INFO6007: Project Management In IT

2021 Semester 2

Team Project

Project Title	Developing and Implementing a Basketball Training Assistant and Referee System Using AI
Team Name	Group 21
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1. Project Charter

1.1 Background of the project

In the unpredictable 21st century, with the awakening of information technology, technologies we have never dared to imagine have emerged to our horizon, and technologies such as 3D printing, big data and artificial intelligence have occupied the mainstream. However, when we talk about it, the first hot word is AI technology.

After the "Alfa GO" overcame the human race, the technical concept of artificial intelligence became well known worldwide, and more and more related applications are being applied. Typical applications such as Google Home, Google Duo, Amazon Alexa, Siri and Du MI are increasingly accepted. Behind these applications, a key technology, "natural language processing", will be used based on voice or text. Through this technology, machines can understand humans, talk to humans, and learn the words in the world to become more innovative.

AI technology goes deep into the field of sports. The emergence of alpha go, intelligent fitness coach, and VaR is accelerating the reform of various subdivided industries in sports. According to AI research, Andrea Di Stefano. AI-based tools are already being deployed in virtually all significant sports disciplines, such as American football, soccer, baseball, and cricket, and non-professional leisure activities like grassroots sports.

We can count sensors, wearables, and computer vision-powered cameras to collect athletes' performance data among these tools. At the same time, natural language processing devices can leverage speech and text recognition to gather insights regarding the audience's sentiment.

All this information will be processed by machine learning (ML) and deep learning (DL) systems to create forecast models and assist coaches and managers in decision-making or automate numerous processes related to broadcasting and fan experience.

At present, AI sports has penetrated our life, providing a better visual experience for the audience, better training suggestions for athletes, recording moments on the sports field or providing fair referees for the competition.

We have to admit that the benefits of the AI + sports model are far from immediate. With the further development of AI technology, unexpected functions will spring up. Based on this, our research topic is: implementing an intelligent basketball training system using AI, providing a series of auxiliary functions for athletes in the basketball field through AI.

1.2 Project Function

1.2.1 Data analysis Function

Regularly measure physical indicators, whether their physical indicators are healthy and meet the specific parameters of basketball players, for example, muscle proportion, body fat rate, blood oxygen index, etc., these indicators will inherently affect the performance of athletes. If a coefficient deviates from its standard range, the system will deliver the evaluation data to team members, coaches, nutritionists, physical rehabilitation engineers and managers in real-time.

In addition to the physical indicators of athletes, their training data and actual combat data are critical.

The training data include personal bouncing, the time of 50m turn back run, the hit rate of training free throw, the hit rate of three-point ball, the success rate of rebounding, the success rate of serving and grabbing the ball, etc. Actual combat data include field-free throw hit rate, three-point hit rate, steals, assists, etc. Average score, rebounds and assists are the criteria for the NBA to evaluate MVP players. Therefore, data statistics and analysis is the essential link in the system.

Through the complete analysis of the data, managers or coaches can specify a scientific and reasonable diet plan and training plan for athletes. Moreover, help them when they are down. For example, if the athlete's body fat rate is too high, his diet will be adjusted. Alternatively, provide them with a reasonable training plan.

In addition, players can be compared internally and externally to analyze the advantages and disadvantages of each player and the gap between them and better players, which is also one of the essential factors to promote their growth.

1.2.2 Referee function

For the controversial point of view in the basketball training game, whether the player has committed a foul or not, we can reconstruct the 3D scene, collect the pictures captured by the camera, reconstruct the 3D model, and then analyze whether the player has committed a foul or not.

In addition, according to the players' gestures and actions, we can predict whether their following possible action is foul.

In basketball, which is challenging and fast, the referee's judgment is easy to be controversial. The introduction of AI technology to assist the judgment can provide a reference for the

referee and reduce the referee's burden and significantly reduce the unclear judgment of "the hand of God" in the 1986 World Cup.

For example, the camera can use computer vision technology to provide video recording and playback functions and combine with AI to record the real-time data of the game and analyze the action. Using AI technology to detect the player's posture and technical action, track the player's action by projecting infrared rays and convert it into three-dimensional images in real-time. According to the image data analysis to judge whether a foul is significantly committed improves the referee's efficiency and accuracy.

1.3 Summary of Project Deliverables

1.3.1 Project management-related deliverables:

1. Project Charter
2. Project Scope
3. Literature Review
4. Work Breakdown Structure (WBS)
5. Detailed Project Schedule
6. Cost Modeling
7. Communication Management
8. Quality Management
9. Risk Management
10. Final project report and presentation

1.3.2 Product-related deliverables:

1. Product prototype: This is a diagram showing the design of UI and interface and the page jumping logic.
2. Software Flow Chart: A diagram describes the main logic of the software.
3. Operation Flow Chart: Diagrams describe each step of operation to fully implement the functions, including the abnormal state handling operations.
4. Computer Vision Technology Survey: Current computer vision technology for posture monitoring will be researched and documented. This information will include hardware and software.
5. Software Diagrams: The software structure will be diagrammed.
6. System Backup Recommendation: A method to backup system data.
7. Operating System Recommendation: The choices of operating systems that could potentially be implemented will be investigated and upgrade options will be provided
8. Test Plan: A method to test the system once it has been upgraded to verify its functionality.

1.4 Total project cost and time

1.4.1 project time

The project started on 2021/7/1 and will be completed on 2021/12/13; the total time of the entire project is 168 days.

1.4.2 project cost

The entire cost of the project which includes human resources, hardware, software, market research, maintenance, reserves fees is 777,639.2 dollars.

1.5 Roles and responsibilities of stakeholders

1.5.1 CEO

Zhenghao Zhou As our leader, he has responsibilities like planning, scheduling, coordinating, and working with people to achieve project goals. He is in charge of all decisions of the project and setting direction for the project. Also, he needs to communicate with all departments' directors to follow the speed of the project to ensure project landing. The most essential is that he has to define the scope clearly and correctly.

1.5.2 CIO

Ruochen Pi The CIO supports the company's goals by guiding the use of information technology, has knowledge of technology and business processes, and closely combines the organization's technology deployment strategy with business strategy. She has to communicate with the IT group and CEO together, work on making decisions and organize the entire group in the project.

1.5.3 Director of Human resource

Juntao Zheng, who is in charge of manpower management of the whole project. The specific works are organizing market research groups to do the research; Timely coordinating contradictions between employees; Improving employee motivation; Being in charge of employee performance and salary.

1.5.4 CFO

Yaolin Qian is responsible for the time and economic resource allocation of the whole project process, and formulating feasible planning schemes. After the commencement of the whole project, the economic and time use of each stage shall be summarized in real-time to form a report, and the scheme shall be adjusted in time according to the remaining available resources.

1.5.5 Director of IT team

Yu Zhang as IT manager is responsible for the work of developing the system. For instance, select hardware devices and software; test system function, programming, etc. With the progress of the project, reporting the completion of the system, and timely communicating and negotiating with other departments in case of time, capital and other problems.

1.5.6 Director of Risk control and compliance department

Yuxuan Ren, whose job is to identify potential risks and prepare corresponding solutions. Before starting the project, he has to communicate with the CEO, CIO, CFO, and all departments' directors together to work on a risk control plan. In the project, we determine to use a risk register sheet. During the stages of the project, when risk encounters, his job is also to cooperate with leaders and group members to solve risks.

