (α = 0.91). The reliability results are summarized in (Table 1).

Table 2. Survey Factor Reliability

Subscale	N	Items	Cronbach's α
Performance Expectancy	54	3	.91
Effort Expectancy	53	4	.81
Social Influence	54	4	.95
Facilitating Conditions	52	4	.71
Hedonic Motivation	48	3	.88
Price / Value	47	3	.85
Habit	38	2	.65
Behavioral Intention	43	3	.91

The Likert-scale data from each question was used to calculate means for the dependent variable (Behavioral Intention for Adoption / Use) and each independent variable included in the UTAUT2 framework. Since the number of responses for each participant varied the number of scores used to compile the composite mean ranged from 47-56. Mean scores for each of the variable (Table 2) show that students on average feel that VR technology provided some benefit to their sport performance (PE) (M = 7.28, SD = 2.29), was easy to use (EE) (M = 7.24, SD = 1.67), that they had enough resources and support to use VR (FC) (M = 7.66, SD = 1.91), and is enjoyable (HM) (M = 7.56, SD = 2.10). Students moderately agreed that they would use VR because others such as family, friends or peers are using it (SI) (M = 6.10, SD = 2.82). Students were neutral when it came to the value versus the cost of VR technology (PV) (M = 5.46, SD = 2.09) and using VR is something they do as a regular part of participating in their sport (Habit) (M = 4.50, SD = 2.77). Overall students felt more strongly that they would potentially use VR to participate in sport (BI) (M = 7.02, SD = 2.81). There was a moderate level of variability in respondent scores across all scores, indicating varying feelings about VR technology.

Table 3. Composite Scores for all Respondents

Variable	N	Minimum	Maximum	Mean	Std Deviation
Performance Expectancy	56	1.00	10.00	7.28	2.29
Effort Expectancy	54	2.75	10.00	7.24	1.67
Social Influence	55	0.00	10.00	6.10	2.82
Facilitating Conditions	53	3.25	10.00	7.66	1.91
Hedonic Motivation	49	2.67	10.00	7.56	2.10
Price / Value	48	1.00	9.67	5.46	2.09
Habit	47	0.00	10.00	4.50	2.77
Behavioral Intention	50	0.00	10.00	7.02	2.81

Due to the considerable number of missing values within the dataset the initial analysis focused on cases with complete data. Analysis involved examining the data from complete cases to guide the process for handling missing data. Of the thirty cases with complete data, descriptives statistics (mean, median, standard deviation, and range) were computed (Table 3). Mean scores for respondents with complete data were higher for all measures compared to those calculated from all respondents.

Skewness and kurtosis measures, along with histograms show the lack of normality in the data from the thirty complete cases (Appendix C). Skewness scores ranged from -1.030 to 0.01 with most scores showing a negative skew indicating a left-sided distribution. Examination of the histograms also indicate the asymmetry of data comprising each variable (Appendix C).

Table 4. Composite Scores for Respondents with Complete Data

Variable	N	Minimum	Maximum	Mean	Std Deviation
Performance Expectancy	30	3.33	10.00	8.09	2.29
Effort Expectancy	30	4.75	10.00	7.94	1.70
Social Influence	30	0.00	10.00	6.64	2.73
Facilitating Conditions	30	4.50	10.00	8.08	1.70
Hedonic Motivation	30	2.67	10.00	7.66	2.19
Price / Value	30	1.00	9.67	5.94	2.05
Habit	30	1.00	10.00	5.15	2.61
Behavioral Intention	30	2.00	10.00	7.81	2.29

Due to the observed asymmetry, the Shapiro-Wilk test and Kolmogorov-Smirnov (K-S) with Lilliefors correction are employed to assess the normality of the data. These tests are recommended when the sample size is < 50 (Wilson Van Voorhis & Morgan, 2007). The assumption for both tests rely on the following hypothesis with a $p \leq 0.05$ significance level. Because the K-S test has been shown to have relatively low power it was used to provide additional insight into the normality of the data (Ghasemi & Zahediasl, 2012; Mishra et al., 2019). The distribution of each variable is calculated separately using the Shapiro-Wilk test (Table 4). The distribution of PE ($W = 0.86$, $p = 0.00$), SI ($W = 0.90$, $p = 0.01$), FC ($W = 0.90$, $p = 0.01$), HM ($W = .90$, $p = 0.01$), BI ($W = 0.87$, $p = 0.00$) all departed significantly from normal. EE ($W = 0.91$, $p = 0.28$), PV ($W = 0.97$, $p = 0.66$), and Habit ($W = 0.96$, $p = 0.39$) did not show evidence of non-normality. Age (W = 0.90, p = 0.01) also departed significantly from a normal distribution. The K-S with Lilliefors (N = 30, p = 0.161) at a 0.05 significance level showed similar results to the Shapiro-Wilk. To prevent bias and address the non-normal distribution of the data, cases with missing values were excluded from further data analysis. Since most variables did not follow a normal distribution, correlation analysis used non-parametric tests.

Table 5. Shapiro-Wilk Test of Normality

Variable	N	W	Sig
Performance Expectancy	30	0.86	0.00
Effort Expectancy	30	0.96	0.28
Social Influence	30	0.90	0.01
Facilitating Conditions	30	0.90	0.01
Hedonic Motivation	30	0.90	0.01
Price / Value	30	0.97	0.66
Habit	30	0.96	0.39
Behavioral Intention	30	0.87	0.00

Correlation analysis measures the strength and relationship between each of the independent variable's PE, EE, SI, FC, HM, PV, Habit, and the dependent variable, BI. Age as a continuous variable is assessed for strength of relationship to BI since it serves as a potential moderator in the UTAUT2 model. Kendall's tau_b correlation was selected to assess the strength and direction between variables. This test is suitable for assessing non-linear relationships between variables and can accommodate irregularities in the data. Kendall's tau_b evaluates the strength and direction of association between data points and is particularly robust for small sample sizes because it is less affected by tied scores (Turner, 2014). The results indicate significant positive correlation between all independent variables within the UTAUT2 framework and behavioral intention to adopt and use VR technology for endurance sport (Table 5). Age did not significantly correlate with BI in Kendall's tau_b ($t_b = .136$, $p > 0.05$).

Scatterplots show the visual representations between PE, EE, SI, FC, HM, PV, Habit, and Age with respect to BI for adoption and use of VR technology (Appendix C).

Table 6. Kendall's tau-b Correlation Analysis

Variable	n	1	2	3	4	5	6	7	8
1. Performance Expectancy	30	_							
2. Effort Expectancy	30	.18	_						
3. Social Influence	30	.38**	.33*	_					
4. Facilitating Conditions	30	.35*	.17	.36**	_				
5. Hedonic Motivation	30	.35*	.31*	.44**	.28*	_			
6. Price / Value	30	.38**	.17	.35**	.47**	.30*	_		
7. Habit	30	.48**	.16	.33*	.35*	.32*	.46**	_	
8. Behavioral Intention	30	.45**	.30*	.34*	.52**	.47**	.52**	.56**	_

*p < .05 **p < .01

The significant, positive correlation between all variables and behavioral intention provided a rationale for conducting further regression analysis. Regression analysis estimates the predictive effects of each independent variable within the UTAUT2 framework on the intention to adopt and use VR technology. General linear model (GLM) regression models are used because of the small sample size of complete data. This type of modeling allows the possibility of studying interactions between each variable and behavioral intention to adopt and use VR (Wilson Van Voorhis & Morgan, 2007). Two regression models help to understand the relationship between each independent variable while considering the influence of gender or age. The first regression model considers the influence of gender on each independent variable. In this model PE, EE, HM, PV, and Habit have a statistically significant positive predictive effect on adoption and use. The regression coefficient (B) indicates the change in the behavioral intention to adopt and use VR for a one unit increase in the predictor variable, holding all other variables constant (Table 7). This effect did not change significantly by gender and gender did not have an independent effect on adoption on any of the predictor variables. Scatterplots show the positive relationship between each predictor variable and behavioral intention to adopt and use VR with respect to gender (Appendix C). The scatterplots suggest differences between the slopes for males and females and age groups. The visual differences observed in the scatterplots do not translate into statistically significant results in the regression analysis. This is likely influenced by the low sample size, which impacts the statistical power of regression analysis. The wide confidence intervals suggest that there is less precision for estimating the effects within the analysis and means differences or interactions may not be detected as significant.

Table 7. Regression Analysis Gender Model

Predictor	B	SE	t	p	95% CI
PE	.832	.206	4.046	.000**	.409 – 1.254
EE	.986	.460	2.141	.042*	.039 – 1.932
SI	.407	.171	2.374	0.25	0.55 - 0.759
FC	.487	.265	1.834	.078	-.0059 – 1.032
HM	.671	.188	3.562	.001**	.284 – 1.059
PV	.725	.210	3.455	.002**	.294 - 1.157
Habit	.603	.150	4.017	.000**	.295 - .912

*p < .05 **p < .01

The second regression model considers the role of age on each independent variable. Creating binary categories for age allowed the regression model to estimate the interaction between the independent variables and age on the adoption and use of VR technology. The model utilizes two categories for age, up to 22 years of age" (n = 18) and more than 22 years of age (n = 12). These age groups capture potential differences between undergraduate and graduate students. In this model, there was statistically significant predictive effect on adoption and use for PE, FC, HM, PV, and Habit (Table 8). However, the effect remained consistent across both age categories. Age had no independent effect on the adoption of VR technology on any variable and the effect did not change by age group. Scatterplots depict the positive relationship between the predictor variables and behavioral intention to adopt and use with age as a moderator (Appendix C).

Table 8. Regression Analysis Age Model

Predictor	B	SE	t	p	95% CI
PE	.690	.306	2.252	0.03*	0.6 – 1.32
EE	.861	.574	1.504	0.15	-0.32 – 2.04
SI	.357	.209	1.709	0.10	-0.72 – 0.786
FC	.620	.294	2.104	0.05*	0.014 – 1.225
HM	.496	.218	2.269	0.03*	0.47 – 0.945
PV	.539	.263	2.051	0.05*	-0.001 – 1.080
Habit	.889	.046	19.127	0.00*	0.796 – 0.982

*p < .05 **p < .01

Individual interviews provide valuable insight into how and why the factors outlined in the UTAUT2 influence the adoption and use of VR technology for endurance sport by participants. Utilizing subthemes provides a deeper understanding of various influences on adoption and use behaviors related to the primary themes within the UTAUT2. Specifically, fourteen subthemes emerged which illuminate the mechanisms through which the UTAUT2 explains adoption and use of VR in this context (Appendix C. Table 8).

Students highlighted how VR technology significantly improved their sport performance. One cyclist shared “There’s about fifteen of us who regularly use ZWIFT, and for reference, there’s twenty of us attending nationals in April.” This demonstrates how VR has become an integral part of their training routine, helping them improve as a competitive cyclist in their sport. Increased productivity of workouts was another benefit noted by students. The use of VR enhanced the efficiency of their workouts by helping them maintain power zones, duration, pedaling technique and heart rate zones, but also made training more engaging. This was illustrated by a quote where one student described “If I'm not riding with a virtual app, I'm riding in my basement staring at a concrete wall. It is tough to measure how many minutes I would be doing, but I can at least get an hour in if I'm on ZWIFT.”

The ease of use of VR technology for cycling can be a barrier for students. One mentioned this inconvenience in explaining why they no longer used it, “Everything needed to be taken up and broken down every single time I used it. The hassle of setting it up and breaking it down was significant.” Initially being able to learn how to use the technology could also present a challenge as one student explained, “There is a certain level of vertical integration that adds this tech barrier to people who are less technologically literate.” Technical and organizational support plays a key role in addressing some of these challenges.

One student suggested that technological support from developers would be helpful in getting started with the technology, “Maybe some more videos interface-wise because it was hard initially to make sure I calibrate my trainer and then connect it” referring to the VR application. Students also perceived that support from universities and colleges facilitated the ease of using VR. A quote from one another student illustrates this theme “I don't know if ZWIFT would sponsor a collegiate club or something like that, or with trainers that they could either check out to team members or get a deep discount. I think that would help.” Physical resources like the equipment and space were also critical factors for students in being able to adopt and use VR technology for endurance sport. Many students spoke about the need to have specialized equipment to maximize the VR experience as influencing their decision to adopt the technology. This was illustrated by one student who remarked, “I think something that probably impacted my willingness to use it was I don't have a smart trainer, so I was just using a regular old trainer or regular center rollers with a power meter.’

Social influence played varying roles in students adopting VR technology. Direct connections with peers and friends were often influential as one student shared, “One of my close family friends was really the first person I knew very well who was getting into the whole power trainer, ZWIFT investment. Everything he said about it made it sound very cool.” Other students found that indirect means of social support such as social media or online videos influenced their use of VR. One student expressed “Honestly, I got into it because I watched one of the first GCN videos on the topic.”

Features of this type of VR technology such as gamification, immersive worlds and the user community made the experience of using it more enjoyable which influenced adoption. One student shared the following about why they use VR, “The interactivity of it's pretty great. Just being able to go out and there are races and things to chase. The motivational kind of gamification features are very appealing."

When considering price/value students typically weighed both the perceived cost/value and the relative cost of VR technology. One student shared their thoughts on if the cost of VR was worth it compared to the functionality and experience it provided "In terms of the price you're paying every month for the subscription, not only are you getting to cycle and are more willing to do it, but you are also getting a little bit of coaching and a lot of feedback." How often students used VR also impacted their view on price/value and if they decided to use it. A quote depicting this sentiment included, "If I use it consistently, you know, two to three times a week, I feel like I really get my money's worth. But if I was not consistent, it would feel a little pricey."

Finally, the use of VR became a habit for students due to situational factors and routine. A consensus among all students is that VR was an adjunct to outdoor riding rather than a substitution for it. One student explained, "In the summer, no, but in the winter, yes. I will always prefer outdoor riding to indoor riding." Another student spoke about how they use it as part of their overall training routine sharing, "I use ZWIFT once a week because two other times we have team sessions. So at least once a week I will be on my trainer for at least an hour."

The student narratives illustrate how various themes within the framework of the UTAUT2 influenced their decision to adopt and use VR technology for endurance sport. Despite the challenges of accessing equipment and using VR technology, students felt that it provided them with ways to make their cycling experience more productive and enjoyable. Opportunities exist for college and universities to make VR more accessible as a tool for physical activity on campus.

Discussion

The purpose of this study was to determine factors that explain the behavioral intention to adopt and use VR technology for endurance sport by college students, while also exploring how and why these factors affect individual decisions. This information is valuable for a variety of stakeholders interested in endurance sport including individuals, organizations, researchers, and technology developers. By understanding these factors, targeted interventions can be developed to increase student participation in VR endurance sport activities, including cycling Esports.

This study shows that the UTAUT2 framework is highly relevant and useful for understanding the drivers of adoption and use of VR technology for Esports by college students. While limited research exists specifically related to this type of VR technology in this specific population, these findings align with previous studies related to the behavioral intention to adopt and use consumer sport apps (Angosto et al., 2023; Dhiman et al., 2020; Kunz & Santomier, 2020; Yang & Koenigstorfer, 2021). The most strongly associated factors in this study were performance expectancy, facilitating conditions, hedonic motivation, price/value, and habit ($p < 0.01$). Performance expectancy was a significant predictor of adoption and use which is consistent with previous research across a variety sport and fitness technologies (Barbosa et al., 2022; Kunz & Santomier, 2020; Westmattelmann et al., 2021; Yang & Koenigstorfer, 2021). In the context of sport related VR both performance expectancy and hedonic motivation play significant roles in adoption and use of VR technology (Kunz & Santomier, 2020; Westmattelmann et al., 2021). When considering the use of VR with the intention to be physically active, this study aligns with other research on the adoption of fitness apps. Specially it indicates that performance expectancy, habit, price/value, and facilitating conditions were strongly related to adoption and use (Yang & Koenigstorfer, 2021). These factors should be prioritized when developing interventions to promote adoption and use of VR technology for Esports.

Students were more likely to use VR technology for endurance sport when they found the technology improved their sport outcomes or workout efficiency. Those who continued to use it did so because they found it helpful for preparing for specific events or improving certain aspects of their fitness. Having available resources such as technical supports, organizational support, and equipment are critical factors that influence students' behavioral intention to adopt and use this technology. Students spoke specifically to issues around access to equipment and the potential for organizational support such as funding for purchasing equipment or subscriptions as a means of encouraging use in the context of cycling Esports. One of the perceptions that students had of this technology was that features of VR make it fun and enjoyable to use. Individuals will be more likely to use the technology if they feel that features such as immersive virtual worlds, entertaining content, social connection, and interactivity, will enhance their cycling experience. Prive/Value is a key factor in the UTAUT2 that influences adoption and use VR technology by college students. When students perceive that the benefits they receive outweigh the financial cost, they are more likely to embrace VR. Specifically, if a VR system offers features that students enjoy using and provides tangible benefits to their workouts or training, adoption becomes more likely. Habit was another important factor within the UTAUT2 that was identified by students as influential to their use of VR. Once students started to use VR for sport or workouts, they were likely to continue using it. Situational cues such as bad weather, season, lack of infrastructure, and time constraints also helped to prompt students to use VR more habitually.

Furthermore, performance expectancy, hedonic motivation, price/value, and habit may have significant positive predictive effects on VR technology adoption and use. These effects are consistent across age group and gender. Age and gender themselves did not independently influence adoption and use of VR technology. This contrasts with findings from other studies that show age and gender are highly predictive of behavioral intention (Angosto et al., 2023; Ong et al., 2023). Because VR technology provides similar benefits for users, age and gender may not have the same influence on the adoption and use of VR technology by college students. Effort expectancy and social influence which other studies identify as predictors did not seem to significantly influence adoption and use of this type of VR by college students. (Barbosa et al., 2022; Dhiman et al., 2020). College students tend to be more technologically savvy which was reflected in the interviews and indicate that they are comfortable using this type of VR technology. Social influence might not impact college students to use VR in specialized activities like endurance sport compared to more popular activities where peers may be more influential. Due to limitations imposed by the small sample size used in the analysis the models should be interpreted cautiously. However, they do provide insight that certain factors may be more predictive of VR endurance sport technology use by college students.

Limitations

One significant limitation of this study was low participation. The initial plan was to recruit a larger sample size for the survey. Having a large sample could make the results of this study more generalizable and reduce bias of the sample. A larger sample would have allowed for additional statistical tests such a hierarchal regression that would contribute to a better predictive model for the factors of the UTAUT2 in a college student population. A potential challenge in expanding the sample size was the timing of the survey. The survey, initially sent out at the beginning of November 2023 and received an exceptionally low response rate. The low response rate may have been that this part of the semester coincides with final exams and projects leaving students limited time to respond to a survey. November and December also include major holidays and holiday break for most academic institutions where students may return home and be off campus. Direct recruitment occurred by reaching out to cycling or triathlon club leaders via email to help distribute the survey to their members. College students may not regularly check emails or respond to emails generated outside of campus. For example, an email to one cycling club sent in November received a response at the end of March when recruitment for the project was complete. Most responses to the survey came at the end of January and occurred through social media channels. Paid, targeted advertisement through Instagram with a direct link to the survey seemed to yield the highest number of responses.