2. Scope And Milestones

2.1 Project Scope

Table 2.1Scope Statement

Project Title: Developing and Implementing a Basketball Training Assistant and Referee System Using AI **Date:** 2021.6.28 **Prepared by:** ZhengHao Zhou, Project Team Member, zzho3315@uni.sydney.edu.au
Project Justification: ZhengHao Zhou, project manager, proposed this project on behalf of his employer, to develop an AI-based system to help basketball players comprehensively promote their basketball skills level. This system will provide AI-assisted training and AI basketball referee functions, which can help basketball players carry out basketball basic skills, physical fitness and basketball confrontation training in a more scientific way. For the coaching staff of each team, it can help them get more information about their players. **Product Characteristics and Requirements:** 1. Technology Studies: Research will be done on current technologies for computer vision, data analysis and machine learning. 2. Compatibility Matrix: Research will be done to see what operating system is used most by the coaching teams and whether it is compatible with this system. 3. Diagrams: Diagrams will illustrate the system layout for visualizing and troubleshooting. 4. System Tests: System tests will allow verification of the integrity of functions and data and the stability and robustness of the software. 5. User-friendly: The user interface will be designed friendly to customers to let them gain a better experience. 6. System security: Proper permission management to ensure that the data of the basketball players and the basketball won't be compromised. 7. Main functions of the system: This system aims to help basketball players correct wrong movements and develop a training plan using computer vision and deep learning. And this system can play the role of referee in practice games in a basketball team based on 3D reconstruction and trajectory prediction.

Summary of Project Deliverables

Project management-related deliverables:

1. Project Charter

2. Project Scope

3. Literature Review

4. Work Breakdown Structure (WBS)

5. Detailed Project Schedule

6. Cost Modeling

7. Communication Management

8. Quality Management

9. Risk Management

Product-related deliverables:

1. Product prototype: This is a diagram showing the design of UI and interface and the page jumping logic.

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5. Software Diagrams: The software structure will be diagrammed.

6. System Backup Recommendation: A method to backup system data.

7. Operating System Recommendation: The choices of operating systems that could potentially be implemented will be investigated and upgrade options will be provided

8. Test Plan: A method to test the system once it has been upgraded to verify its functionality.

In Scope

1. Performing solution design

2. Purchase related equipment

3. Carry out scheme design

4. Project requirements analysis

5. Project outline design

6. Detailed design of the project

7. Coding Implementation

8. Testing and commissioning

9. Installation of AI-assisted training systems on training equipment.

10. Installation of AI judges into the training grounds.

11. Conduct overall functional and performance testing.

12. Team coaching staff training.

13. Organize and file documents.

14. Project handover.

Out of Scope

1. This project only includes the development of AI-assisted training and AI referee system and the purchase of customized equipment, not including the layout of the training venue.

2. This project only includes testing the athletes' training status and analyzing it to develop a follow-up training plan, but not monitoring the implementation of the training plan.

3. This project is the construction work of AI-assisted training and AI referee system, excluding the maintenance work of the system applied to the production equipment in daily training and team training games.

4. It is not the responsibility of this project for new requirements and features requested by the customer in the future.

Project Success Criteria: Our project's goal is to develop and implement a system that can help the players train in a more efficient way and help judge the practice games in a basketball team. The project is expected to be finished in six months for 780,000 dollars. To make the project successful, a one week buffer is added at the end, so if this project is finished in six months and a week, and it meets the functions and requirements, this project will view success.

2.2 Milestones

Table 2.2 The milestones table

Milestones	Time Points
Begin	1st July
Complete Market Research	15th July
Complete Project Management Plan	31st July
Complete Requirement Analysis	6th August
Complete Team Foundation	20th August
Complete System Design	10th September
Complete System Development	10th November
Complete System Testing	12th December
Deliver System	23rd December

3. Literature Review/Market Research

As of now, there is a lot of excellent literature in the world that provides ideas for AI-assisted basketball training. Bin Li from Georgetown University Medical Center and Xinyang Xu from Washington Institute for Health Sciences introduced some applications of AI in basketball sport, including the performance analysis for players and the whole basketball team, the game result prediction, the analysis of the shooting posture of players, the coaching assistance system based on AI and the injury prevention. (Li, B. and Xu, X. 2021). In this literature, they widely introduced the main application using AI for basketball and provided some advanced ideas for this system. Junliang Xing, Haizhou Ai, Liwei Liu from Department of Computer Science and Technology, Tsinghua University and Shihong Lao from Core

Technology Center, Omron Corporation, Kyoto, Japan proposed a two-mode bidirectional Bayesian inference method with asymptotic observation modelling for multiplayer tracking in sports videos (J. Xing, H. Ai, L. Liu and S. Lao. 2010). Guang-Qi Lu proposed a model based on RBF neural network to evaluate the physical quality and basic skills of youth basketball players. (GuangQi Lu. 2016). In his research, he worked on building up a scientific and systemic analyzing model for young basketball players. He used fuzzy hierarchical analysis to determine the weights of each physical quality and basic technical index to make a comprehensive evaluation of youth basketball players. An RBF neural network model was established for these indicators, which provided a new idea for the comprehensive evaluation of youth basketball players. Andrea Schmidt from German Sport University Cologne, Institute of Cognitive and Team/Racket Sport Research published a paper on motion pattern recognition in basketball free throws. (Schmidt A. 2012) In his paper, he analyzed the movement patterns of free-throw shooters with different skill levels and used an artificial neural network called 'Dynamic Control Network (DyCoN)' to calculate a complex feature consisting of isolated features, and in further analysis, he classified the throwing patterns with the detection of individual features and movement phases. Rajiv Shah and Rob Romijbders from the University of Illinois at Chicago applied deep learning to Basketball Trajectories. In their research, recursive neural networks are applied in the form of sequence modelling to predict whether a three-point shot will be successful or not. Using a dataset of over 20,000 three-pointers from NBA SportVu data, the model based on continuous positional data only outperformed the static feature-rich machine learning model in predicting whether the three-point shot was successful. Zhuo Yang from 1College of physical education, Shaanxi Xueqian Normal University published research on basketball players' training strategy based on AI. (Yang, Zhuo. 2020) She developed a system that could measure the athletic skills of basketball players, collect athletes, sports data and establish a data management platform to fully explore sports rules and strengthen their daily training using Baum-Welch algorithm. Susanne Jauhiainen, Jukka-Pekka Kauppi, Mari Leppänen, Kati Pasanen, Jari Parkkari, Tommi Vasankari, Pekka Kannus, Sami Äyrämö proposed a new machine learning method for detecting injury risk factors in young team sports athletes. (Jauhiainen, S., Kauppi, J., Leppänen, M., Pasanen, K., Parkkari, J., Vasankari, T., Kannus, P., & Äyrämö, S. 2020). They presented how a predictive machine learning approach can be used to detect sports injury risk factors in a data-driven manner. The approach can be used to find new hypotheses for risk factors and to confirm the predictive power of previously identified hypotheses.

And for the AI referee, there is not much literature about it, so we propose an idea that we can reconstruct the scene of the practice games within the basketball team using multiple depth sensors, and then track the players on the court, predict the trajectory of the movement of the body parts, and then judge whether they have a foul play. For the 3D reconstruction, Mingyou Chen, Yunchao Tang, Xiangjun Zou, Kuangyu Huang, Lijuan Li, Yuxin He from key Laboratory of Key Technology on Agricultural Machine and Equipment, College of Engineering, South China Agricultural University proposed a high-precision multi-camera reconstruction which is enhanced by adaptive point cloud correction algorithm. (Mingyou Chen, Yunchao Tang, Xiangjun Zou, Kuangyu Huang, Lijuan Li, Yuxin He. 2019). They constructed a four-camera system to get the visual information of the scene. They used local

calibration and global calibration to achieve multi-camera association, then filtered and stitched the point cloud to obtain the global point cloud. Marco Lombardi, Mattia Savardi, and AlbertoSignoroni from the Information Engineering Department, University of Brescia, Italy raised an idea of Cross-domain assessment of deep learning-based alignment solutions for real-time 3D reconstruction. (Marco Lombardi, Mattia Savardi, Alberto Signoroni. 2021) They used a depth camera to scan the test scene in real-time and used deep learning for real-time 3D reconstruction of the scene. Alexandre Alahi, Kratarth Goel, Vignesh Ramanathan, Alexandre Robicquet, Li Fei-Fei, Silvio Savarese from Stanford University proposed human trajectory prediction in crowded spaces (Alexandre Alahi, Kratarth Goel, Vignesh Ramanathan, Alexandre Robicquet, Li Fei-Fei, Silvio Savarese. 2016). In their work, they proposed a data-driven approach to learn person-to-person interactions to predict future trajectories. They shared information among multiple LSTMs through a new pooling layer. These layer pools hid representations from LSTMs corresponding to neighbouring trajectories to capture interactions within that neighbourhood. We demonstrate the performance of our approach on several public datasets. As a result, their model outperforms previous prediction methods by more than 42%. Jianqi Zhong, Hao Sun, Zhihai He and Wenming Cao from Shenzhen University worked on Stereo-based 3D deep pose estimation and trajectory learning for pedestrian motion trajectory prediction (J. Zhong, H. Sun, W. Cao and Z. He. 2020). They observed that learning and predicting pedestrian trajectories in 3D places is much more efficient. So they used a stereo camera system to detect and track human pose through deep neural networks, and extensive experimental results showed that their method could significantly improve the pedestrian trajectory prediction performance. J. Wiest, M. Höffken, U. Kreßel and K. Dietmayer from Institute of Measurement Control and Microtechnology Ulm University proposed probabilistic trajectory prediction with Gaussian mixture models (J. Wiest, M. Höffken, U. Kreßel and K. Dietmayer. 2012). In their contribution, a new trajectory prediction method is proposed that is able to predict the trajectory of a vehicle several seconds in advance, the so-called long-term prediction. Using this distribution, trajectories can be predicted by calculating the probability of future motion, conditional on the currently observed historical motion patterns. The advantage of probabilistic modelling is that the results are not only predictions, but the overall distribution of future trajectories, and those specific predictions can be made by the evaluation of statistical properties, such as the mean value of that conditional distribution.

In the AI-assisted basketball training part, in addition to the existing technology mentioned above, our group would like to introduce a new technology called basketball trajectory prediction and correction. This technology would use a high-speed camera to capture the ball's trajectory and predict its trajectory in a very short time to come. Combined with the analysis of the shooting posture of players, the system could give advice to the players who use it in their shooting habits, like the arc of the shot. This technology requires several powerful high-speed cameras to capture the basketball in different directions, algorithms help to rebuild a 3-dimensional environment and analyze the shot gesture.

In the AI-assisted basketball training part, we also introduce the technology to predict the injury of the players. Collecting the players' body data, combined with the training

arrangement, could give advice to the user's team and coaches. To achieve this target, precise medical instruments are necessary and needed. The joint site(e.g. knee, ankle) is the most vulnerable part to the athletes. Precise medicine could detect wear and tear at the joints, feedback the result to the players and coaches, which could help avoid unnecessary hurts and predict injuries in the games.

In the AI referee part, while finding relevant references on AI referee, this technology is still immature and there is a shortage of existing literature support. So, the team devoted themselves to developing a system that combines methods of 3D reconstruction, motion trajectory prediction and deep learning. And the target of this group project devotes to developing a precise, swift system to call a basketball game. The existing literature points out that collaborative 3D reconstruction with multi-angle cameras can capture details ignored or obscured by a single camera, thus achieving a complete 3d reconstruction of the stadium scene. However, in a basketball game, 4 cameras are still not enough to capture all the details. So, the system will need at least 8 high-speed cameras, placing them at four corners and four lines in different heights, in order to capture all the details in the games. 8 cameras ensure that information about the court is captured horizontally. The different heights of the cameras ensure the information about the court is captured vertically. Besides setting 8 cameras, the system innovatively introduced radar detection technology into it. The system selects Velarray M1600 solid-state lidar. This radar can capture 3D images in real-time at 32X1024 depth points. Radar could help the system detect the exact position of the athletes on the court. After collecting image information from the cameras and digital information from the radar, the system needs to real-time restore the scene on the court. In the existing literature, it points out that multi-camera collaborative 3D reconstruction cannot achieve real-time 3D reconstruction. The system was devoted to developing new software that could rebuild the real-time environment on the court through combining the several cameras and radar above. Another technical gap is how to deal with the complex model collisions on the court. Existing literature gives an algorithm that predicts people how to avoid collisions on crowded streets. The logic of this algorithm is totally different from the moving logic in the basketball rules--in the basketball game, players would like to actively seek collisions. The system needs algorithms to judge if the players' model collisions are legal or not. The algorithm must have the ability to judge where the collisions happen and which part of athletes touched. In addition to building models of athletes, the algorithms need to identify human limbs and predict their movement individually. After doing that, the system could judge the athletes' fouls, like hand-checking, foul attack, foul defence. The system puts forward new algorithms that could predict the trajectory of athletes. After doing all things, the complex basketball rules are imported into the system. The system needs to judge the collision on the court under the rules standard.

4. Work Breakdown Structure (3 levels)

The following figure shows the work breakdown structure for the project "Developing and Implementing a Basketball Training Assistant and Referee System Using AI", which includes research analysis, project management, requirement analysis, team-foundation, system development, system testing, system delivery, and system maintenance.
The WBS is decomposed according to the implementation process.