A second limitation was the number of individuals that clicked on the survey and did not answer all the questions. This may indicate that the survey tool needs further refinement. The survey questions purposely referred to endurance sports rather than cycling to broaden the reach to triathletes who do not refer to themselves as cyclist but use VR to participate in their sport. Revising the survey questions may motivate students to complete all parts of the survey instead of giving partial responses.

Conclusions

This study shows that the UTAUT2 framework is a potential framework for identifying factors that may influence college students to use VR technology to participate in endurance sports such as cycling. Significantly, all the constructs of the UTAUT2 demonstrate that they are influential factors influencing decisions around VR technology adoption. Despite the small sample size this study builds on earlier research exploring the adoption of commercial virtual reality programs such as ZWIFT but extends it to a new population. This research also contributes research that explains consumer adoption of technology using the UTAUT2 framework. Additional research would provide a means to refine the survey tool and improve the generalizability and reliability of these results.

The results of this study can help to promote cycling Esports sport participation using VR technology as a recreational sport on college campuses. Studies have shown that VR technology for cycling Esports appeals to users for both health and performance related reasons. This type of programming can provide students with additional opportunities for physical activity, social interaction, and improving personal well-being. Colleges can support initiatives that attract students looking for a competitive outlet and those seeking fitness benefits. Promotional activities can attract students looking to engage in cycling Esports for fitness reasons by emphasizing how it eliminates barriers such as weather, time, and safety concerns. Additionally, features of VR such as immersive worlds, social interactions, and game elements can increase enjoyment and motivation for students. VR offers students already interested in competitive cycling similar benefits but also an opportunity to engage in virtual races, competitions, and specific workout features that help them improve performance. Programs can further support adoption and use by targeting ways to reduce costs around equipment, space, and technological support.

CHAPTER II: DISSEMINATION

The findings from this dissertation will be distributed in the form of recommendations for exercise professionals, recreational sport programs, and college students interested in adopting virtual reality technology for cycling Esports. Because the current VR infrastructure for cycling is more developed than running or other endurance sports this presentation will focus on its use in that area. The knowledge gained from this study will be used to create a presentation that can be customized and shared with various stakeholders. The following slides are found in Appendix D.

Slide 1: About cycling Esports

Cycling Esports refers to competitive cycling that takes place in a virtual environment. Although new, cycling Esports can be a gateway into the sport of cycling. Virtual cycling can serve to attract demographics who may not have considered cycling as an option for participating in sport. This form of cycling offers an accessible and convenient way for individuals to participate in the sport of cycling. Cycling Esports can reduce barriers to entry that are associated with traditional forms of cycling.

Imagine riding your bike indoors but instead of staring at your wall or watching a movie you are riding in a virtual world with other people from all over the world. Now instead of being in your living room you are riding in fantasy world or one of the most iconic routes in all of cycling such as climbs in the Tour de France or the Italian Alps.

Slide 2: Barriers to cycling

Barriers exist that prevent individuals from participating in the sport of cycling. Cycling traditionally has a high cost of entry. An entry level racing bike can cost upwards of $1000. Lack of skill or experience is another factor that may make someone choose not to enter the sport. Individuals may lack confidence in their ability to ride while sharing the road with traffic, navigate certain terrain such as trails, or ride with other people. Safety concerns such as the risk of falling, collisions with vehicles, and accidents may also pose another barrier to entry. Participants may also be reluctant to enter the sport because they do not see peers involved or they see a lack of diversity and inclusivity. Additional challenges such as not having accessible infrastructure, weather, and time constraints can dissuade participation.

Slide 3: Cycling Esports reduce barriers

Cycling Esports may reduce barriers that are associated with traditional forms of cycling. Participants can primarily ride from the comfort of their own living space. Virtual cycling allows participants to ride at any time of day, regardless of weather or traffic. Cycling Esports allows participants with various backgrounds, fitness levels, and experience to participate in cycling. Platforms for cycling Esports allow participants to ride and connect with others regardless of their location. Additionally, Esports cycling allows diverse ways to participate in the sport such as group rides, racing, challenges, and workouts. Although specialized equipment is necessary that cost can often be less than participating in traditional forms of the sport.

Slide 4: VR technology used for cycling Esports

Virtual Reality or VR is a type of technology that aims to allow users to feel physically and mentally present in a virtual world. Commercial applications run on computers connected to “smart bikes or trainers” that facilitate an interactive experience. A display shows a virtual world with an avatar adjusting to the rider’s speed and effort. The smart bike/trainer responds to changes in the virtual environment. For example, riding up a climb will increase the resistance you need to pedal against, and riding downhill will be easier.

Slide 5: Applications

Several popular applications exist for cycling Esports. ZWIFT is the most popular and allows users to ride in an imagined virtual world. Users can interact socially during rides, participate in races, complete pre-programmed workouts, or join public group rides. MyWhoosh is another app that is like ZWIFT but provides a greater number of structured workouts and training plans. The Rouvy application simulates real world routes and uses real life video to create a virtual environment.

Slide 6: College Students and Esports

College provides an ideal time to introduce students to cycling Esports. During the transition to college, a substantial percentage of students discontinue their participation in both competitive team and endurance sports. Recreational sport programs on college campuses allow students to try new sports for fun and provide an ideal setting for cycling Esports. Interest in cycling exists on campus as spinning is currently one of the most popular forms of recreational fitness programming. Esports is extremely popular with college students. There are 160+ Esports programs in the United States and over 600 universities with club programs. Leveraging the popularity of spinning and Esports opens opportunities for cycling Esports.

Slide 7: Support for cycling Esports

The USA Cycling Collegiate program provides opportunities for student cyclists of all abilities and genders. Two of the key objectives of the program include providing new riders with an introduction to cycling both riding and racing and ensuring that the sport is low cost and accessible to anyone who wants to participate. USA Cycling offers opportunities in cycling disciplines such as road, mountain bike, cross, and cycling Esports. USA cycling currently supports cycling on campus through club and varsity programs. An Esports cycling program can help draw students to live forms of the sport.

Slide 8: My research

The purpose of my research was to examine what factors are important to college students when deciding to adopt and use VR reality technology for cycling. First, I wanted to identify a framework that would capture factors that are more likely to relate to uptake of VR technology used for cycling. Secondly, I wanted to understand how and why these factors influenced student’s choices to use VR technology. The goal of this research was to be able to inform the development of effective strategies to promote its use among this demographic and increase participation in cycling Esports.

I used emails and social media to reach college students who were likely to have used VR applications for cycling. This included sending emails to active collegiate cycling and triathlon programs. Students completed a survey tool and those that were interested an interview as part of the project.

Slide 9: UTAUT2 Framework

The framework that I chose for my study was the Unified Theory of Acceptance and Use of Technology 2. This framework is useful in evaluating factors that influence the decision to use technology, including sports applications. Although there is limited research specific to VR technology for endurance sport, the framework offered a broad set of constructs that were applicable within this context. To constructs with the UTAUT2 that explain the behavioral intention to adopt and use technology include, performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation (enjoyment), price/value, and habit.

These constructs can be explained in the context of cycling as, does the individual feel the technology improves their performance either sport or fitness, is it easy to use, do others influence them to use it, barriers, or facilitators, is it enjoyable to use, what is the cost benefit, and has using it become part of their cycling routine. To use the UTAUT2 for this project it required developing a survey tool that fit VR technology for cycling. Interviews with students provide a description of how the factors influence their use of this technology.

Slide 10: Research Results

I had 125 students open the link to the survey, but only 63 complete it. Of those 63, 30 completed all parts of the survey. Thirteen students responded that they were willing to participate in an interview, to which five responded to a follow-up invitation.

The survey tool showed good average construct reliability across all factors within the UTAUT2 framework. On average students that completed the survey felt that this type of VR technology was something they were likely to adopt and use for participating in cycling. Students rated more favorably that the technology was likely to improve their performance, it was easy to use, they had enough resources to use it, and it was enjoyable. They moderately agreed that they would use it if they knew others that did and that there was value relative to the cost. On average about half the participants had incorporated VR technology into their cycling routine.

I found that all the factors within the UTAUT2 framework were likely to be associated with the adoption and use of VR technology. The best predictors of the intent to use VR was that it improved their cycling or exercise performance, regular use, enjoyment, perceived value, and having available resources to use it.

Slide 11: What students said

There was agreement from all students that despite using VR technology it did not fully replace the outdoor riding experience. However, many had incorporated it into their cycling routine as it reduced barriers such as weather, time constraints, limited cycling infrastructure, and availability of peers to ride with. Students spoke of using the technology to improve their performance in a specific event or that it improved the quality of their training sessions. A common theme that students alluded to was resources that would make using this technology easier and support for these resources. Cost, access to equipment, and physical space were frequently mentioned as resources that influenced student use of VR. Additionally, the influence of peers, friends, family, and observing others engaging with VR technology was noted as significant. Students found that they enjoy using VR cycling technology such as ZWIFT because it provides immersive virtual environments, social features which facilitate interaction with other cyclists, and the options it provides for riding.

Slide 12: Takeaways

For those looking to leverage cycling Esports to increase interest in cycling, college students are an ideal demographic. Students may be interested in different sports that provide ways to connect with other students in a less competitive environment than traditional varsity sports.

Cycling Esports can potentially reduce barriers associated with traditional cycling sports such as a perceived lack of skill, inexperience, concerns around peer participation, time, equipment costs, and travel requirements. It is important to address concerns around cost, equipment and the physical space needed to make using the technology accessible. An emphasis should be placed on the features that make VR technology enjoyable to use and beneficial to performance. Family, friends, peers as well as watching others has the potential to shape student options about using VR technology for cycling Esports. Habits related to using VR technology are already being established. This suggests the potential for engaging students in using it for additional activities.

Slide 13: Recommendations

Promote the benefits of using VR technology for cycling to students. (Example, joining a cycling community, easy to find people to participate with, reduces skill level needed to start in the sport). Emphasize that cycling Esports can be a cheaper alternative than its real-life counterpart. Although a smart bike is often an initial cost, multiple riders can share one and there is no need for annual maintenance as with a traditional bike. Explore group discounts with equipment manufacturers. Provide space on campus for a cycling Esports program. Organize events where students can try VR technology and participate in different types of events such as group rides, races, or workouts. Develop a social media campaign in which students share their experiences participating in cycling Esports.

CHAPTER III: ACTION PLAN

The focus for this project is to help understand factors which potentially explain the intention to adopt and use VR technology for cycling by college students. The intention is to use this information to create an Esports cycling program on my campus. The first step will be to present this information on campus to various stakeholders such the division of student life who coordinate clubs and recreational sports on campus.

During this research project the schools that I reached out to participate in expressed an interest in the results. An infographic that sums up the major findings will be distributed to schools or through social media. The infographic will have two main parts, the first will describe which factors influence adoption and use, highlighting which ones may be more predictive among college students for this technology. The second part will provide recommendations and practical implications to increase adoption and use in the college setting.

Another way to provide this information is to publish an article in a medium that covers cycling Esports. Having already made a connection with the publisher of a popular website covering virtual cycling and Esports, this presents an excellent opportunity to disseminate the findings to a relevant audience. This article can serve as a resource for those seeking to create programs or initiatives to increase cycling Esports participation by college students or conduct additional research in this area.

Finally, this project presents the opportunity for additional research in this area. Although the findings are from a small sample of participants, it creates a starting point for more extensive research. This study does show that the UTAUT2 is potentially a viable framework for understanding adoption and use behavior in college students for VR cycling technology. Sharing the information from this study with developers of VR technology may make it more attractive for them to help reach out to their user base to support additional research. The findings from this study contribute to larger studies involving the use of the UTAUT2 framework by showing that it translates to VR technology for endurance sport by college students.

There are several journals within the field of Kinesiology that would be appropriate to submit a manuscript for publication. The findings from this research will be disseminated at the regional ACSM conference and or College Esports Expo which is in Boston on an annual basis.

Throughout this project, I built a network with various industry leaders in Esports, cycling, and VR cycling tech which will be beneficial when for sharing infographics or relevant information from this project to reach a wider audience.

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APPENDIX A: RECRUITMENT MATERIALS

Figure A1. Social Medial Recruitment Poster 1

Figure A2. Social Media Recruitment Poster 2

Figure A3. Recruitment Blog Post

News

From Campus to Virtual Courses: Guiding Cycling's Rise in Collegiate Esports Culture

The research aims to transform the collegiate esports model through research into adopting virtual reality technology in virtual cycling. Complete the short survey!

Author: *Devin Cashman is an Assistant Professor at Regis College in Weston, MA, and a doctoral student at the University of North Carolina, Greensboro. As a competitive triathlete and cyclist, Devin's research seeks to expand the sport of cycling by increasing participation at the college level.*

College presents an exciting opportunity to introduce students to the world of cycling. USA Cycling's Collegiate Program is at the forefront, promoting cycling within universities and offering a wide array of participation opportunities. There's something for everyone, from track to mountain biking, cyclocross to BMX, road cycling, and now even esports.

Latest Podcast!

Check out Episode Thirty Nine here!

Latest Posts!

VVN's Most Impactful People in Cycling Esports For 2024
March 18, 2024

UCI's Fair Cycling Campaign Opens the Door For Formal Cycling Esports Cheat Reporting
March 13, 2024

Beyond ZRL: What's Next For Women's Racing?
March 11, 2024

Get to know USA Cycling Esports National Age Group Champion and USAC Esports Committee Member Jenn Real
March 4, 2024

Danish Federation's Cycling Esports Leadership is an Example for NGBs
February 28, 2024

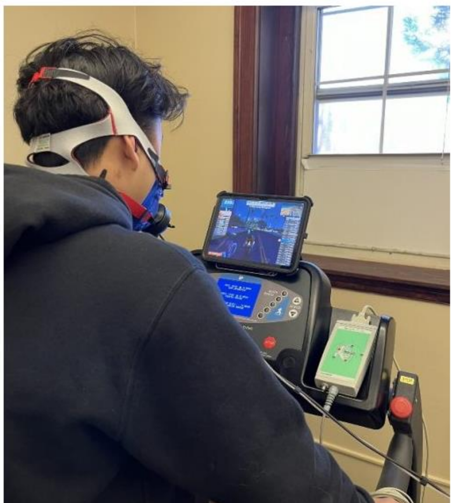
Do you want to join the VVN team? Tap the logo for details!

st

Recently, the 2024 USA Cycling Esport National Championships, hosted by Echelon Racing Promotions, crowned the champions in this emerging discipline. Despite being new to the collegiate racing scene, esports provides an accessible entry point for students keen on cycling. Platforms like ZWIFT, Mywhoosh, Rouvy, and indieVelo offer immersive virtual environments, adding a new dimension to the sport.

Also Read: ***USA Cycling Crowns 23 National Champions at the 2024 Esports National Championships***

As esports gains popularity across college campuses, cycling stands to benefit. However, the challenge lies in integrating esports into traditional sports. Understanding what drives students to embrace virtual reality technology for cycling is crucial, given their role as early adopters of new trends and technologies.



By tapping into student enthusiasm, organizations and teams can drive the growth of cycling esports on campuses. It involves making technology readily available, promoting the sport, organizing competitions, and securing company sponsorships and discounts. Moreover, colleges can play a pivotal role in advancing specialized VR technology to enrich the immersive cycling experience.

Please scan the QR code above if you or someone you know wants to be involved in this study!

Christopher Schwenker

Semi-retired as owner and director of his private Orthopedic Physical Therapy practice after over 20 years, Chris is blessed with the freedom to pursue his passion for virtual cycling and writing. On a continual quest to give back to his bike for all the rewarding experiences and relationships it has provided him, he created a non-profit. Chris is committed to helping others with his bike through its work and the pages of his site.

In the summer of 2022, he rode 3,900 miles from San Francisco to New York to support the charity he founded, TheDIRTDadFund. His "Gain Cave" resides on the North Fork of Long Island, where he lives with his beautiful wife and is proud of his two independent children.

You will read him promoting his passion on the pages of Cycling Weekly, Cycling News, road.cc, Zwift Insider, Endurance.biz, and Bicycling. Chris is co-host of The Virtual Velo Podcast, too!

APPENDIX B: SURVEY TOOLS

Survey Tool

Screening Questions (Yes/No)

A. Are you currently a student at a college or university in the United States?
B. Do you currently participate in the sport of cycling (road cycling, mountain biking, cyclocross, triathlon)?
C. Have you used virtual reality technology to participate in cycling?

Demographic Questions:

1. Age?
2. Gender?
3. How frequently do you use VR endurance sport technology such as ZWIFT? (0-10 never – frequently).

All the following questions would be a Likert Scale 1-10

Performance Expectancy

4. Using VR endurance sport technology enhances my physical activity and sport experience.
5. VR endurance sport technology helps me achieve better results in sport activities.
6. VR endurance sport technology makes my physical activity and sport experience more productive.

Effort Expectancy

7. VR endurance sport technology is easy to use.
8. Learning how to use VR endurance sport technology is easy and straightforward.
9. VR endurance sport technology is easy for me to integrate into my existing physical activity and training routine.
10. It was easy for me to become skillful in using VR endurance sport technology.

Social Influence

11. People who are important to me think that I should use VR endurance sport technology.
12. People who influence my behavior think that I should use VR endurance sport technology.

13. People whose opinions that I value think that I should use VR endurance sport technology.
14. The endorsement of people from my sport community influences me to use VR endurance sport technology.

Facilitating Conditions

15. I have the necessary equipment and space to use VR endurance sport technology.
16. I have the technical knowledge and skills required to use VR endurance sport technology.
17. I can get technical support and assistance for using VR endurance sport technology.
18. The infrastructure and resources required for me to use VR endurance sport technology are available to me.

Hedonic Motivation

19. Using VR endurance sport technology is fun.
20. VR endurance sport technology offers an immersive and entertaining experience.
21. VR endurance sport technology makes my physical activity or sport experience more enjoyable.

Price/Value

22. VR endurance sport technology is reasonably priced.
23. The benefits I receive from using VR endurance sport technology outweigh the costs involved with using it.
24. The cost of VR endurance sport technology makes it a good value for participating in physical activity or sport.

Habit

25. I have developed a routine of using VR endurance sport technology regularly for physical activity or sport.
26. I need to use VR endurance technology to participate in physical activity or sport.

Behavioral Intention

27. I intend to continue using VR sport technology in the future.
28. I would actively seek out opportunities to use VR endurance sport technology.
29. I plan on continuing to use VR endurance sport technology regularly for physical activity or as part of my sport.