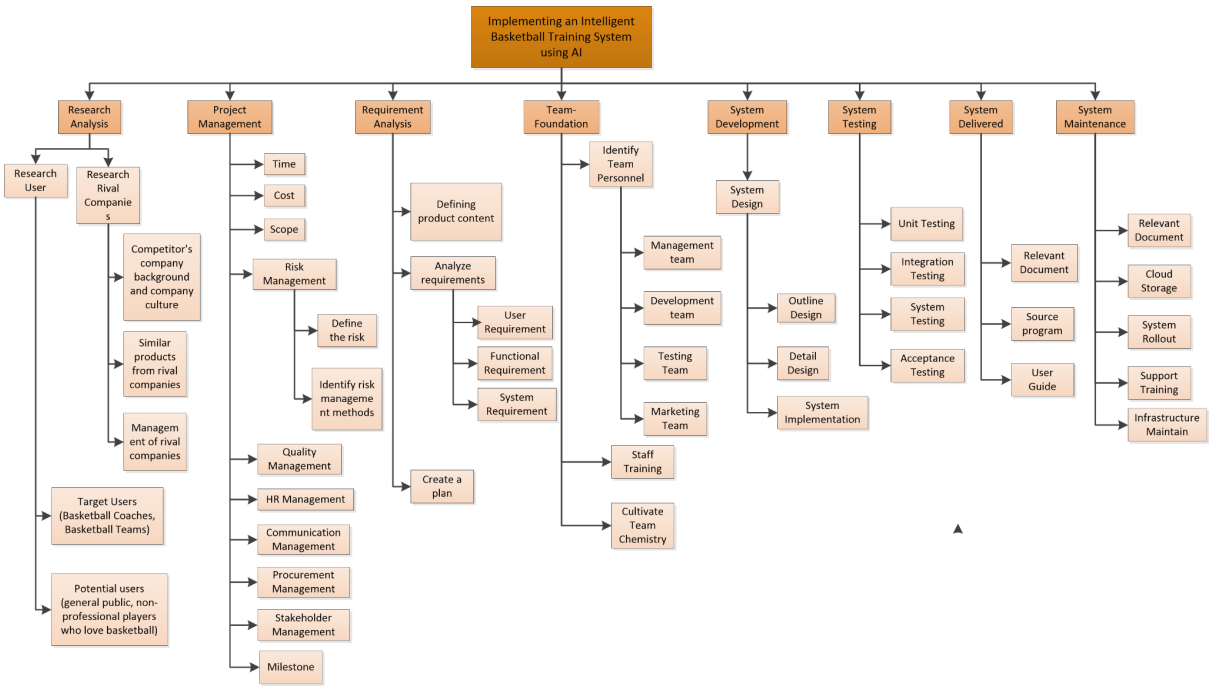

Figure 4.1 Work Breakdown Structure(WBS) for the Project

The table below is a detailed description of the activities in the work breakdown structure.

Table 4.1 WBS table

Developing and Implementing a Basketball Training Assistant and Referee System Using AI	
1. Research Analysis	Activity description
1.1 Research User	Investigate target users and potential users and analyze their preferences

1.1.1 Target Users	Target users include basketball coaches, basketball teams, and other professionals in the field of basketball
1.1.2 Potential users	Potential users include the general public, non-professional amateurs who love basketball
1.2 Research Rival Companies	Research rival companies, including those with similar products. Investigate their corporate background, corporate culture, products, and management methods
1.2.1 Background and company culture	Investigate the corporate background and corporate culture of the rival company, and make use of the advantages and avoid the disadvantages
1.2.2 Similar products	Investigate similar products launched by rival companies, and make use of the advantages and avoid the disadvantages
1.2.3 Management	Investigate management methods launched by rival companies, and make use of the advantages and avoid the disadvantages
2. Project Management	Activity description
2.1 Time	Project time management, the design of the process to ensure that the project is completed on time, generally including activity definition, activity sequencing, activity duration estimation, schedule development, schedule control(Schwalbe, K. 2019).

2.2 Cost	Project cost management involves ensuring the processes required to complete the project within the approved budget, generally including resource planning, cost estimating, cost budgeting, cost control (Schwalbe, K. 2019).
2.3 Scope	Project scope management, the process of defining and controlling what is and is not included in a project., generally including initiation, scope planning, scope definition, scope verification, and scope change control (Schwalbe, K. 2019).
2.4 Risk Management	Project risk management, in order to best achieve the objectives of the project, and to better identify, allocate, and respond to the project life cycle risks (Schwalbe, K. 2019).
2.5 Quality Management	Project quality management involves ensuring that the project meets all the requirements it is supposed to meet, generally including quality planning, quality assurance, and quality control (Schwalbe, K. 2019).
2.6 HR Management	Human resource management is to effectively play the role of everyone involved in the project (Schwalbe, K. 2019).
2.7 Communication Management	Communication management is the proper creation, collection, delivery, and processing of project information for emergencies, generally including communication plan preparation, information delivery, performance report, management closure (Schwalbe, K. 2019).
2.8 Procurement Management	Procurement management involves the process of obtaining required products or services from outside the implementing organization. It generally includes procurement planning, inquiry planning, inquiry, supplier selection, contract management, and contract closure (Schwalbe, K. 2019).

2.9 Stakeholder Management	Stakeholder management to ensure long-term shareholder value maximization, managers and key stakeholders to maintain good relationships.
2.10 Milestone	Set milestones, control the progress of project work, feedback project stage results, and reserve buffer time for the progress.
3. Requirement Analysis	Activity description
3.1 Defining product content	Defining product content refers to the macro needs, that is, what new solution we are going to provide and what existing industry problems we are going to solve. It's usually put forward by the owner of the company or the product owner at the top level.
3.2 Analyze requirements	Analyze requirements include user requirements, content requirements, and system requirements.
3.2.1 User Requirement	Identify which users there are and analyze specific user needs.
3.2.2 Functional Requirement	Functional requirements are optimized and perfected according to user needs.
3.2.3 System Requirement	System requirements are technical requirements that are completely hidden in technical implementation.
3.3 Create a plan	Make relevant plans according to differentiated requirements.

4. Team-Foundation	Activity description
4.1 Identify Team Personnel	Set up project team, including management group, development group, test group, marketing group.
4.1.1 Management team	Set up a management team to serve for project management.
4.1.2 Development team	Set up a development team to realize services for project requirements.
4.1.3 Test Team	Set up a test team to implement services for project testing
4.1.4 Marketing Team	Set up a marketing team to serve the marketing of the products developed by the project.
4.2 Staff Training	Staff training, standardize staff behaviour, improve staff professional level.
4.2 Cultivate Team Chemistry	Cultivate team chemistry, in order to better cooperate
5. System Development	Activity description
5.1 System Design	System design includes outline design, detail design, and system implementation.

5.1.1 Outline Design	Translate software requirements into data structures and software system structures
5.1.2 Detail Design	Process design, through the structure refinement, software detailed data structure, and algorithm
5.1.3 System Implementation	Obtaining the complete internal description of the state space from the external relation between the input and output of the system
6. System Testing	Activity description
6.1 Unit Testing	Unit testing is the examination and verification of the smallest verifiable units in software (Types of software testing: Different testing types with details. Hackr.io. n.d.).
6.2 Integration Testing	Tests that are assembled into modules, subsystems, or systems based on unit tests (Types of software testing: Different testing types with details. Hackr.io. n.d.).
6.3 System Testing	As a part of a computer system, it is combined with other parts of the system to test in the actual operating environment to find potential problems in software and ensure the normal operation of the system (Types of software testing: Different testing types with details. Hackr.io. n.d.).
6.4 Acceptance Testing	Formal testing of user requirements, business processes to determine whether the system meets acceptance criteria, with acceptance determined by the user, customer, or other authorized authority (Types of software testing: Different testing types with details. Hackr.io. n.d.).

7. System Delivered	Activity description
7.1 Relevant documentation	Relevant documentation, including design documentation and test documentation
7.2 Source program	Source procedures can be in the form of a CD-ROM
7.3 User Guide	User guide, including user operation instructions, user installation instructions
8. system maintenance	Activity description
8.1 Relevant Document	System maintenance related documentation, including follow-up test guide
8.2 Cloud Storage	Storing user data
8.3 System Rollout	To promote the product
8.4 Support Training	After-sales service personnel training
8.5 Infrastructure Maintain	Infrastructure Maintenance

5. Time Management

5.1 Defining Activities

With the WBS and the project scope, the project manager can define the activity list and activity attributes. Activity List illustrates the details about the activities and Activity Attributes shows the constraint between those activities.