Information Sheet

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

INFORMATION SHEET FOR PARTICIPATION IN RESEARCH

Protocol Title: The Adoption and Use of VR Technology for Endurance Sport Participation by College Students

Principal Investigator: Devin Cashman, 23 Long Hill Road, Ashland, MA 01721, 781-801-3086

What is this all about?

I am inviting you to participate in this research study that seeks to examine factors influencing college students' decisions to adopt and use VR technology for participating in endurance sports. If you agree to participate in this study, you will be asked to complete an online questionnaire. The online questionnaire will gather information about your demographics, technological background, and your opinions and experiences related to virtual reality technology adoption and use for endurance sport. The questionnaire will take approximately 10 minutes to complete. In addition, you will have the opportunity to participate in an interview with the primary investigator of this study. If you choose to participate in the interview, the researcher will contact you to schedule a convenient time for the interview to take place. The interview will be conducted over the phone, or via video conference based on your preference. During the interview the researcher will ask open-ended questions to explore your perspective and experiences of VR technology adoption and use. The interview will take approximately 15 minutes of your time. You can skip any questions you don't want to answer in the survey or if you agree to be interviewed.

Are there any Risks?

One of the potential risks associated with participating in this research study is the risk of a breach of confidentiality. This refers to the possibility that the information you provide as part of this study may be accessed, disclosed, or shared with unintended parties, either intentionally or unintentionally. While every effort will be made to protect your data and personal information, it is essential to acknowledge and understand this potential risk.

What about my confidentiality?

We will do everything possible to make sure that your information is kept confidential, but absolute confidentiality cannot be guaranteed. All information obtained in this study will be maintained confidentially unless disclosure is required by law. We will implement several measures to minimize the risk of a breach of confidentiality.

UNCG Institutional Data Protection Standards will be followed for maintaining the confidentiality of the data collected during this research project. Data will be subject to the L2-Classification Standards for research data. All data will be stored in UNCG approved data storage locations as outlined in the UNCG Data classification policy. Password protection will be used to prevent unauthorized access to data research and only shared with the primary researcher and co-researchers as listed in the IRB proposal. Primary research data will be retained for a minimum of five years after the project is completed. All research data will be maintained by the university as specified in the Access and Retention of Research Data in the University Policy Manual. Data will be maintained in UNCG facilities during this period. Data destruction will be coordinated with UNCG in accordance with university policy. Data destruction will be appropriate for the type of media or storage. All electronic data collected will be subject to secure wiping using software to overwrite the data multiple times. Documentation of data destruction will include verifying the date, time, and method used in each instance. Live transcription using Zoom/Microsoft Teams will be used to convert interviews to written text during the interviews with participants. Video/Audio recordings will be stored in a separate file from the transcription data. Participants will have the opportunity to review the transcript during or after the interview to verify the accuracy of their statements. The video/audio data will be deleted as soon as verified by the participant. Aggregated data and pseudonyms will be used to protect the identity of participants during dissemination or publication of data from this research project.

Absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet access. Please be sure to close your browser when finished so no one will be able to see what you have been doing.

If you choose to participate in an interview with the researcher, your voice and face will be potentially identifiable by anyone who hears or sees the recording. Confidentiality for things you say on the recording cannot be guaranteed although the researcher will try to limit access to the recording as described in this section.

<u>What if I do not want to be in this research study?</u>
You do not have to be part of this project. This project is voluntary, and it is up to you to decide to participate in this research project. If you agree to participate at any time in this project, you may stop participating without penalty. You have the right to refuse to participate or to withdraw at any time, without penalty. If you do withdraw, it will not affect you in any way. If you choose to withdraw, you may request that any of your data which has been collected be destroyed unless it is in a de-identifiable state. The investigators also have the right to stop your participation at any time. This could be because you have had an unexpected reaction, or have failed to follow instructions, or because the entire study has been stopped.

If you are a UNCG student or employee, withdrawal or refusing to participate will not affect your relationship with the University of North Carolina at Greensboro in any way. You may choose not to be in the study or to stop being in the study before it is over at any time. Neither your academic status or grades, nor your employment, will be affected by your participation decision.

<u>Will I be paid?</u>
There are no costs to you, or payments made for participating in this study.

What if I have questions?

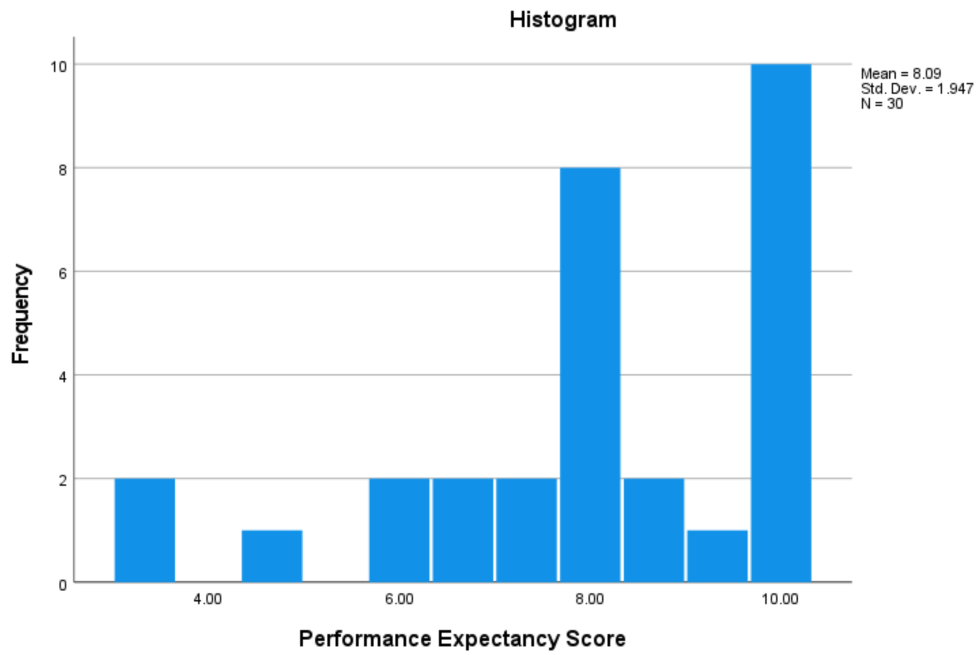
You can ask Devin Cashman, dpcashman@uncg.edu the primary researcher or Dr. Louisa Raisbeck, ldraisbe@uncg.edu, Faculty Advisor, anything about the study. If you have concerns about how you have been treated in this study, contact the Office of Research Integrity Director at 1-855-251-2351 or ori@uncg.edu.

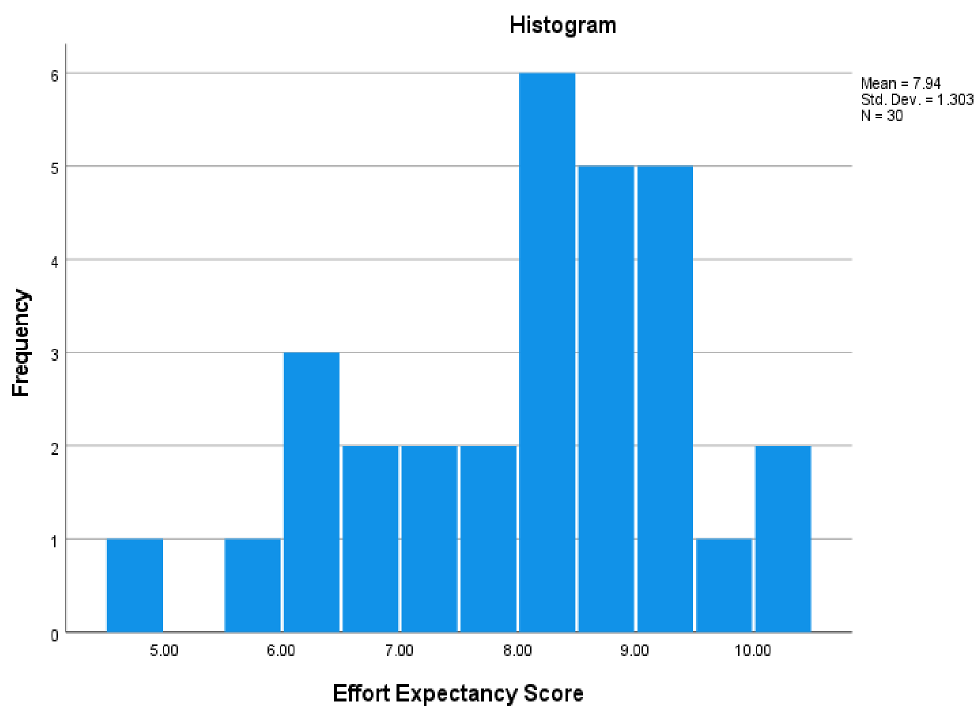
Voluntary Consent by Participant:

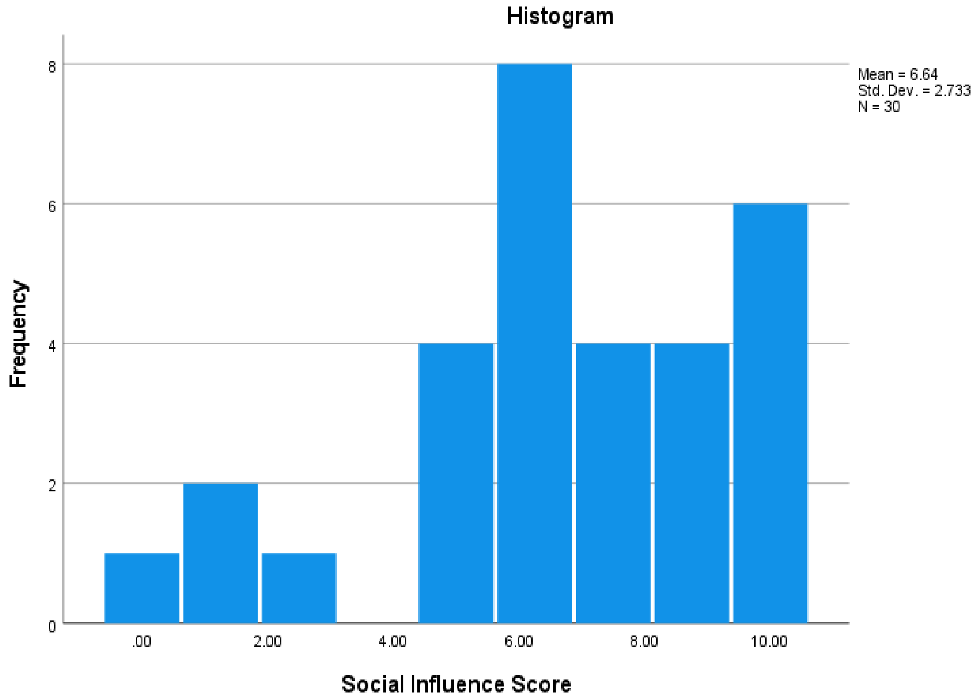
By completing this survey/interview you are agreeing that you are 18 years of age or older and have read, or it has been read to you, and you fully understand the contents of this document and are openly willing consent to take part in this study.

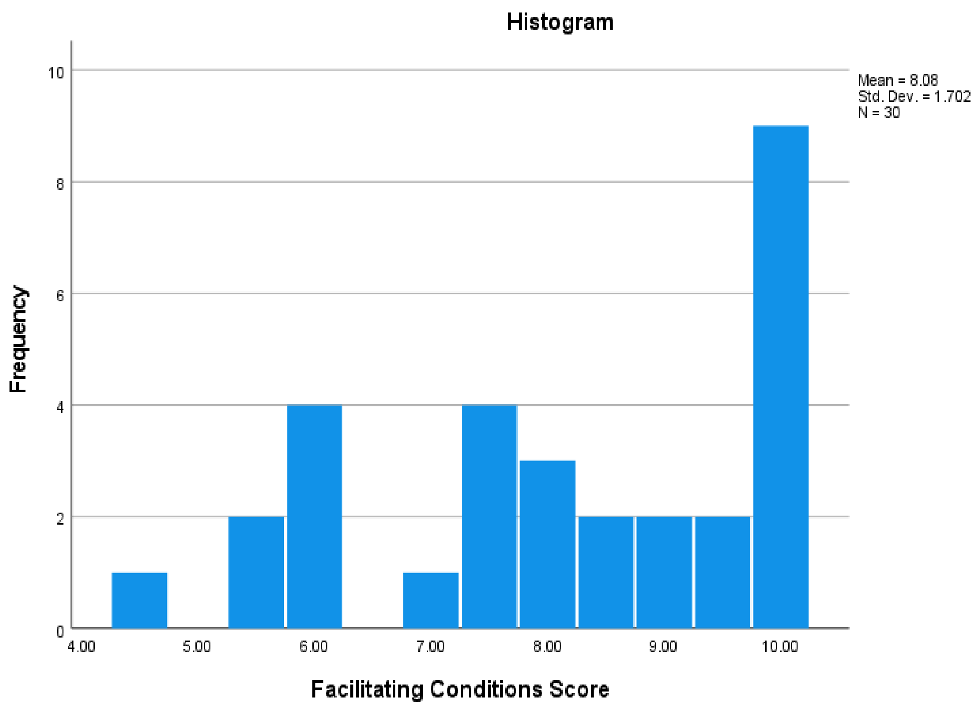
If you wish, you can print or take a screenshot of this consent page for your records.

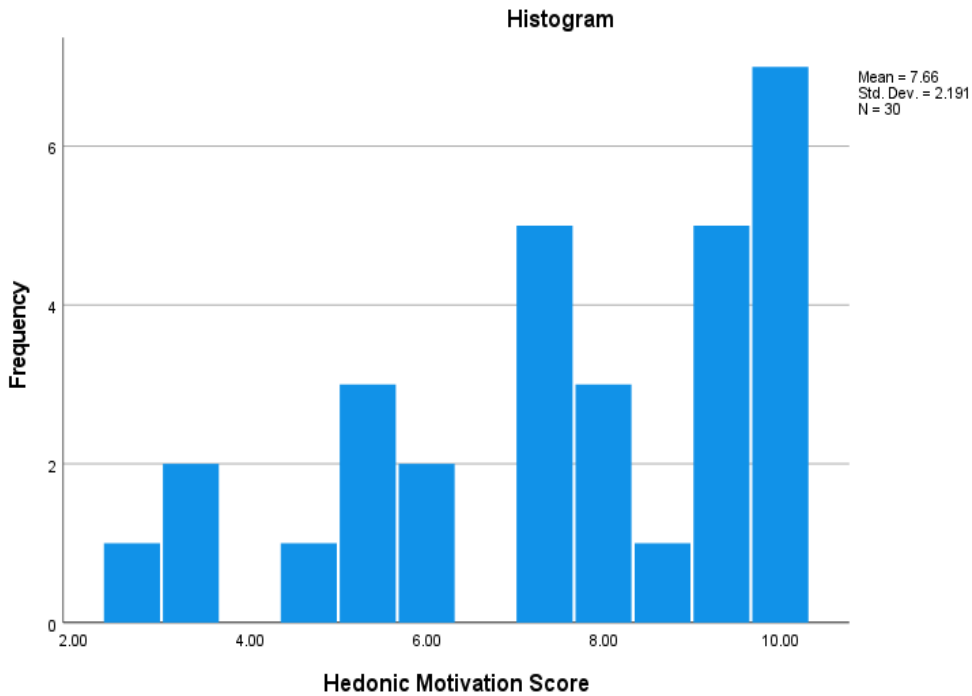
Figure C4. Frequency Histograms



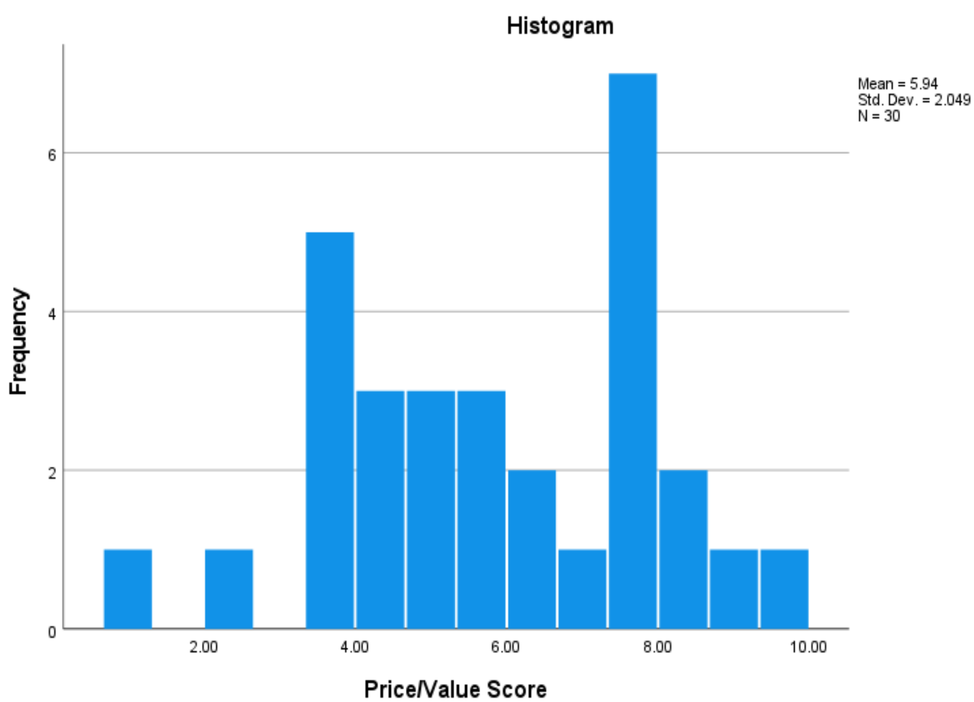



Histogram
Mean = 6.64
Std. Dev. = 2.733
N = 30
Frequency
Social Influence Score
0
2
4
6
8
.00
2.00
4.00
6.00
8.00
10.00