5.1.1 Activity List

Tabel 5.1 Activity List

Number	Name	Description
1.1	Research Users	Research the preferences and opinions of target customers and potential customers by means of questionnaires or interviews.
1.2	Research Rival Companies	Investigate competitor companies in multiple directions
2.1	Plan Project Scope	Define the project scope; indicate what should be included in the project
2.2	Plan Project Cost	Plan the project budget
2.3	Plan Project Time	Plan a time for the project and each of its parts
2.4	Plan Project Risk	Define the project risks and suggest the ways to respond
2.5	Plan Project Quality	Define the quality requirements of the project
2.6	Plan Project Resources	Plan the resources needed for the project, including human resources and hardware resources, etc.
2.7	Plan Project Communication	Define communication regulations

2.8	Plan Project Procurement	Plan the procurement process of the project
2.9	Define Project Stakeholders	Define the stakeholders
2.10	Set Milestones	Set the milestones to control the progress of project work
3.1	Define Product Content	Define product contents
3.2	Analyze requirements	Analyze several kinds of requirements and submit user needs survey reports
3.3	Create Plans	Write down software development plan, software test plan, software management plan, quality assurance plan, etc.
4.1	Set Up Project Team	Post the job information on the website to gather the team
4.2	Train Staffs	Standardize staff behaviour
4.3	Icebreaking	Cultivate team chemistry in order to have a better cooperation
5.1	Outline Design	Convert the requirements into data structures
5.2	Detail Design	Detailed structure design
5.3	System Development	Develop the whole system according to the previous documents and designs by coding
6.1	Unit Testing	Conduct the unit tests
6.2	Integration Testing	Conduct the integration tests
6.3	System Testing	Conduct the system tests
6.4	Acceptance Testing	Conduct the acceptance tests
7.1	Deliver Documentation	Deliver relevant documentations
7.2	Deliver Source Program	Deliver the whole programs
7.3	Delver User Guide	Deliver user operation instructions

5.1.2 Activity Attributes

Tabel 5.2 Activity Attributes

Name	Attributes
Market Research	At the beginning of the project
Make Project Management Plan	Aftermarket research
Requirement Analysis	After project management
Set Up Project Team	After requirement analysis
Outline Design	5 days before setting up project team ended
Detail Design	After outline design
System Development	After detail design
Unit Testing	After system development
Integration Testing	After unit testing
System Testing	After integration testing
Acceptance Testing	After system testing
Deliver System	After Acceptance Testing

5.2 Milestones and time points

A milestone is an important event that occurs at a certain point in time during a project. The project manager can effectively track the progress of the project by defining milestones.

Tabel 5.3 Milestones

Milestones	Time Points
Begin	1st July
Complete Market Research	15th July
Complete Project Management Plan	31st July
Complete Requirement Analysis	6th August

Complete Team Foundation	20th August
Complete System Design	10th September
Complete System Development	10th November
Complete System Testing	12th December
Deliver System	23rd December

5.3 Estimate Activity Duration

Activity Duration is useful for the following task in project time management. The activity duration for this project was estimated by the PERT method.

Tabel 5.4 Activity Duration List

Number	Name	Duration
1	Market Research	14 days
2	Plan Project Managements	13 days
3	Requirement Analysis	7 days
4.1	Set Up Project Team	13 days
5.1	Outline Design	7 days
5.2	Detail Design	10 days
5.3	System Development	60 days
6.1	Unit Testing	10 days
6.2	Integration Testing	7 days
6.3	System Testing	7 days
6.4	Acceptance Testing	7 days
7	Deliver System	11 days

5.4 Network Diagram

Network diagrams use arrow lines to represent the logical relationships between activities (tasks), which can easily represent various logical relationships between activities.

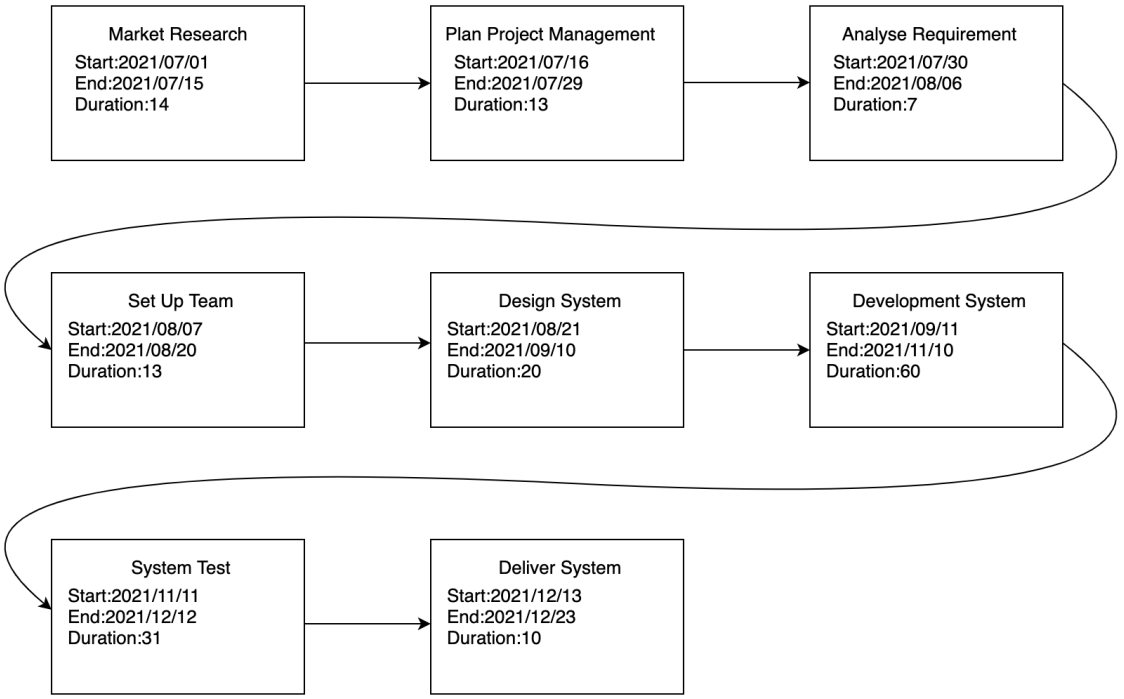

Figure 5.1 Network Diagram

5.5 Gantt Chart

Through a list of activities and a time scale, a Gantt chart graphically displays the sequence and duration of specific items. It is easy for project managers to figure out the remaining tasks of a project and assess the progress of work.