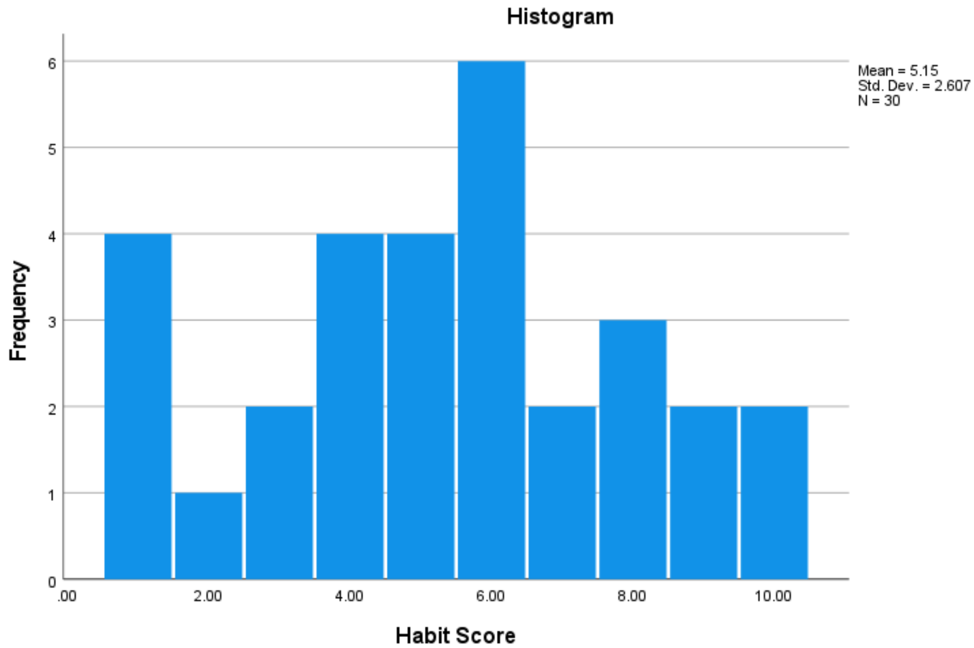

Histogram
Mean = 8.08
Std. Dev. = 1.702
N = 30
Frequency
Facilitating Conditions Score
0
2
4
6
8
10
4.00
5.00
6.00
7.00
8.00
9.00
10.00

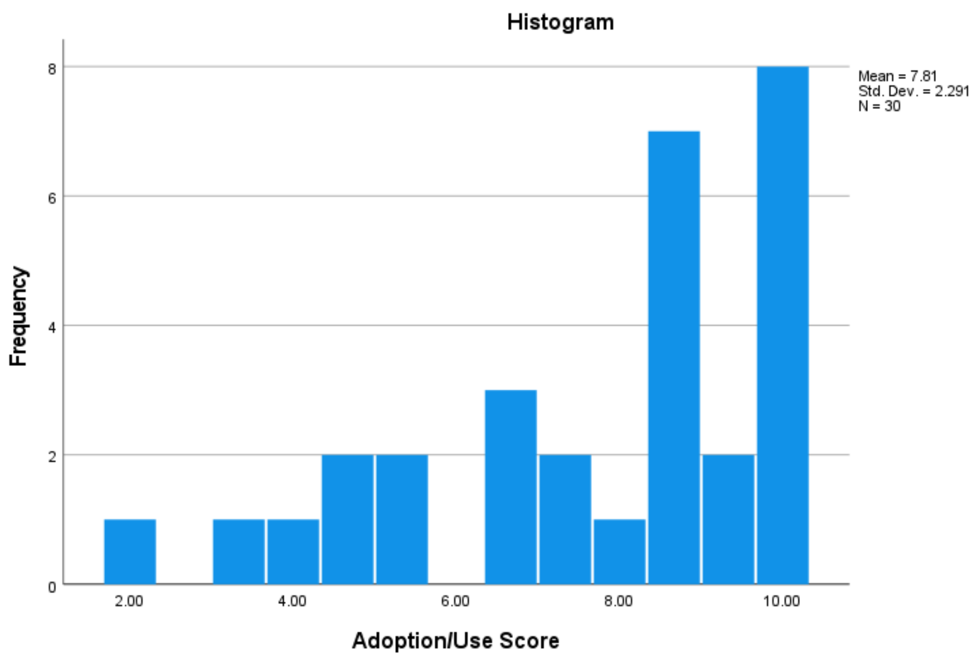


Histogram
Mean = 7.66
Std. Dev. = 2.191
N = 30
Frequency
0
2
4
6
2.00
4.00
6.00
8.00
10.00
Hedonic Motivation Score



Histogram
Mean = 5.94
Std. Dev. = 2.049
N = 30
Frequency
0
2
4
6
2.00
4.00
6.00
8.00
10.00
Price/Value Score


Histogram
Mean = 5.15
Std. Dev. = 2.607
N = 30
Frequency
0
1
2
3
4
5
6
.00
2.00
4.00
6.00
8.00
10.00
Habit Score


Histogram
Mean = 7.81
Std. Dev. = 2.291
N = 30
Frequency
0
2
4
6
8
2.00
4.00
6.00
8.00
10.00
Adoption/Use Score

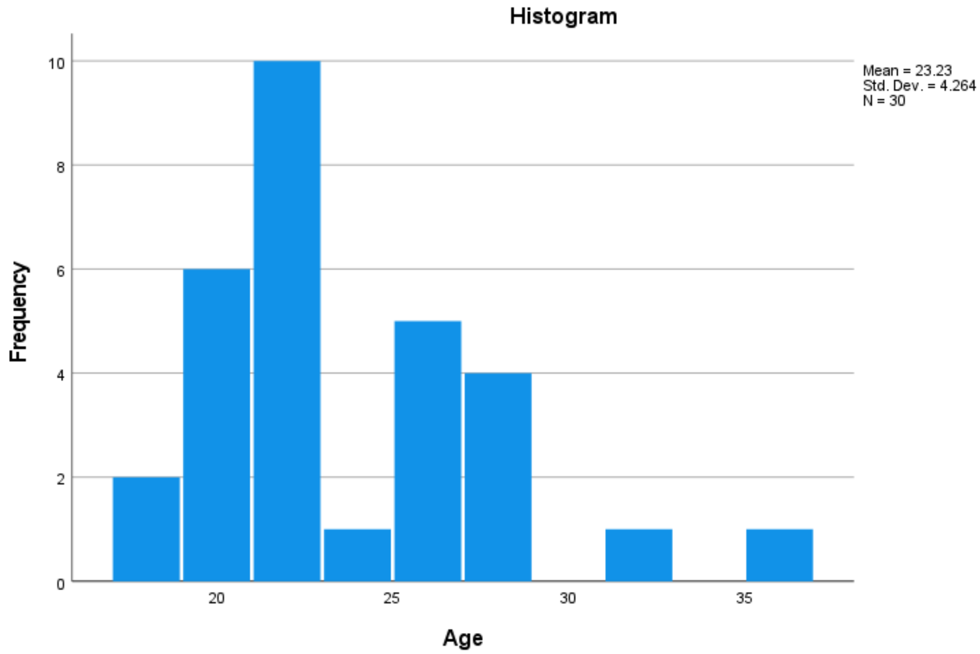
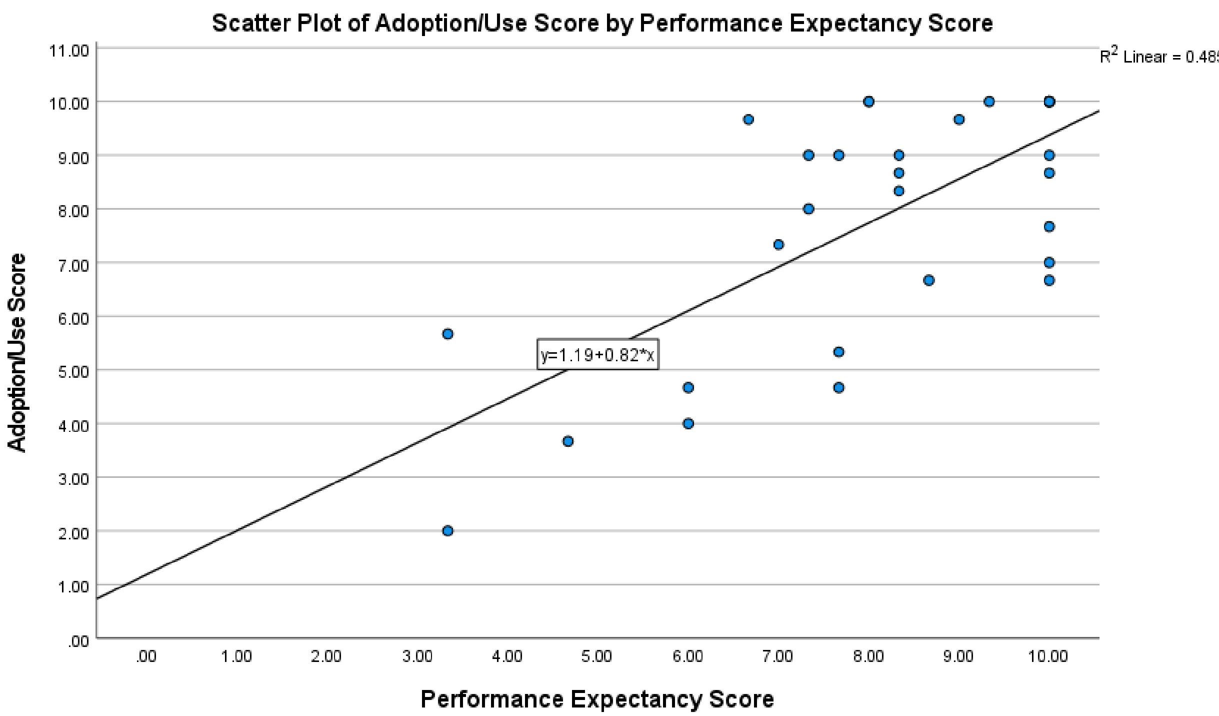
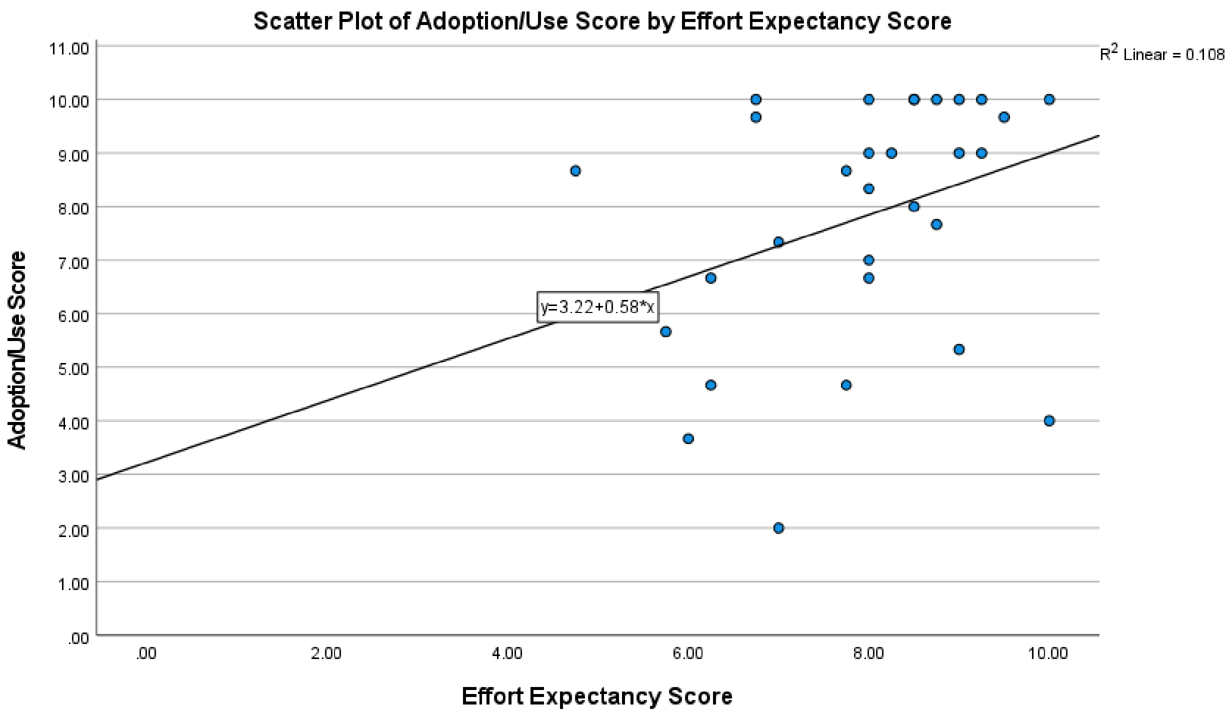
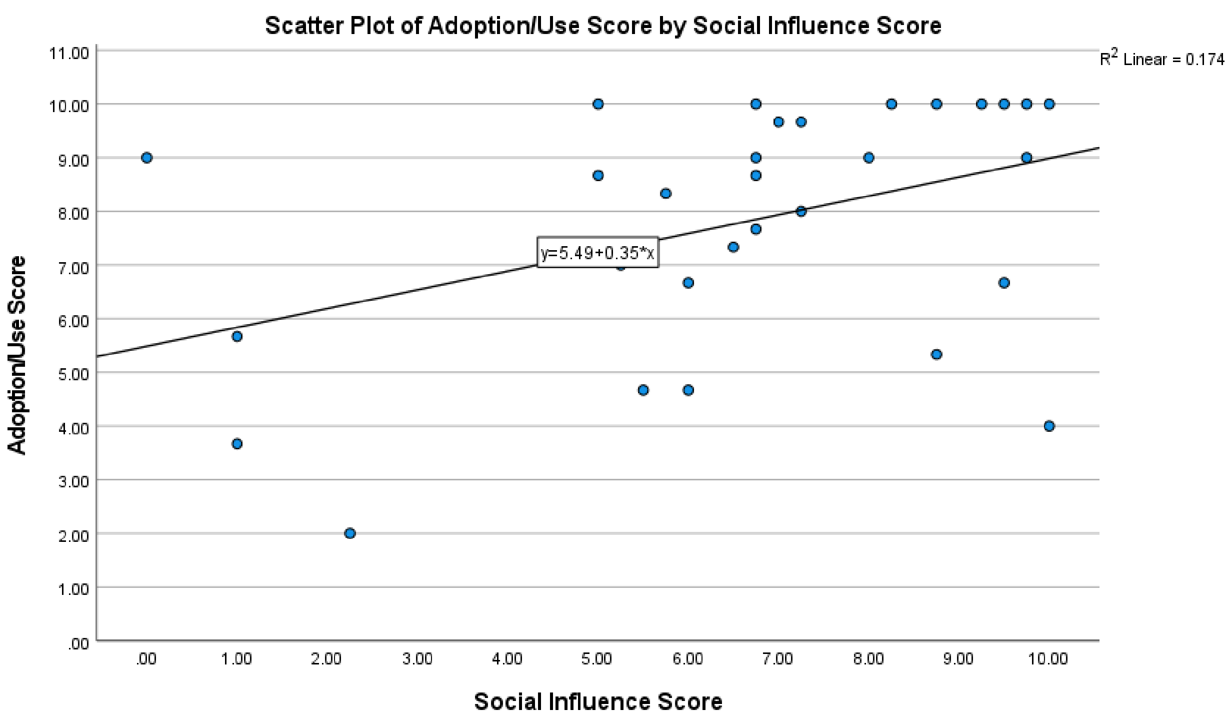


Figure C5. Correlation Scatterplots




Scatter Plot of Adoption/Use Score by Effort Expectancy Score
R² Linear = 0.108
y=3.22+0.58*x
Adoption/Use Score
Effort Expectancy Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
2.00
4.00
6.00
8.00
10.00


Scatter Plot of Adoption/Use Score by Social Influence Score
R² Linear = 0.174
y=5.49+0.35*x
Adoption/Use Score
Social Influence Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
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2.00
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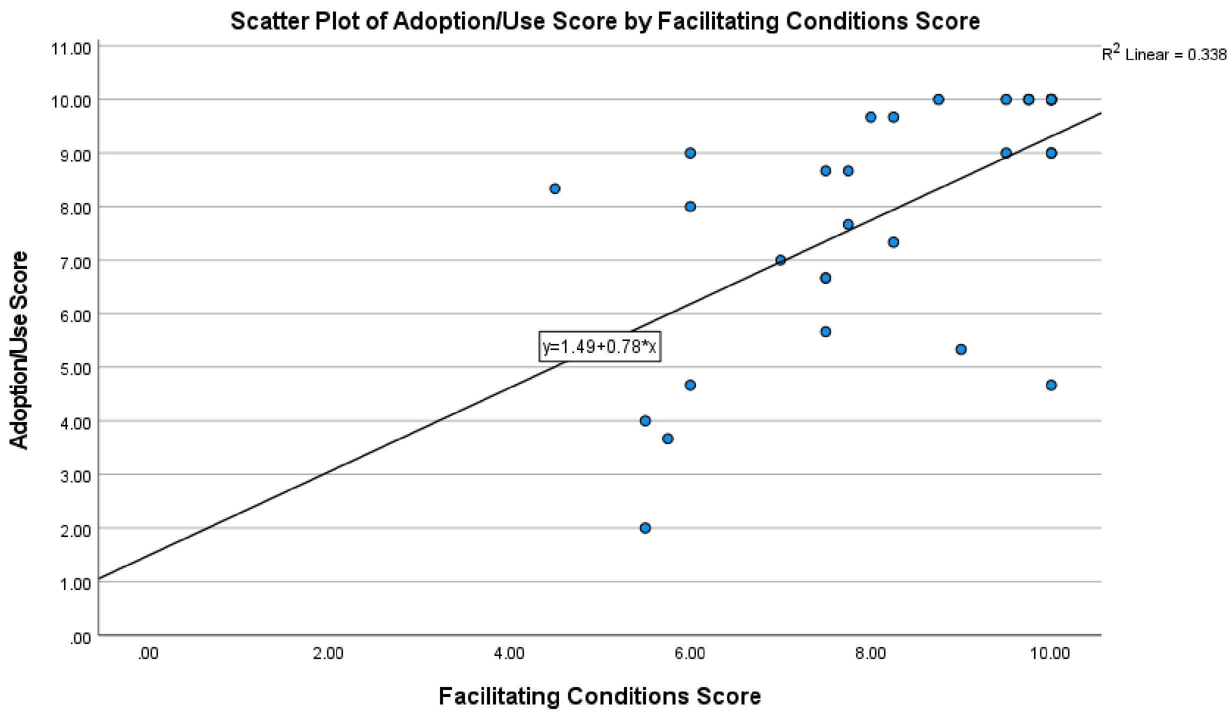
8.00
9.00
10.00