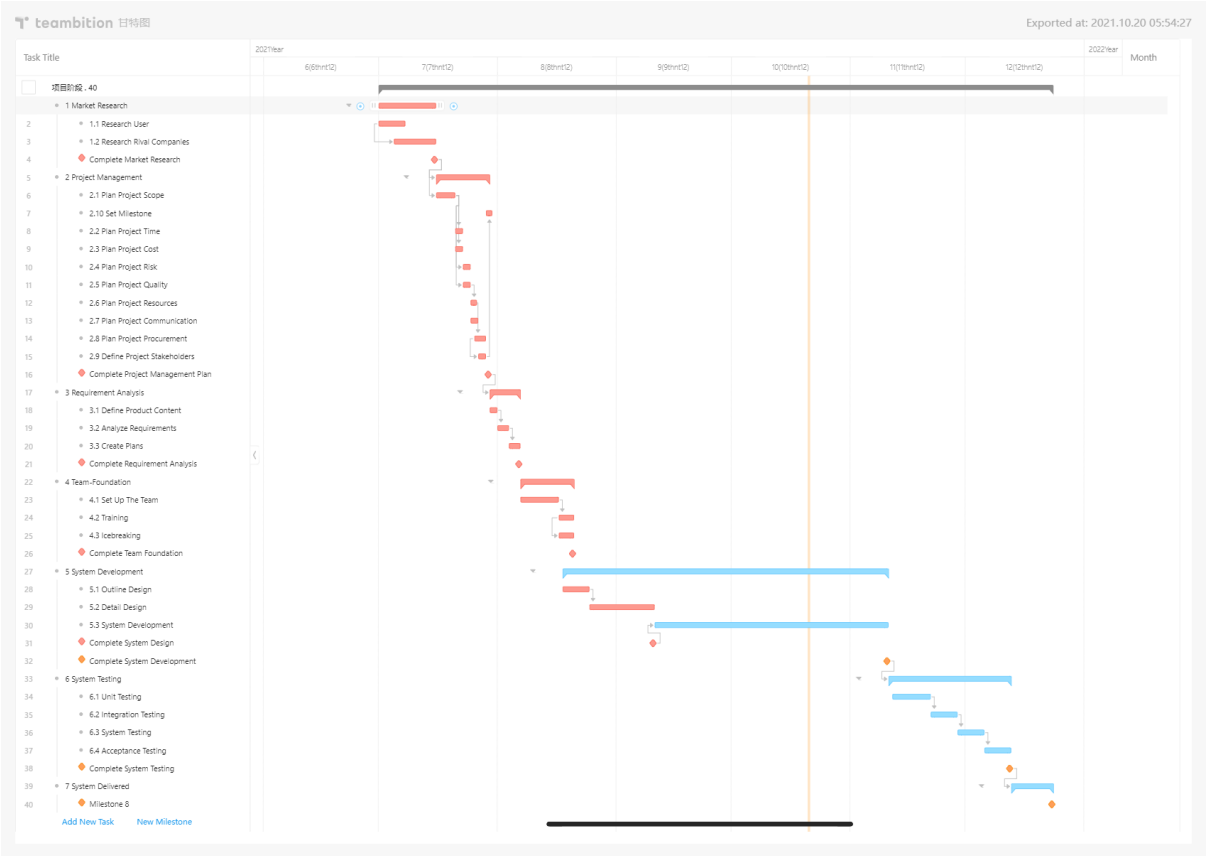

Figure 5.2 Gantt Chart

*Gantt charts are completed on Teambition and the colour of the graph only represents the completion of the task at the current time point.

5.6 Schedule Control

The project manager controls the project schedule by setting clear timelines and defining milestones for each part of the project. By constructing Gantt charts, for example, the project manager can track the project process in real-time and give alerts or guidance to team members. These efforts enable the project to be completed on time.

6. Cost management

6.1 Costs

The cost of this project consists of the following components: Human Resource Costs, Hardware Costs, Software Costs, Maintenance Costs, Market Research Costs and Reserves.

6.1.1 Human Resources Cost

The cost of human resources is calculated by the number of people, the hourly rate, and the number of hours worked. The hourly rate is calculated from payscale.com, using the median hourly rate for the corresponding occupation, calculated in AUD.

Table 6.1 Human Resources Cost

Job Title	Count	Salary Per Hour(median) [AUD]	From	To	Workdays	Daily Work Hours	Total	Start Phrase
Machine Learning Engineer	5	40	2021/8/25	2021/12/12	109	8	174400	Detail Design
User Experience Designer	2	31.86	2021/9/11	2021/12/12	92	8	46897.92	System Development
Software Architect	1	92.96	2021/8/18	2021/11/10	84	8	62469.12	Outline Design
Software Engineer	5	31.04	2021/8/25	2021/12/12	109	8	135334.4	Detail Design
Software Tester	3	26.08	2021/11/12	2021/12/12	30	8	18777.6	Unit Testing
IT Project Manager	1	51.7	2021/7/1	2021/12/23	175	8	72380	Begin
Market Researcher	2	25.16	2021/7/1	2021/7/15	14	8	5635.84	Research User
Total							515894.88	

The table shows the payroll cost breakdown for each position on the team, where Count refers to the number of people and Start Phrase indicates at what stage of the project the career person joined.

6.1.2 Hardware Cost

The hardware cost mainly includes server equipment, database equipment and professional equipment used to build the algorithm model, etc.
We will purchase 10 Velarray M1600 lidar and 3 Tesla V100 GPU for constructing our machine learning model. Web servers and database servers are used to deploy our application on the Internet. The total cost of hardware is 90403 AUD.

Table 6.2 Hardware Cost

Hardware Name	Unit Price	Number	Total
Web Server	5000 AUD	4	20000
Database Server	5000 AUD	4	20000

Velarray M1600	681.3 AUD	10	6813
Tesla V100	14530 AUD	3	43590
Total			90403

6.1.3 Software Cost

Development tools, IDEs, project management tools and other software that require commercial licenses, the expenses of which are part of the software costs.
We subscribe to IDEs (JetBrain Suite) for 6 months. The unit price is 64.9USD per month per user, which is 88.4457AUD. And in the project, there is a total of 16 users. So the total price is 88.45*16*6=8491.2AUD
We also subscribe to Microsoft Project as a project management tool. The unit price is 30.0USD per month per user, which is 40.90AUD. We subscribe to 1 copy for 6 months. So the total price is 40.90*6*1=243.6 AUD

Table 6.3 Software Cost

Software Name	Unit Price	Number	Total
JetBrains Suite	88.45 AUD/Month/Person	96	8491.2
Microsoft Project Plan 3	40.9 AUD/Month/Person	6	243.6
Total			8734.8

6.1.4 Market Research Cost

Some additional expenses are needed for inviting users for interviews when doing user research. This type of expenditure will be classified as market research costs.
In this project, we will spend 3000 AUD on market research.

6.1.5 Maintenance Cost

After the delivery of the program, we also need to set aside an amount to carry out maintenance work. Depending on the actual situation, 30,000 AUD is the necessary cost to carry out maintenance work.

6.1.6 Summary

Table 6.4 Cost Summary

Type	Cost	Percentage
Human Resources	515894.88	66.34%
Hardware	90403	11.63%
Software	8734	1.12%
Market Research	3000	0.39%
Maintenance	30000	3.86%
Reserve	129096.376	16.67%

Total	648031.88	

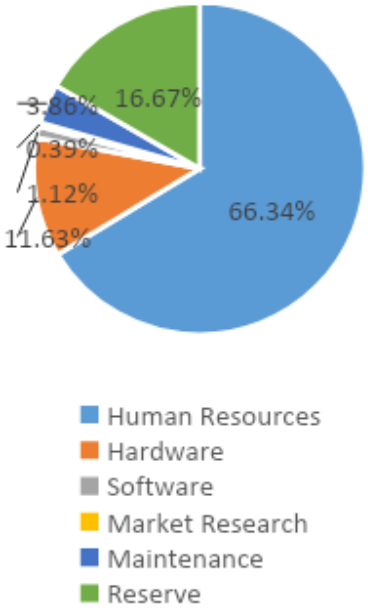

Figure 6.1 Cost Pie Chart

According to the graph, the human resources cost accounts for the largest part of the total cost, 66.34%; the hardware budget is the second largest, accounting for 11.63%; software, market research, and maintenance account for only 1.12%, 0.30%, and 3.86%, respectively. And the reserves are generally 20% of the total other costs and accounts for 16.67% of the total costs.

6.2 Baseline

Based on the above description, the cost baseline is given below, enabling the project manager to measure and monitor cost performance.