Scatter Plot of Adoption/Use Score by Facilitating Conditions Score
R2 Linear = 0.338
y=1.49+0.78*x
Adoption/Use Score
Facilitating Conditions Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
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3.00
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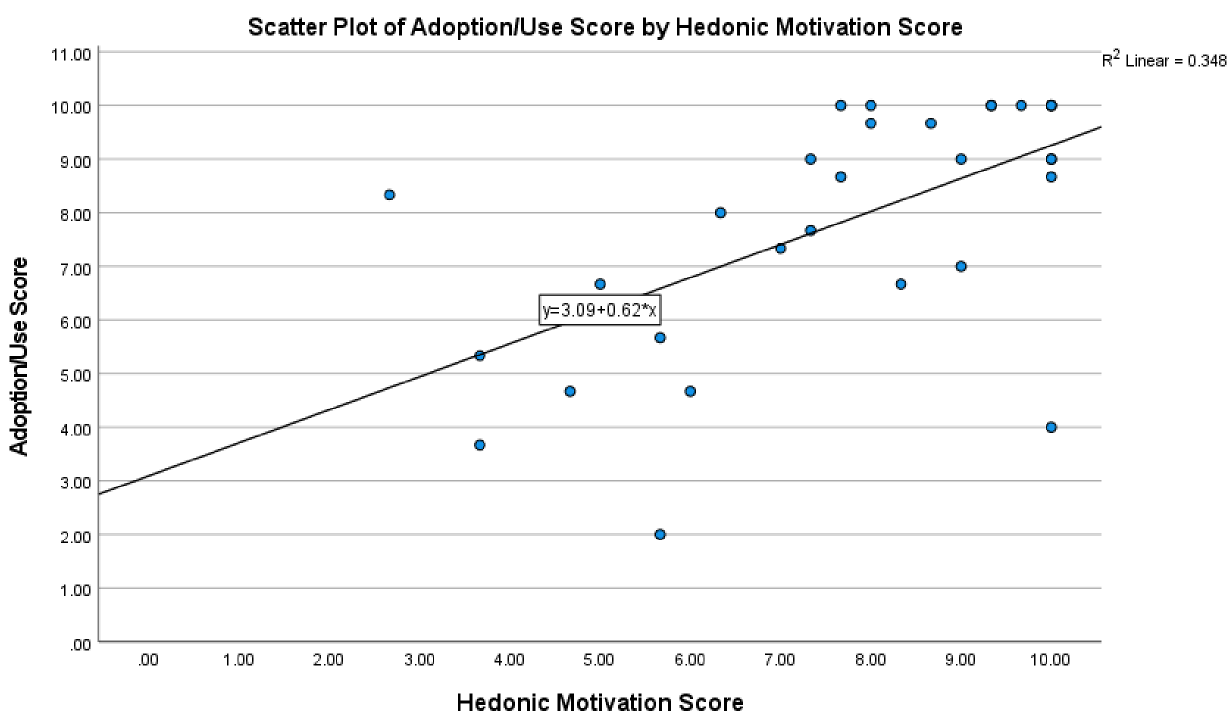
1.00
.00
.00
2.00
4.00
6.00
8.00
10.00


Scatter Plot of Adoption/Use Score by Hedonic Motivation Score
R2 Linear = 0.348
y=3.09+0.62*x
Adoption/Use Score
Hedonic Motivation Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
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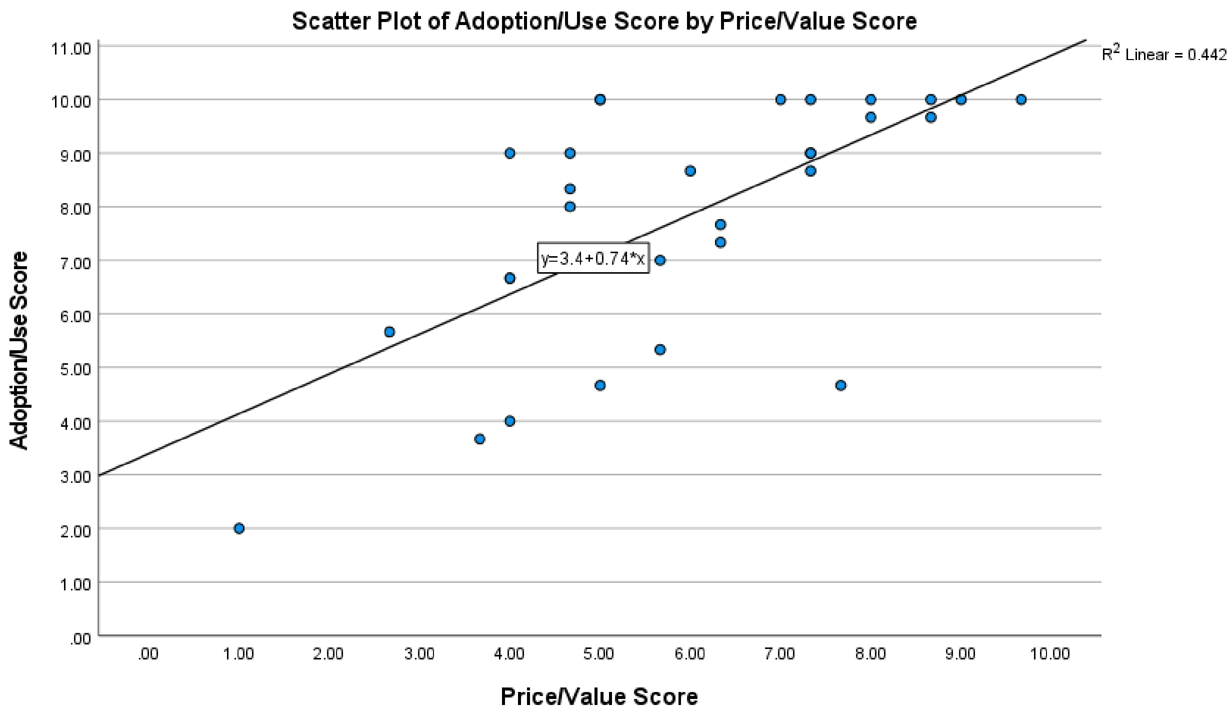
8.00
9.00
10.00


Scatter Plot of Adoption/Use Score by Price/Value Score
R² Linear = 0.442
y=3.4+0.74*x
Adoption/Use Score
Price/Value Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
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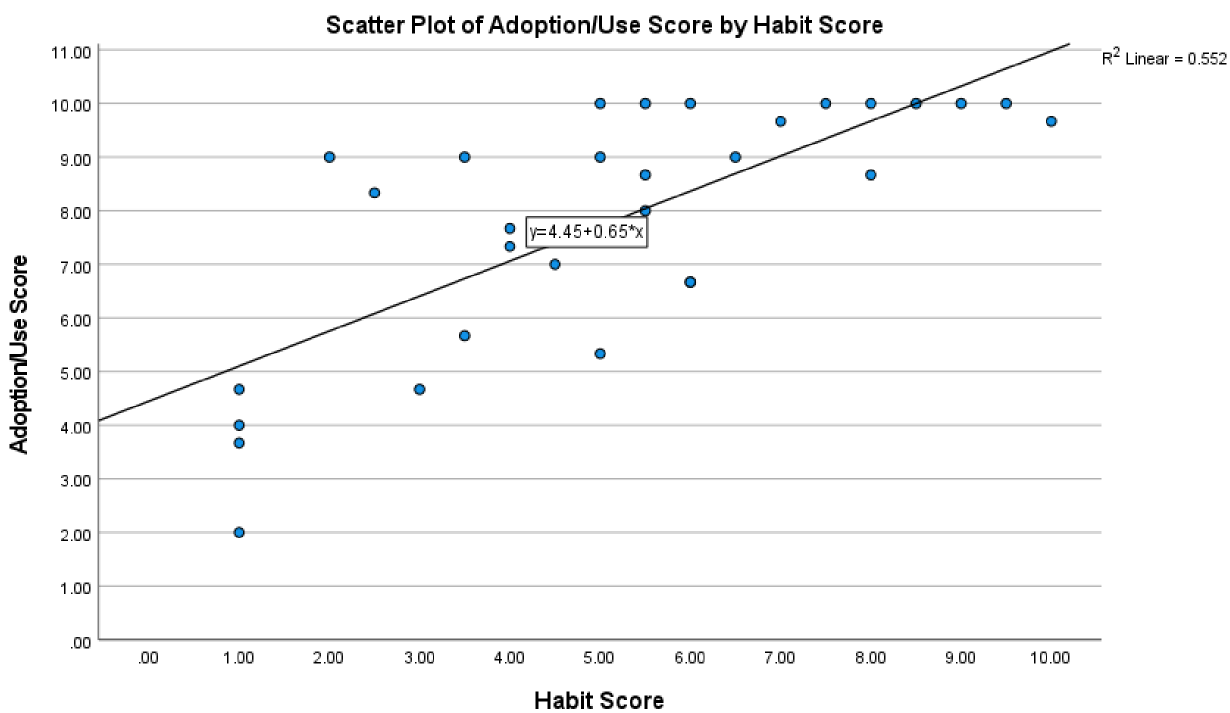
10.00


Scatter Plot of Adoption/Use Score by Habit Score
R² Linear = 0.552
y=4.45+0.65*x
Adoption/Use Score
Habit Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
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8.00
9.00
10.00

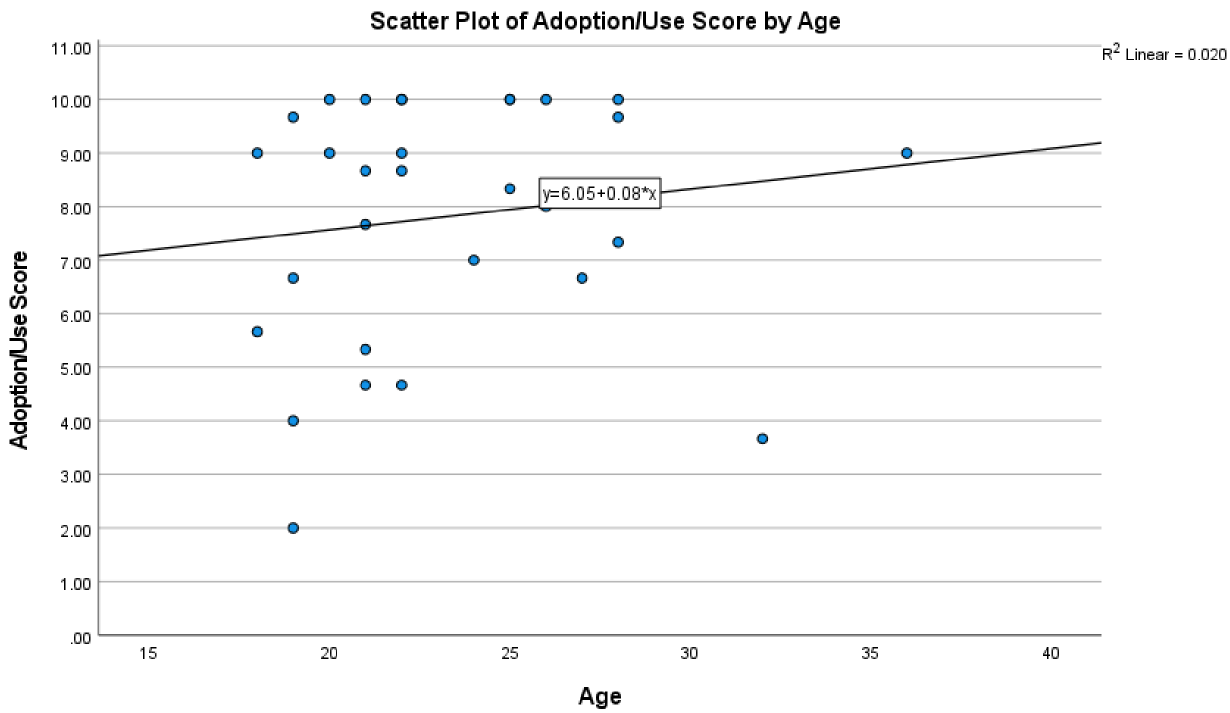
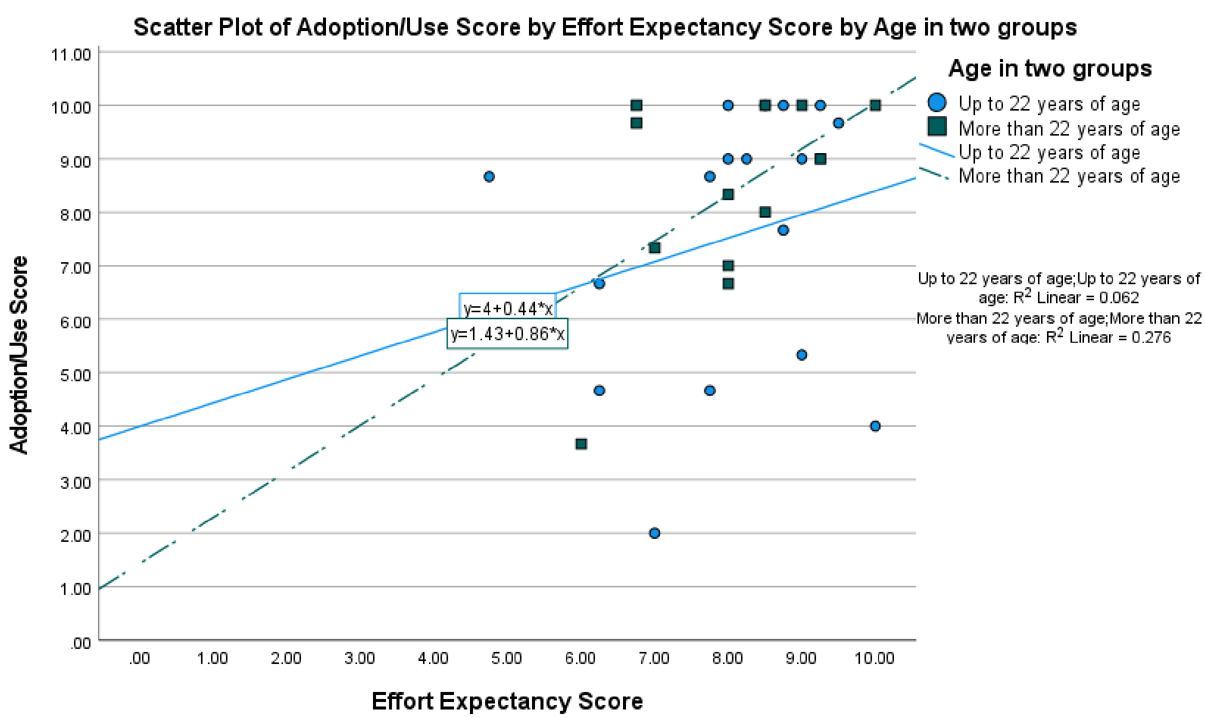
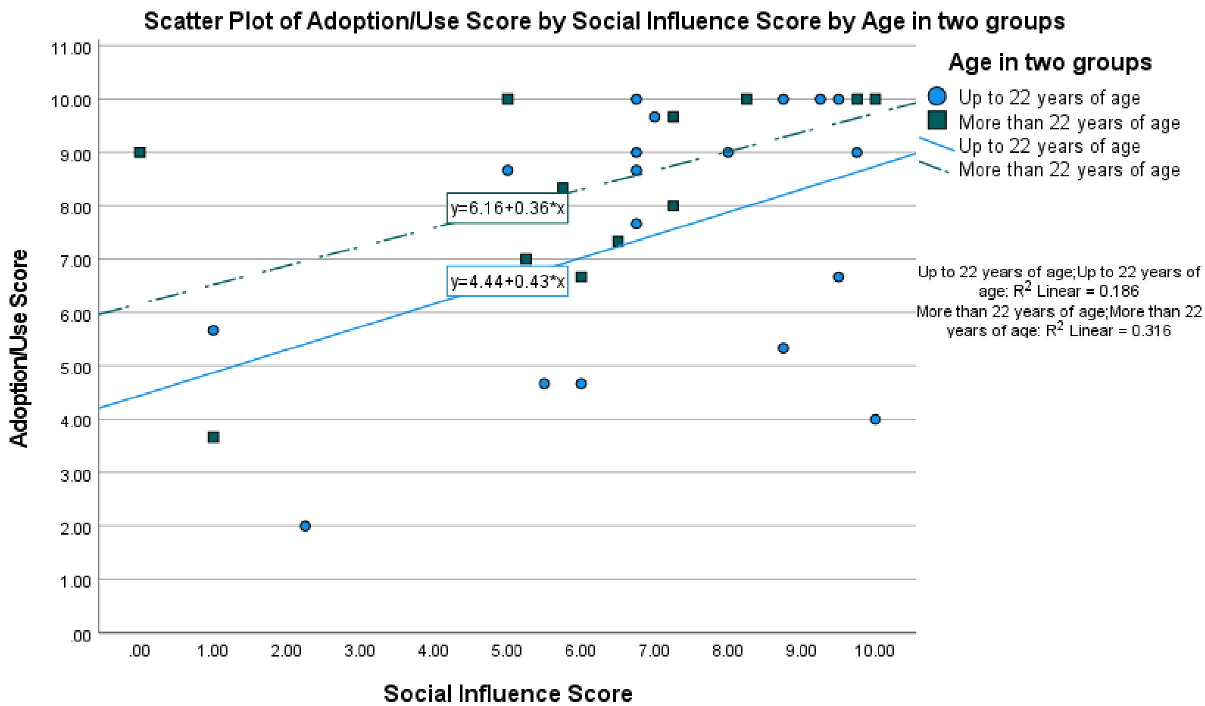
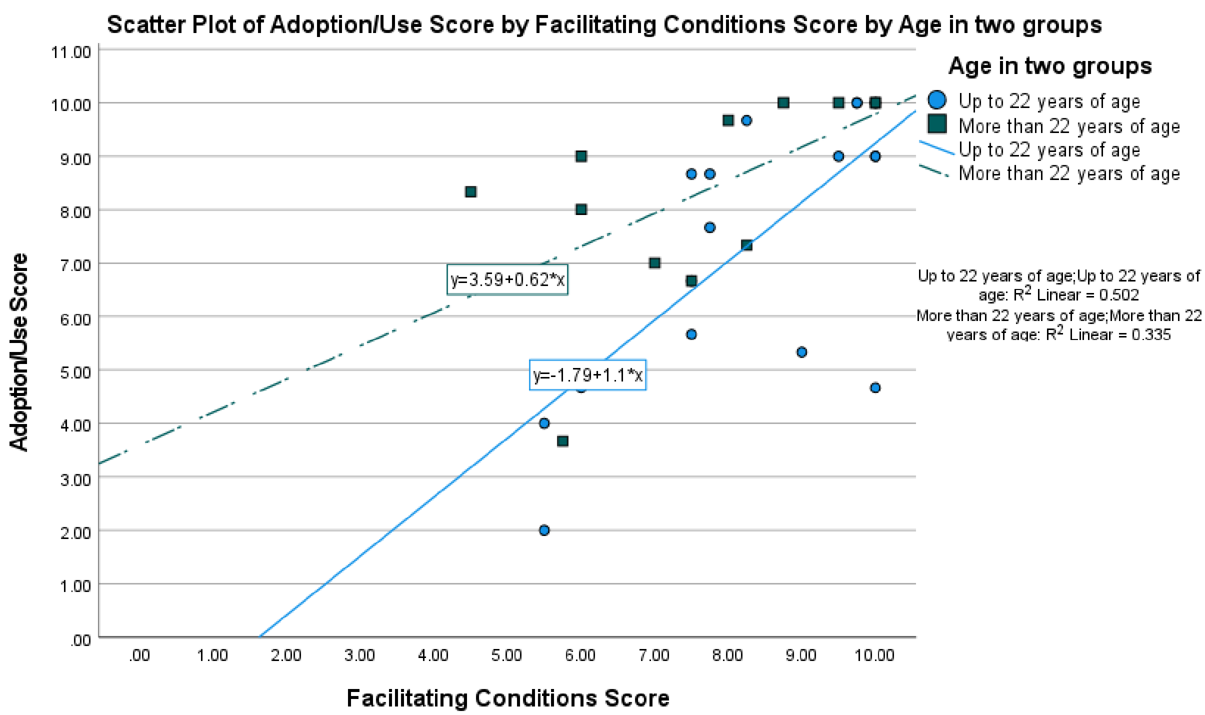
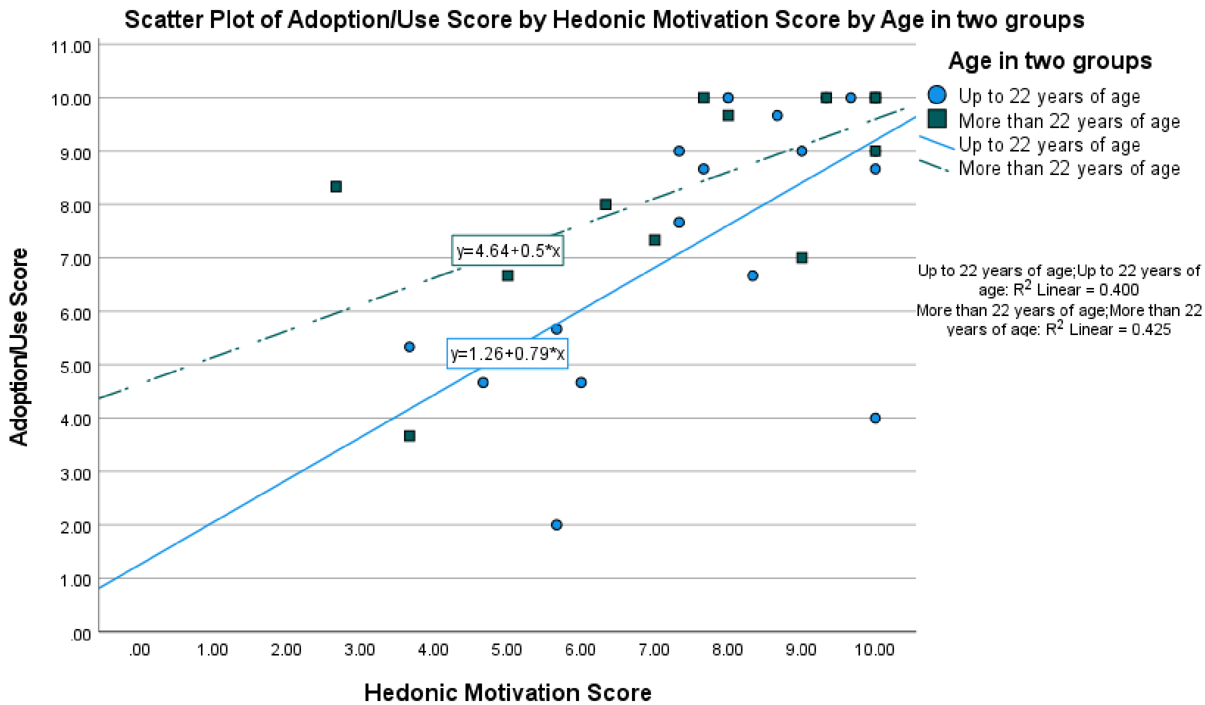


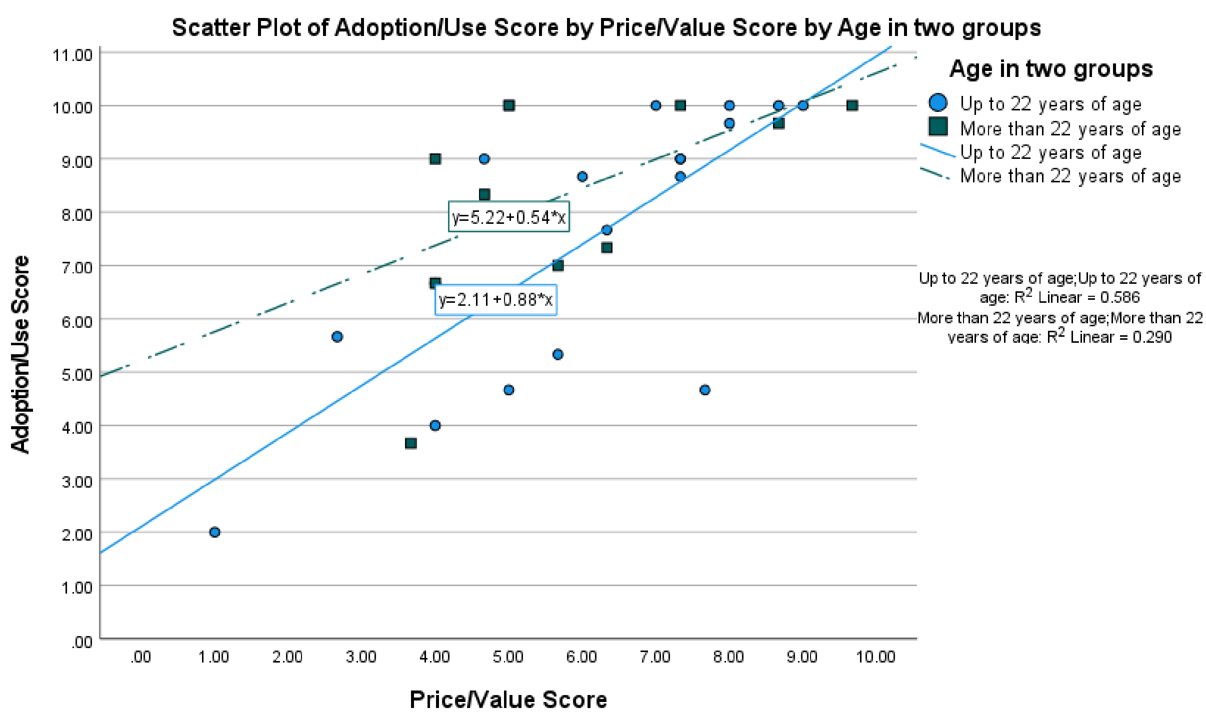
Figure C6. Regression Scatterplots

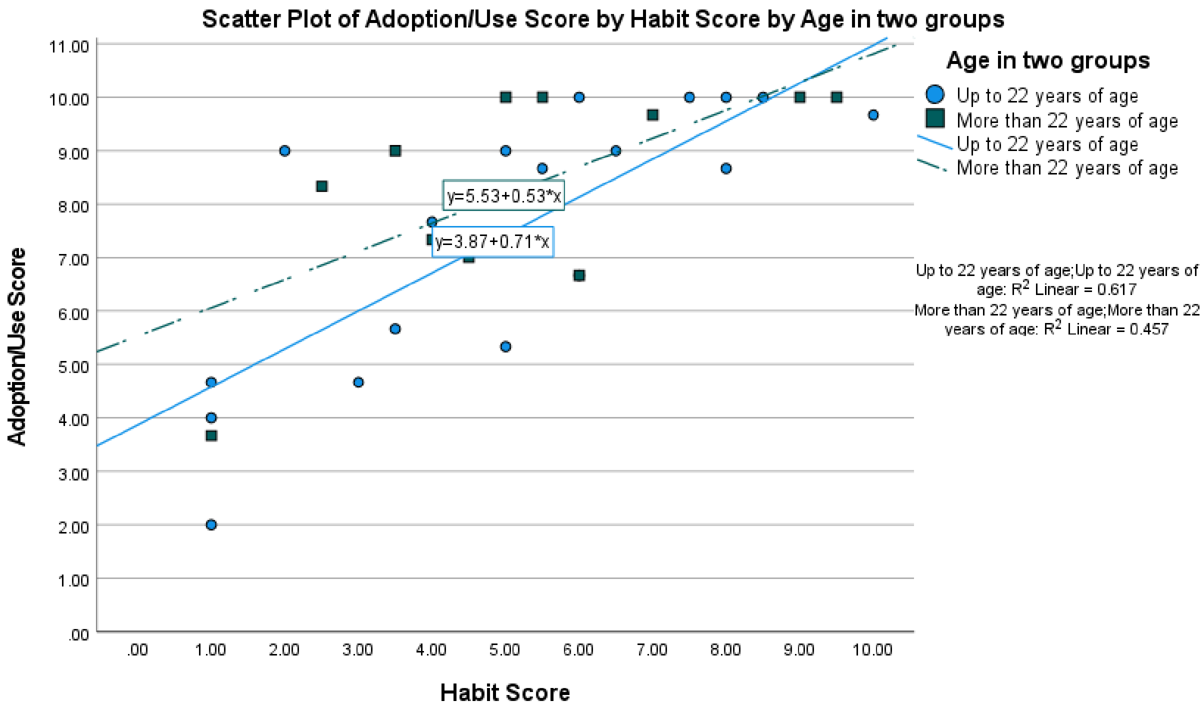


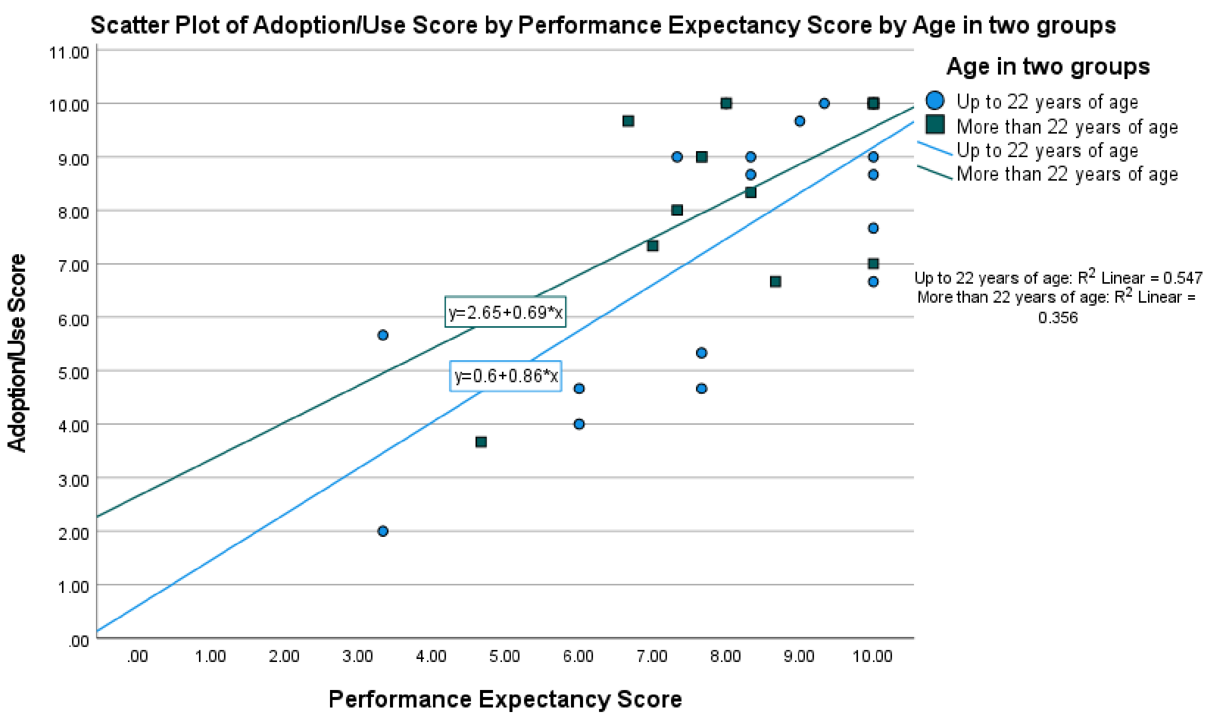

Scatter Plot of Adoption/Use Score by Social Influence Score by Age in two groups
Adoption/Use Score
Social Influence Score
Age in two groups
Up to 22 years of age
More than 22 years of age
Up to 22 years of age
More than 22 years of age
y=6.16+0.36*x
y=4.44+0.43*x
Up to 22 years of age;Up to 22 years of age: R2 Linear = 0.186
More than 22 years of age;More than 22 years of age: R2 Linear = 0.316

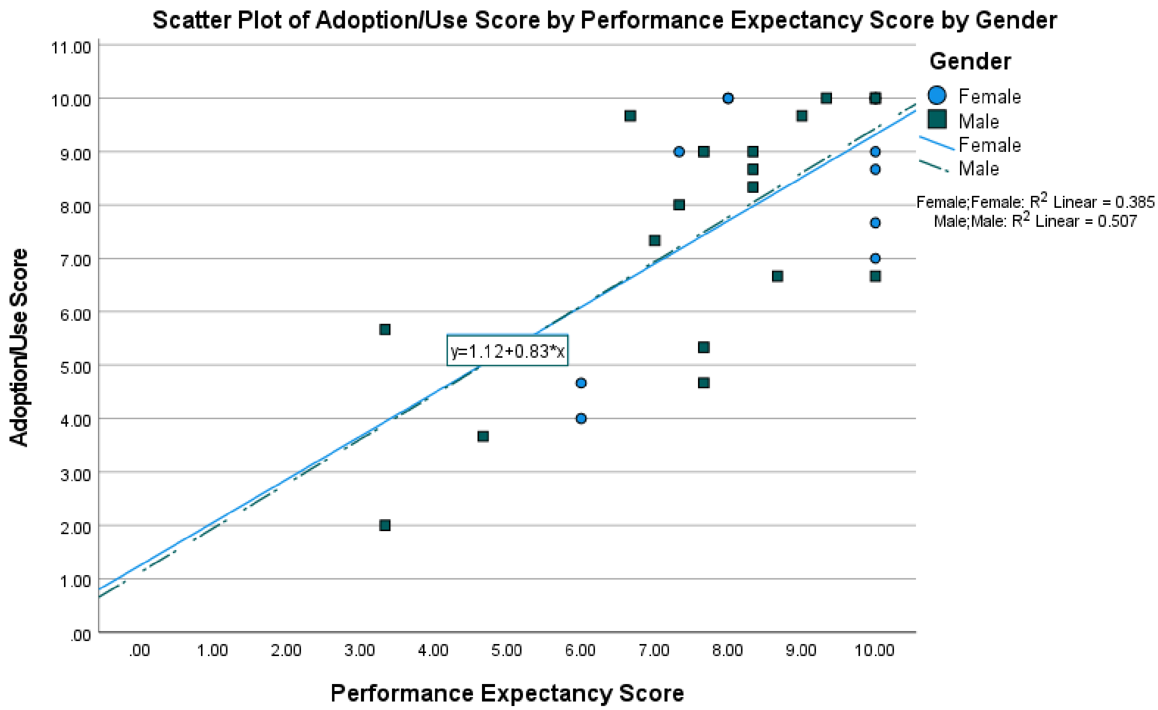

Scatter Plot of Adoption/Use Score by Facilitating Conditions Score by Age in two groups
Adoption/Use Score
Facilitating Conditions Score
Age in two groups
Up to 22 years of age
More than 22 years of age
Up to 22 years of age
More than 22 years of age
y=3.59+0.62*x
y=-1.79+1.1*x
Up to 22 years of age;Up to 22 years of age: R2 Linear = 0.502
More than 22 years of age;More than 22 years of age: R2 Linear = 0.335

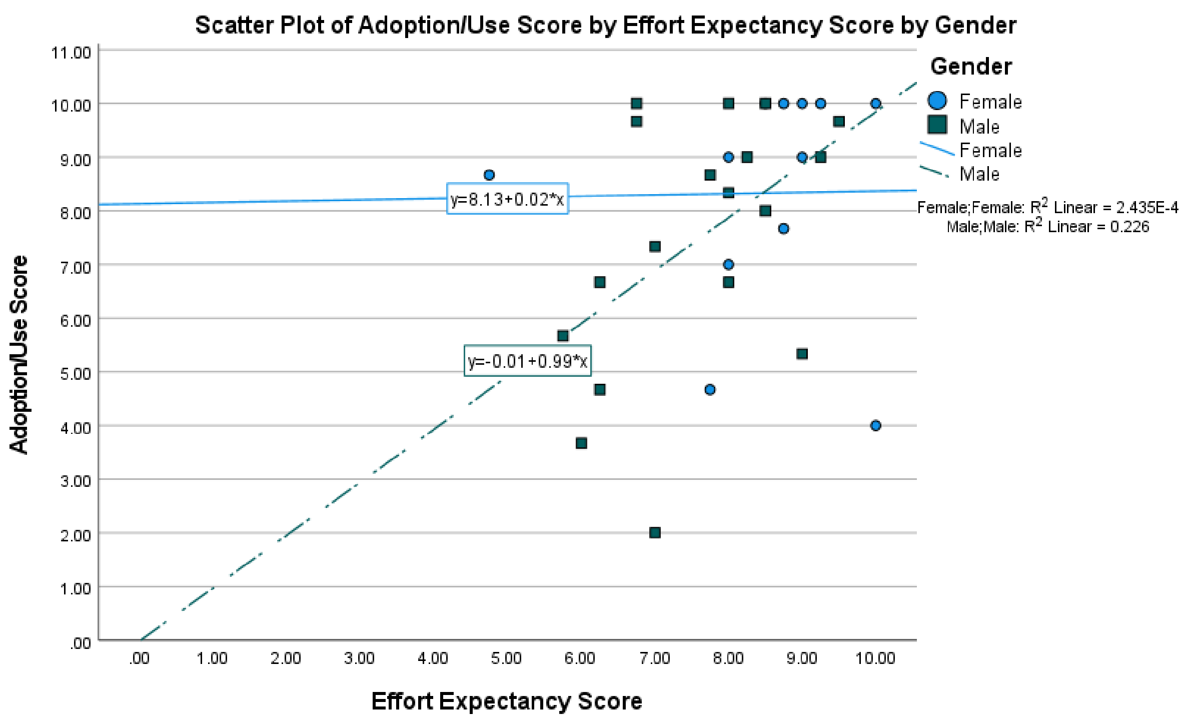

Scatter Plot of Adoption/Use Score by Hedonic Motivation Score by Age in two groups
Adoption/Use Score
Hedonic Motivation Score
Age in two groups
Up to 22 years of age
More than 22 years of age
Up to 22 years of age
More than 22 years of age
y=4.64+0.5*x
y=1.26+0.79*x
Up to 22 years of age;Up to 22 years of age: R2 Linear = 0.400
More than 22 years of age;More than 22 years of age: R2 Linear = 0.425