Table 6.5 Cost Baseline

Item	July	August	September	October	November	December	Total
1.Human Resources							
1.1Machine Learning Engineer		9600	48000	49600	48000	19200	174400
1.2User Experience Designer			9685.44	15802.56	15292.8	6117.12	46897.92
1.3Software Architect		9667.84	22310.4	23054.08	7436.8		62469.12
1.4Software Engineer		7449.6	37248	38489.6	37248	14899.2	135334.4
1.5Software Tester					11266.56	7511.04	18777.6
1.6IT Project Manager	12821.6	12821.6	12408	12821.6	12408	9099.2	72380
1.7Market Researcher	5635.84						5635.84
2.Hardware							
2.1Web Server		20000					20000
2.2Database Server		20000					20000
2.3Velarray M1600		6813					6813
2.4Tesla V100		43590					43590
3.Software							
3.1JetBrains Suite	8491.2						8491.2
3.2Microsoft Project Plan 3	243.6						243.6
4.Market Research	3000						3000
5.Maintenance						30000	30000
6.Reserves	6038.4	25988.4	25930.4	27953.6	26330.4	17365.3	129606.5
Total							777639.2

6.3 Controlling Cost

With the cost baseline and the various cost breakdowns described above, project managers can easily track project progress and budget utilization through earned value calculations. For example, CPI indicates whether actual costs are higher than budgeted costs, and SPI indicates whether the actual schedule is the same as the planned schedule.

7. Communication

Table 7.1 Communication plan

Stakeholders	**Description of interest or concern**	**Document Name**	**Document Format**	**Contact person**
CIO	Real-time project process	Monthly status report	Hard copy, E-mail and meeting	Project manager, Internal technology team

CEO	Real-time project process	Monthly status report	Hard copy, E-mail and meeting	Project manager
CFO	Project cost; CPI, SPI	Monthly status report	Hard copy, E-mail and meeting	Project manager, Business management
Sponsors	Real-time project process; ROI	Monthly status report	Hard copy and meeting	Project manager
Customer management	Customer requirement & satisfaction	Half-monthly status report	Hard copy and meeting	Project manager
Business management	Financial report	Half-monthly status report	Hard copy and meeting	Project manager
Market management	Market survey	Half-monthly status report	Hard copy and meeting	Project manager
Internal management	Arrangement of the project work	weekly status report	Intranet, E-mail	Project manager
Internal technology team	Technical details of the project	weekly status report	Intranet, E-mail	Project manager
Technology staff	Technical details of the project	weekly status report	Intranet, E-mail	Internal technology team, Internal management
Outsourcing team(if need)	Technical details of the project	weekly status report	E-mail, Third-party	Technology staff, Internal

			communication software	technology team

8. Quality Management

8.1 Purpose of The Project Quality Management Plan

Quality management discovers the underlying causes of quality issues in a project with feedback, results in the project meeting requirements or standards, and documents the process of proving how the project meets the relevant quality requirements (Arthur, n.d.; Hasan, 2021).

8.2 Quality planning

8.2.1 Define project quality

The project will follow the ISO 9000 quality standards, including planning for the project, documenting a continuous cycle, providing the organization with the minimum requirements for the project to meet the qualification standards, helping the organization to reduce costs and improve user satisfaction (Hasan, 2021).

The project stakeholders for the project include the relevant organization and the users. The expectations of the organization or company for the project is to meet the laws and regulations and a series of quality management requirements involved, it is also to achieve the purpose of profitability. On the other hand, the expectation of users for the project is the security issue of data, whether the analysis results provided by the product in the mentoring training function are accurate, and whether the referee function can accurately restore the game process and accurate prediction.

8.2.2 Measure Project quality

Project quality will be measured according to ISO 9000. The team will use quality control methods and quality tools to document the results or processes to assess the performance of the project during the project implementation, such as to cause and effect diagrams, quality control charts, etc. Based on the quality standards, the team will plan a cycle for each phase of the project and periodically check the completion of tasks within that cycle. Also, it is necessary to test whether the technology and hardware facilities involved in the project can

meet the relevant quality certification and project requirements to reduce the development cost. For example, whether the project can accurately predict the movement of athletes, whether the sensor function of LiDAR is accurate, etc. Finally, the team will collect user feedback to improve satisfaction.

8.3 Quality Assurance

8.3.1 Analyze project quality

The purpose of the quality assurance process is to prevent project defects, and the process will ensure that the methods and technologies designed for the project are implemented correctly（Arthur, n.d.; Hasan, 2021）. For this project, the team needs to analyze the relevant technologies and products currently on the market, evaluate their quality strengths and weaknesses, use the results as one of the reference materials in the project development process to avoid defects and ensure that the project meets the required quality level. For example, the accuracy of the sensor function in different LIDAR companies, the placement and coverage angle of the LIDAR, the quality and portability of similar AI products for wearable devices, and the accuracy of the track prediction function.

In addition, the team also needed to analyze and evaluate relevant technologies. The work analyzed the existing products with training assistance and referee functions, as well as the technologies involved in similar fields. For example, whether the visual camera can accurately record the track of the user's movement, the extent to which the 3D reconstruction model restores the game situation, and whether the InfraRed technology can accurately capture the track and physical condition data of the athletes. On the other hand, the team also needs to analyze and understand the related technologies under research to prepare for subsequent product generations, such as whether the prediction of tracks can be accurate to specific parts of the human body, whether the visual camera technology can be improved so that the size of the machine can be reduced or the number can be reduced to achieve the same effect as before.

8.3.2 Improve project quality

The team can work on the project based on the existing equipment and technologies available in the market to make the project finally meet the quality requirements, such as the existing LIDAR technology, infrared sensing technology, body sensing technology to measure body index, etc. The use of already mature and relevant technologies can reduce the project cost as well as speed up the development project. In addition, during the project, the selected technology and hardware products need to be tested several times, besides that, it is also necessary to select alternative options for the products and technologies involved in the

project to prevent force majeure and to save the project development time by quickly replacing the relevant parts if the subsequent products do not perform as expected.

8.4 Quality Control

Quality management is the process of testing that the project results follow standards and processes and produce the required deliverable internal and external products. The testing team performs quality checks on the results of the project during the process and examines them at critical points in the project cycle. In addition, the team also conducts relevant structured tests or code tests on the project, documenting the performance and changes needed to ensure that the project meets quality requirements, such as the accuracy of the analysis results of the project (relevant parameters, body indices of the athletes, motion track analysis).

9. Risk management

The risk points of the project are mainly oriented to the project scope, time and cost. According to the category of IT project risk, containing market risk, economic risk, people risk, technology risk and structure/process risk. The risk register sheet shows the details of each risk in the project.