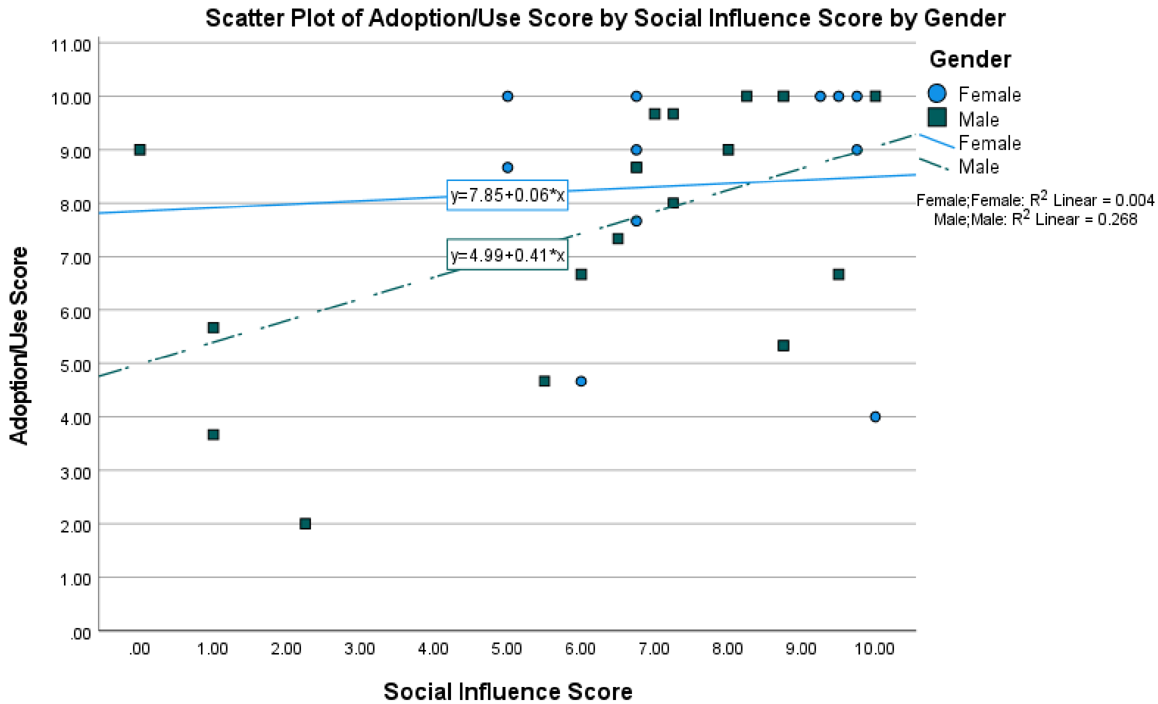

Scatter Plot of Adoption/Use Score by Price/Value Score by Age in two groups
Adoption/Use Score
Price/Value Score
Age in two groups
Up to 22 years of age
More than 22 years of age
Up to 22 years of age
More than 22 years of age
y=5.22+0.54*x
y=2.11+0.88*x
Up to 22 years of age;Up to 22 years of age: R2 Linear = 0.586
More than 22 years of age;More than 22 years of age: R2 Linear = 0.290

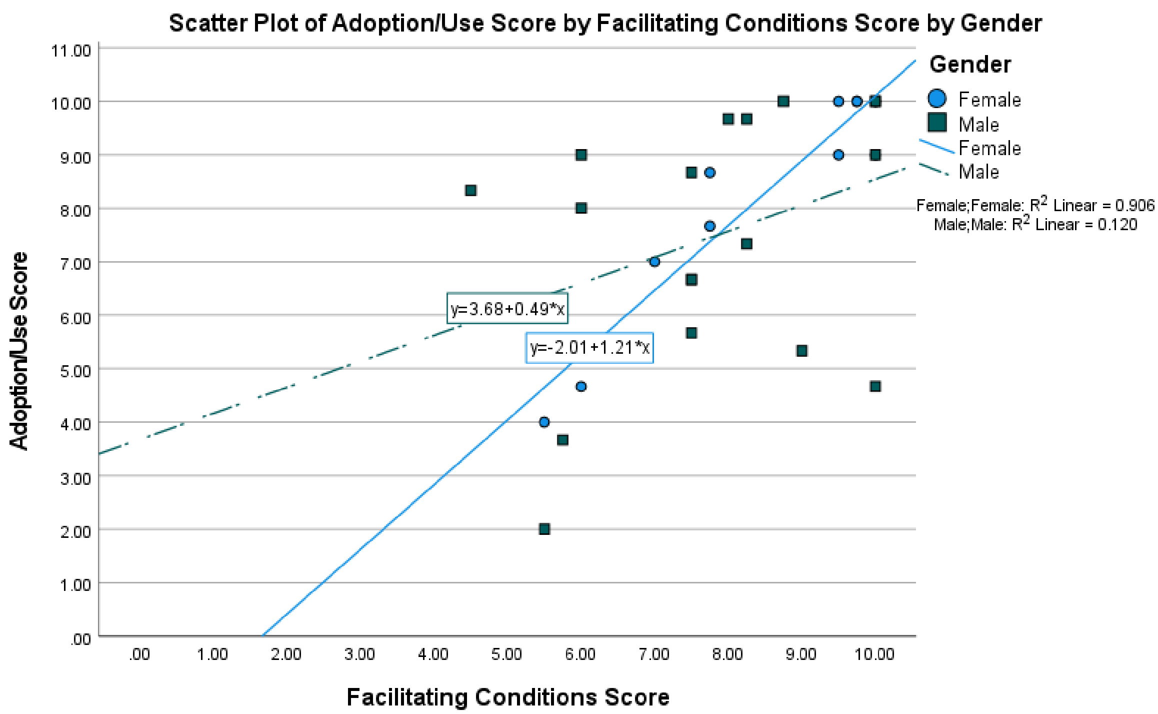

Scatter Plot of Adoption/Use Score by Habit Score by Age in two groups
Adoption/Use Score
Habit Score
Age in two groups
Up to 22 years of age
More than 22 years of age
Up to 22 years of age
More than 22 years of age
y=5.53+0.53*x
y=3.87+0.71*x
Up to 22 years of age;Up to 22 years of age: R2 Linear = 0.617
More than 22 years of age;More than 22 years of age: R2 Linear = 0.457

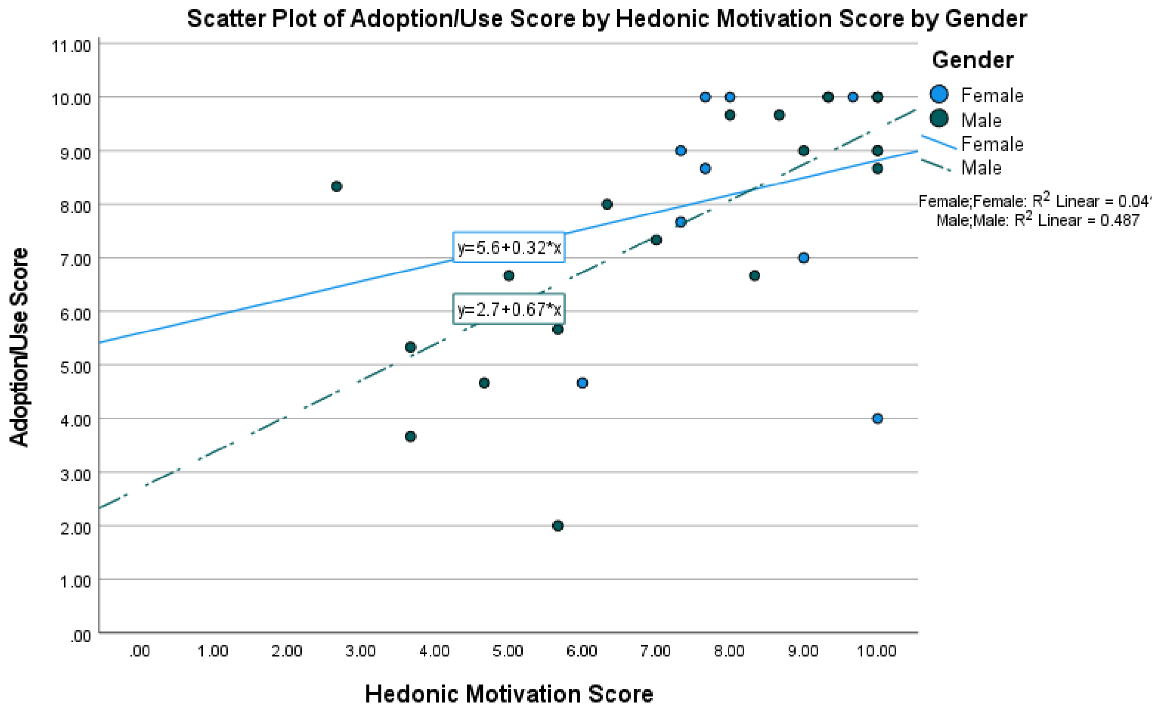

Scatter Plot of Adoption/Use Score by Performance Expectancy Score by Age in two groups
Adoption/Use Score
Performance Expectancy Score
Age in two groups
Up to 22 years of age
More than 22 years of age
Up to 22 years of age
More than 22 years of age
y=2.65+0.69*x
y=0.6+0.86*x
Up to 22 years of age: R2 Linear = 0.547
More than 22 years of age: R2 Linear = 0.356

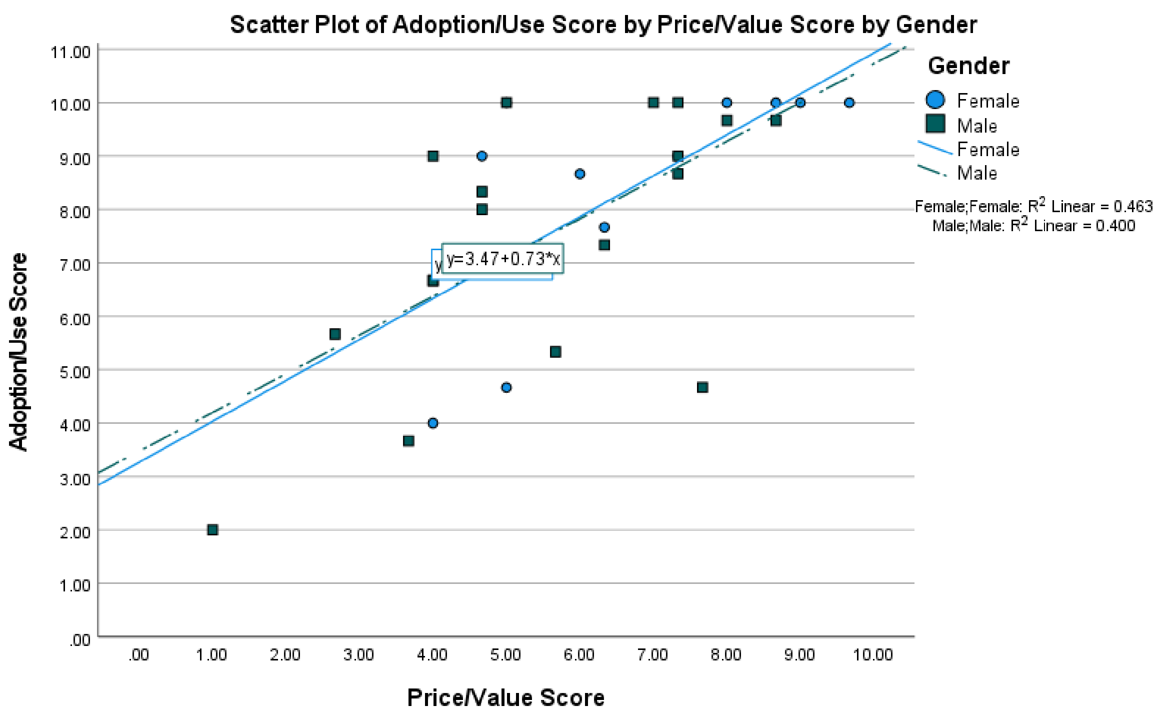

Scatter Plot of Adoption/Use Score by Performance Expectancy Score by Gender
Adoption/Use Score
Performance Expectancy Score
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 0.385
Male;Male: R2 Linear = 0.507
y=1.12+0.83*x
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00


Scatter Plot of Adoption/Use Score by Effort Expectancy Score by Gender
Adoption/Use Score
Effort Expectancy Score
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 2.435E-4
Male;Male: R2 Linear = 0.226
y=8.13+0.02*x
y=-0.01+0.99*x
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00


Scatter Plot of Adoption/Use Score by Social Influence Score by Gender
Adoption/Use Score
Social Influence Score
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 0.004
Male;Male: R2 Linear = 0.268
y=7.85+0.06*x
y=4.99+0.41*x


Scatter Plot of Adoption/Use Score by Facilitating Conditions Score by Gender
Adoption/Use Score
Facilitating Conditions Score
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 0.906
Male;Male: R2 Linear = 0.120
y=3.68+0.49*x
y=-2.01+1.21*x


Scatter Plot of Adoption/Use Score by Hedonic Motivation Score by Gender
Adoption/Use Score
Hedonic Motivation Score
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 0.041
Male;Male: R2 Linear = 0.487
y=5.6+0.32*x
y=2.7+0.67*x
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00


Scatter Plot of Adoption/Use Score by Price/Value Score by Gender
Adoption/Use Score
Price/Value Score
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 0.463
Male;Male: R2 Linear = 0.400
y=3.47+0.73*x
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

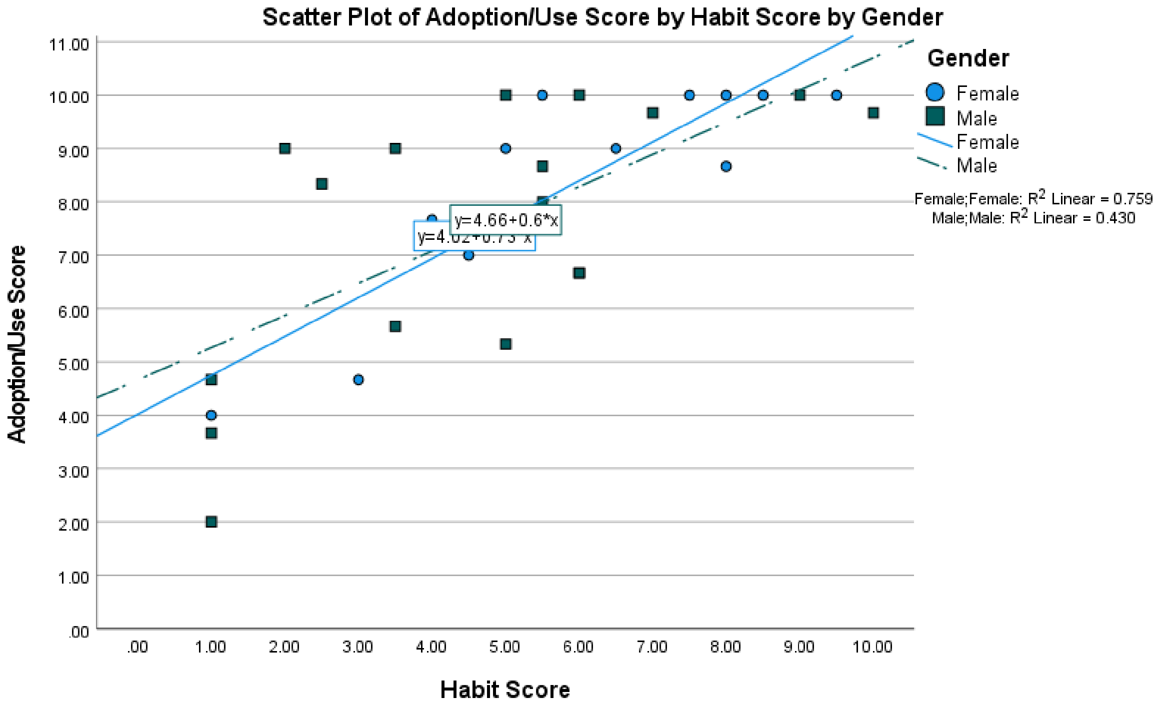

Scatter Plot of Adoption/Use Score by Habit Score by Gender
Adoption/Use Score
Habit Score
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
y=4.66+0.6*x
Gender
Female
Male
Female
Male
Female;Female: R2 Linear = 0.759
Male;Male: R2 Linear = 0.430

Table C9. Spearman's Rho Correlation Analysis

Variable	n	1	2	3	4	5	6	7	8
1. Performance Expectancy	30	_							
2. Effort Expectancy	30	.23	_						
3. Social Influence	30	.47**	.41*	_					
4. Facilitating Conditions	30	.45**	.25	.44*	_				
5. Hedonic Motivation	30	.48**	.43*	.54**	.34*	_			
6. Price / Value	30	.49**	.24	.46**	.65**	.41*	_		
7. Habit	30	.62**	.20	.44*	.44*	.42*	.62**	_	
8. Behavioral Intention	30	.57**	.40*	.41*	.66**	.61**	.64**	.72**	_

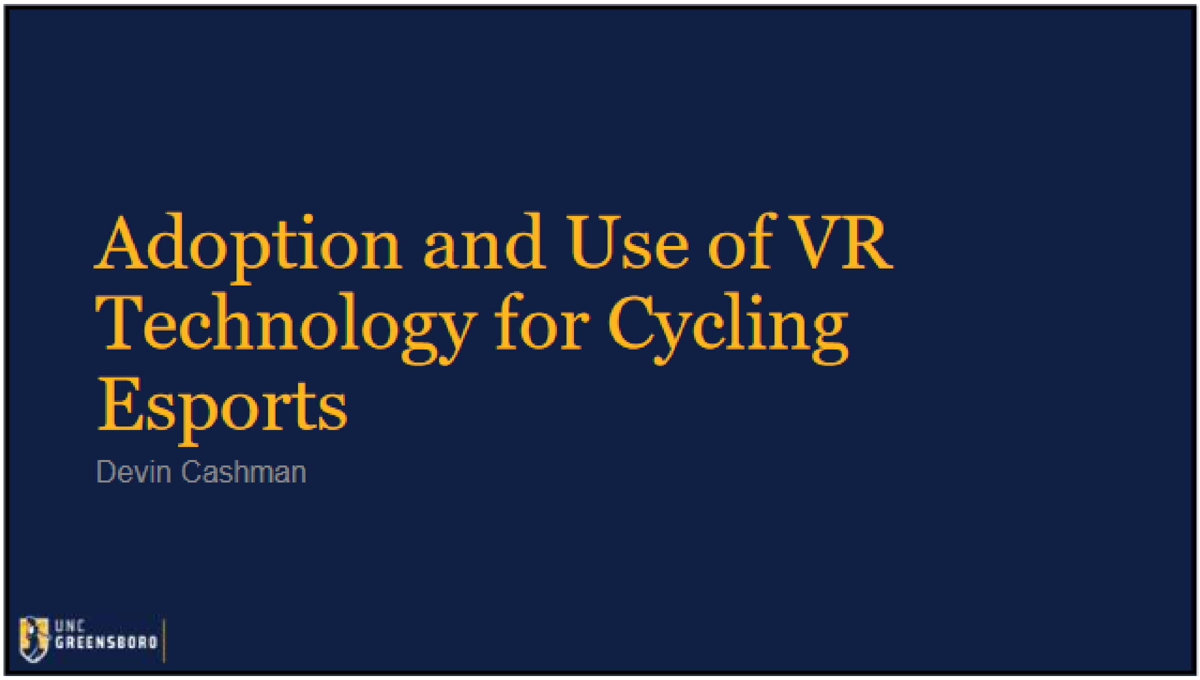
*p < .05 **p < .01

Table C10: Contextualization of UTAUT2 Framework

Theme	Subthemes	Definitions	Example
Performance Expectancy			
	Enhances Sport Performance	Improves their ability to perform in their sport. (i.e. ride longer, faster, on certain terrain).	"there's about fifteen of us who regularly use ZWIFT and for reference there's twenty of us attending nationals in April."
	Increased productivity	Improves the efficiency of workout. (i.e. to maintain power zones, duration, pedaling technique, HR Zones, focus).	"If I'm not riding with a virtual app, I'm riding in my basement staring at a concrete wall, it is tough to measure how many minutes I would be doing, I would like to say I can at least get an hour in if I'm on ZWIFT."
Effort Expectancy			
	Ease of Use	How easy is it to interact with VR technology (set-up, use equipment).	"Everything needed to be taken up and broken down every single time I used it. I think the hassle of setting it up and breaking it down."
	Ease of Learning	How easy is it to learn how to use the technology and incorporate it into training.	"I think there is a certain level of vertical integration that adds this tech barrier to people who are less technically, you know, technologically literate. "
Social Influence			
	Direct connections	Influence from peers, friends, family, teammates	"One of my close family friends. . . He was really like the first person I knew very well who was getting into the whole power trainer, ZWIFT

			investment. Everything that he said about it made it sound very, very cool. . .”
	Indirect connections	Influence from competitors, indirect connections (videos) social media	“Honestly, I got into it because I like watched one of the first GCN videos on the topic.”
Facilitating Conditions			
	Technical Support	Technological resources to learn how to use technology	“Maybe some more videos interface wise because it was hard initially to make sure I calibrate my trainer and then connect it.”
	Organizational Support	Support from university/colleges to use the technology	“I don't know if Zwift would sponsor a collegiate club or something like that or with trainers that they could either check out to team members or get a deep discount. I think that would help.”
	Resources	Physical space, equipment	“I think something that probably impacted my willingness to use it was I don't have a smart trainer, so I was just using a regular old trainer or regular center rollers with a power meter.”
Hedonic Motivation			
	VR Features	Technological features that make using VR enjoyable (social aspect, virtual worlds, gamification).	“I think the interactivity of it's pretty great. Like just being able to go out and you know like there's races and like to chase and stuff. . . there's the motivational kind of gamification features.”
Price/Value			

	Perceived Cost / Value	Perception of value relative to the cost of VR technology	“So, in terms of the price that you're paying every month for the subscription, not only are you getting to cycle and you're more willing to do it you are also getting a little bit of coaching. You are getting a lot of feedback.”
	Relative Cost	Return on Investment (ROI)	“I've found if I use it consistently, you know two to three times a week, I feel like I really get my money's worth. But if I if I was not consistent and pushing that, I would say it would be a little pricey.”
Habit			
	Situational	Likely to use due to circumstances	“Yeah, definitely. I would say that in the summer, no, in the winter, yes. So. I will always prefer outdoor riding to like indoor riding.”
	Routine	Incorporates it into cycling experience	“Yeah, so I use ZWIFT once a week because two other times we have team sessions. So at least once week I will be on my trainer for at least an hour.”


Adoption and Use of VR Technology for Cycling Esports
Devin Cashman
UNC GREENSBORO


Cycling Esports
• Offers a virtual cycling sport experience
• Considered a new cycling discipline
• USA Cycling, UCI, IOC
• Skills and fitness for cycling translate directly to virtual form of the sport
• Reduces barriers to cycling
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Barriers to Traditional Cycling

- Cost
  - Bikes, equipment, maintenance
- Travel
- Lack of skill / experience
  - Shifting
  - Riding with others
    - Group riding
  - Traffic
- Risk
  - Falling, collisions, accidents
- Lack of peer involvement
- Accessible infrastructure
- Weather
- Time constraints

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Cycling Esports Reduce Barriers

- Potentially lower cost
  - One smart-bike can be shared with several riders
    - Compared to single bike per rider
    - No maintenance
- No travel
  - Can ride any time of the day
- Safe
  - No traffic, bad weather, crashes
- Opportunity to learn about the sport
- Variety of events
  - Races, group rides, workouts
- Accessible, / inclusive
  - Experience, ability
  - Allow students of different backgrounds to participate
  - Social experience

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Virtual Reality (VR) Technology

- Technology that allows individuals to mentally and physically in a virtual world
- Display (immersion)
  - Computer or headset
  - Virtual environment
  - Responds to rider input
    - Speed, effort, route
- Connected Device (interactivity)
  - Smart bike or smart trainer
  - Provides sensory feedback
    - Terrain
    - Rider effort

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Commercial VR application for cycling Esports

- ZWIFT
  - Most popular
  - Ride in an imagined world
- MyWhoosh
  - Emphasis structured workouts and training plans
- Rouvy
  - Simulates real world routes using real-life video
  - Racing
- All applications allow for a variety of ways to participate such as races, workouts, group rides or solo riding

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College Students and Esports

- Recreational Sport Programs
  - Ideal time to introduce students to new sports
    - Students discontinue participation in sport from HS to College
  - Opportunity to increase physical activity on campus
  - Cycling (spinning) is the 2nd most popular form of fitness programming
- Esports
  - Popular on campus
    - 160+ schools belong to National Association of Collegiate Esports (NACE)
    - Estimated there are 600 universities with Esports clubs
  - One of the fastest growing sports industries
  - $1.79 billion dollars in 2022

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Support for Cycling Esports

- USA Cycling Collegiate Program
  - Promotes sport of cycling both racing and riding
  - Recently added Esports as a discipline
  - 2024 Esports National Championship Event
- Esports can draw students to in person cycling

USA CYCLING

UNC GREENSBORO

My Research

- Understand factors that influence the adoption and use of VR technology for cycling by college students
  - Identify a framework that relates to VR cycling
  - Identify which factors within the framework influenced students to use this type of technology
- Develop effective strategies to promote the use of this technology for cycling Esports on campus
  - Create a club program on my campus

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Unified Theory of Technology Adoption and Use (UTAUT2)

- Used to evaluate use of fitness and sports applications
- Limited use in the context of VR for cycling
- Broad set of constructs that might help explain use behavior in college students
- Survey and Interviews

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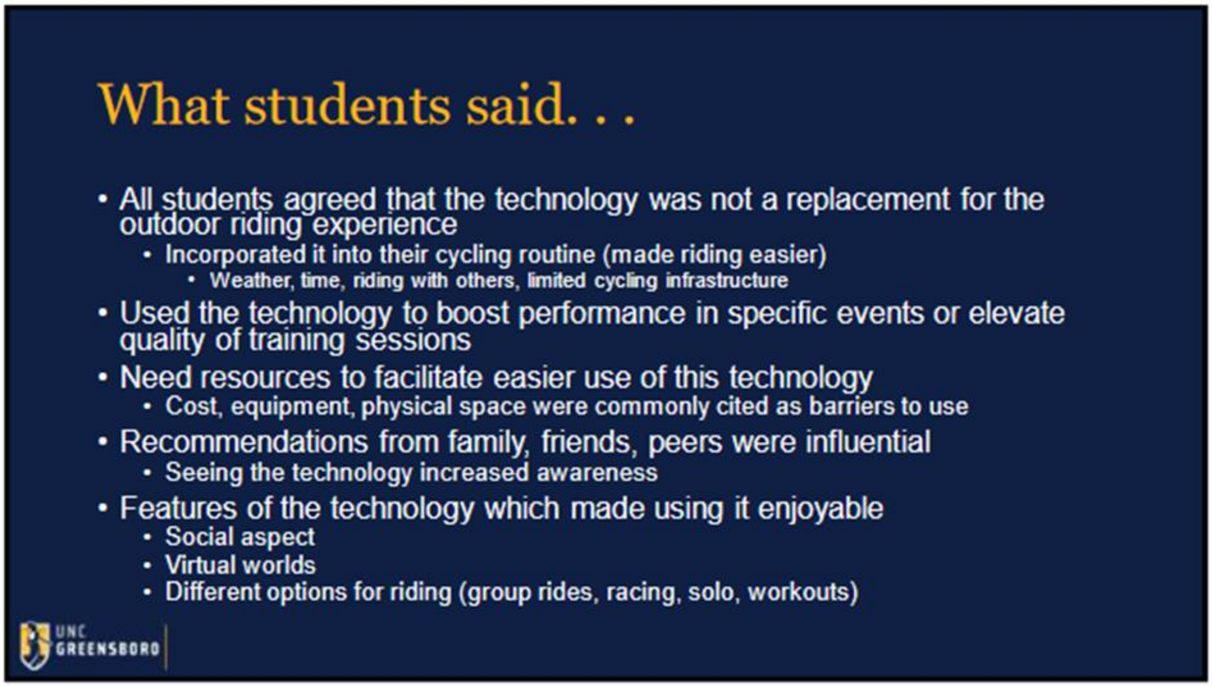
What students said. . .
• All students agreed that the technology was not a replacement for the outdoor riding experience
• Incorporated it into their cycling routine (made riding easier)
• Weather, time, riding with others, limited cycling infrastructure
• Used the technology to boost performance in specific events or elevate quality of training sessions
• Need resources to facilitate easier use of this technology
• Cost, equipment, physical space were commonly cited as barriers to use
• Recommendations from family, friends, peers were influential
• Seeing the technology increased awareness
• Features of the technology which made using it enjoyable
• Social aspect
• Virtual worlds
• Different options for riding (group rides, racing, solo, workouts)
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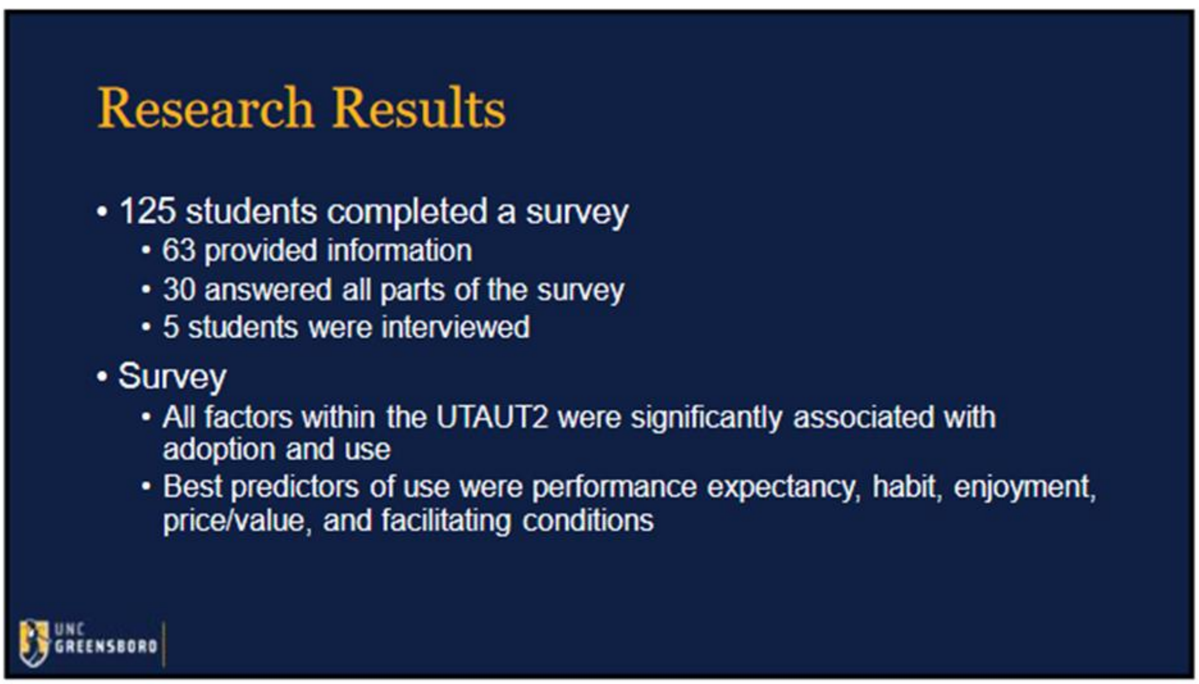
Research Results
• 125 students completed a survey
• 63 provided information
• 30 answered all parts of the survey
• 5 students were interviewed
• Survey
• All factors within the UTAUT2 were significantly associated with adoption and use
• Best predictors of use were performance expectancy, habit, enjoyment, price/value, and facilitating conditions
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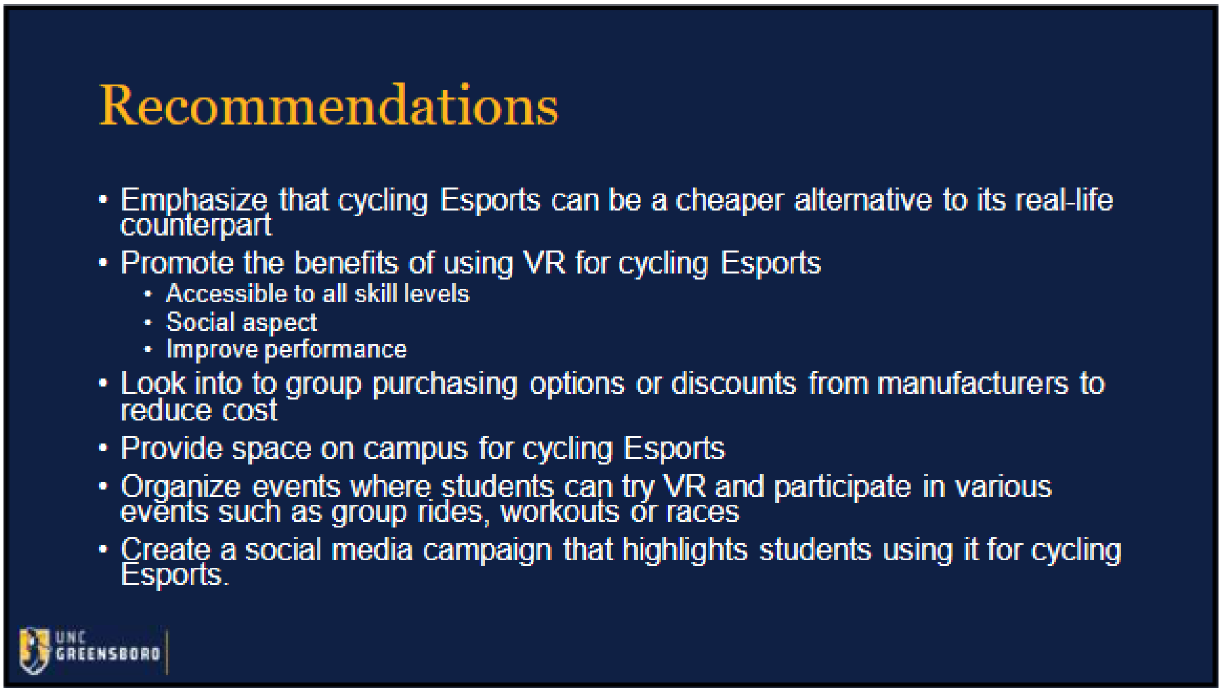
Recommendations
• Emphasize that cycling Esports can be a cheaper alternative to its real-life counterpart
• Promote the benefits of using VR for cycling Esports
• Accessible to all skill levels
• Social aspect
• Improve performance
• Look into to group purchasing options or discounts from manufacturers to reduce cost
• Provide space on campus for cycling Esports
• Organize events where students can try VR and participate in various events such as group rides, workouts or races
• Create a social media campaign that highlights students using it for cycling Esports.
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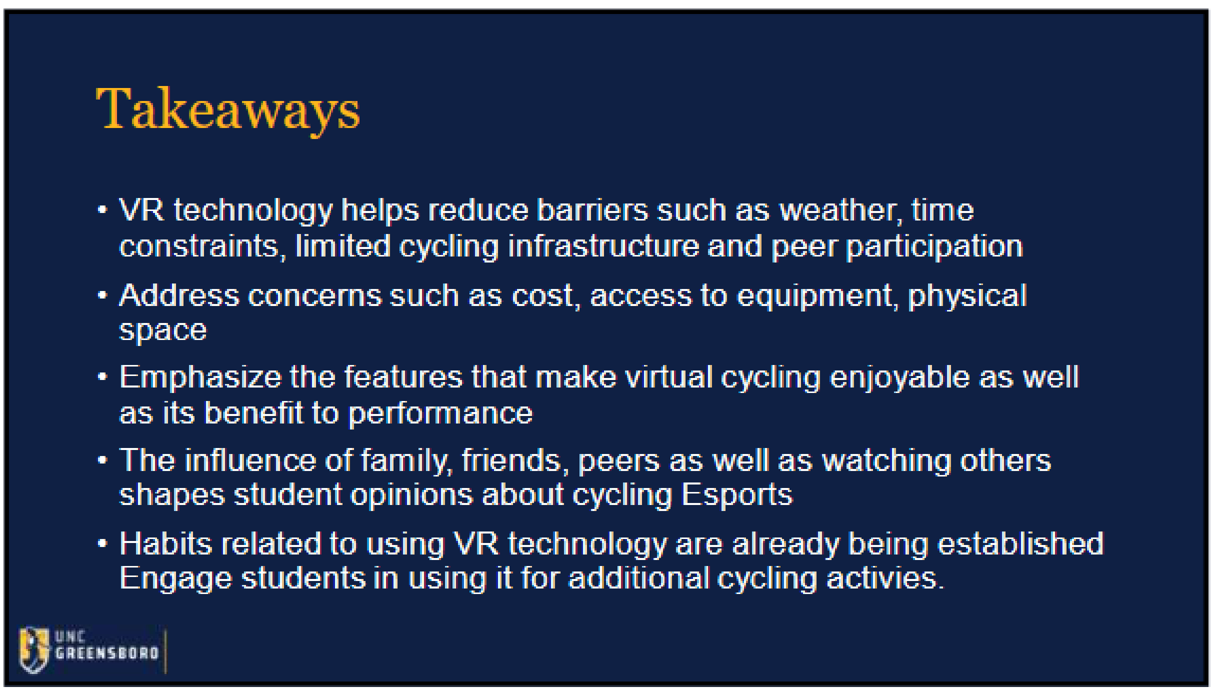
Takeaways
• VR technology helps reduce barriers such as weather, time constraints, limited cycling infrastructure and peer participation
• Address concerns such as cost, access to equipment, physical space
• Emphasize the features that make virtual cycling enjoyable as well as its benefit to performance
• The influence of family, friends, peers as well as watching others shapes student opinions about cycling Esports
• Habits related to using VR technology are already being established Engage students in using it for additional cycling activies.
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