9.1 Risk Register sheet

Table 9.1 Risk sheet

Risk No.	name	Risk Description	Risk Owner	Category	Mitigation Plan (what to do to avoid the risk occurring)	Impact level	Description of impact	Likelihood of occurrence	Contingency Plan (what to do if the risk occurs)

R01	The employees demanded a pay rise	Some stages may cost a lot of energy of employees, which leads to dissatisfaction of employees. In this case, they want to get a higher salary	Project manager	Financial risk	At the beginning of the project, improve employees' work enthusiasm and promise them to give a certain project bonus after the project is completed.	Moderate	This leads to more cost in human source, which is to give money to employees to satisfy project to be successful	Possible 0.3	Appease employees' emotions, give them a day's rest if time permits, and promise to give bonuses after the successful implementation of the project.
R02	Hardware cannot be suitable for the system	Former Hardware may not be suitable to the system, therefore need a new one which is of higher price	Internal technology team	Technology risk	Make a survey before the start of the project, select the hardware equipment with the best price and performance, and select the second and third alternative facilities.	high	Results in higher cost in hardware and cost more time in the stage of the project	Rare 0.14	Choose alternative hardware as soon as we can and test new hardware; If also cannot be suitable, select another hardware until satisfying system.
R03	Function development failed	The function developed cannot satisfy customers' demand or the function internal	Internal technology team	Technology risk	After talking with the customer about the requirements, the project manager shall hold a meeting with the IT development	Very high	If we cannot handle this risk properly, it leads to failure of the entire project.	Possible 0.3	Ask other project outsourcing companies for help or let all technical teams engage in finding solutions.

		technology team cannot develop it.			team in time to clarify whether the functions proposed by the requirements can be realized and cannot undertake the work beyond his own ability.				
R04	Test code risk	When testing codes in a new hardware and software environment, it may encounter lots of problems due to the new environment the codes cannot suit.	Internal technology team	Technology risk	In fact, it is ordinary to have this kind of problem during the project time. Therefore, it needs technology team prepare sometime duration to work on testing to avoid happening problems	low	It causes more time to test on new hardware and software, but not serious problem	Very Likely 0.6	Programmer should find the problems in time.And then hold an emergency Seminar with project manager to find solution together.
R05	Equipment broken risk	Someone may break the equipment unintentionally or intentionally	somebody	Technology risk	Tell everyone in the group the importance of the equipment and put it in a safe place	low	Equipment damaged means that we need to buy a new one	Rare 0.15	Buy a new one or replace it

R06	Equipment operates risk	The operator may use equipment incorrectly leads to equipment damage or cost more time	operator	People risk	Organize formal and professional equipment, use training for operators, and conduct training and examination for them to accept the examination results. And further, equip them with instrument operation manual	low	Equipment slightly damaged or cost more time to test system	Likely 0.4	Repair the injured part of the equipment Retest the system
R07	Customers dissatisfied with deliverable	Customers are dissatisfied with the final deliverable, so we have to struggle with a method to solve this problem	Project manager Internal technology team	People risk	In the beginning, communicate with customers deeply, and make sure that the team's direction is correct. Then in every step, examine if the function satisfies the customer's demand. And give each stage's deliverable to the customer to check	Very high	The failure of the project	Rare 0.1	Firstly communicate with customers to know their actual thought; which part can satisfy them and what they want. Then the plenary held an emergency meeting to conclude a method to solve the problem.

R08	Poor relationship between managers and team members	In the project process, the manager will not always get along well with his team members. There must be some friction. It will cause bad effects on all teams and projects.	Project manager employee	People risk	As the project manager, we have to communicate with our workers frequently. Only by learning about what they think, what they want, just the same way treating customers, will we build a good relationship. As team members, we learn to understand our leaders, they have too many things to consider, and we should feel for each other to win together.	moderate	A bad circumstance in the team may cause low work efficiency, which leads to failure in delivering on time	Likely 0.39	Find the root contradiction and solve it.
R09	New employees are not familiar with the project	New employees who aren't familiar with the project means that they are new to the project, therefore	Project manager employee	People risk	Arrange old employees with experience in this project to conduct all-round training and corresponding training tests for new employees	low	This leads to low work efficiency and the new employees may make a big mistake like breaking hardware device	Unlikely 0.24	If the device is broken by the new workers, repair it. And then train them again; make a restricted rule for them to obey, else reduce their salary.

		they might not know how to handle the equipment or the details of the project.							
R10	change in demand	In the middle stage of the project, customers want to change demand into another or add new demands	Project manager	People risk	In order to deal with the occurrence of such risks, managers should set aside part of the time, about a week, to prevent demand changes or increases	moderate	If a group has spare time to deal with that, it will be an opportunity to earn more money. Else it will cause harm to the entire project. Therefore, we should set aside time to prevent it.	Unlikely 0.2	Using spare time to analyze demands. Just the same as the entire project. However, the whole team has to be engaged in working on new demands from customers to ensure project landing.
R11	Management's wrong decision	The project manager's wrong decision may lead to entire project failure. For instance, in the middle stage of a project, the budget has already cost according to the	Project manager	Structure /process risk	Before starting the project, assign 2 or 3 leaders to take part in making decisions. During the process solicit the opinions of team members.	Very high	Wrong decisions will lead the entire project to failure.	Nearly impossible 0.05	When wrong decisions have been made and cause a great harm to the project. Find a new project who is also familiar in this area and apply for more budget and people to make up for fault as possible as they can.

		wrong decision.							

References

1. Li, B. and Xu, X. (2021) “Application of Artificial Intelligence in Basketball Sport”, Journal of Education, Health and Sport, 11(7), pp. 54–67. doi: 10.12775/JEHS.2021.11.07.005.
2. J. Xing, H. Ai, L. Liu and S. Lao, "Multiple Player Tracking in Sports Video: A Dual-Mode Two-Way Bayesian Inference Approach With Progressive Observation Modeling," in IEEE Transactions on Image Processing, vol. 20, no. 6, pp. 1652-1667, June 2011, doi: 10.1109/TIP.2010.2102045.
3. Lu, Guang-Qi. “Evaluation model of young basketball players physical quality and basic technique based on RBF neural network.” (2016).
4. Schmidt A. (2012). “Movement pattern recognition in basketball free-throw shooting.” Human movement science, 31(2), 360–382.
5. Shah, Rajiv Ratn and Rob Romijnders. “Applying Deep Learning to Basketball Trajectories.” ArXiv abs/1608.03793 (2016): n. pag.
6. Yang, Zhuo. (2020). “Research on Basketball Players” Training Strategy Based on Artificial Intelligence Technology. Journal of Physics: Conference Series. 1648. 042057. 10.1088/1742-6596/1648/4/042057.
7. Jauhiainen, S., Kauppi, J., Leppänen, M., Pasanen, K., Parkkari, J., Vasankari, T., Kannus, P., & Äyrämö, S. “New Machine Learning Approach for Detection of Injury Risk Factors in Young Team Sport Athletes.” International journal of sports medicine. (2020).
8. Mingyou Chen, Yunchao Tang, Xiangjun Zou, Kuangyu Huang, Lijuan Li, Yuxin He, “High-accuracy multi-camera reconstruction enhanced by adaptive point cloud correction algorithm”, Optics and Lasers in Engineering, Volume 122,2019, Pages 170-183, ISSN 0143-8166
9. Marco Lombardi, Mattia Savardi, Alberto Signoroni, “Cross-domain assessment of deep learning-based alignment solutions for real-time 3D reconstruction, Computers & Graphics”, Volume 99, 2021, Pages 54-69, ISSN 0097-8493
10. Alexandre Alahi, Kratarth Goel, Vignesh Ramanathan, Alexandre Robicquet, Li Fei-Fei, Silvio Savarese “Social LSTM: Human Trajectory Prediction in Crowded Spaces” Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2016, pp. 961-971
11. J. Zhong, H. Sun, W. Cao and Z. He, "Pedestrian Motion Trajectory Prediction With Stereo-Based 3D Deep Pose Estimation and Trajectory Learning," in IEEE Access, vol. 8, pp. 23480-23486, 2020, doi: 10.1109/ACCESS.2020.2969994.
12. J. Wiest, M. Höffken, U. Kreßel and K. Dietmayer, "Probabilistic trajectory prediction with Gaussian mixture models," 2012 IEEE Intelligent Vehicles Symposium, 2012, pp. 141-146, doi: 10.1109/IVS.2012.6232277.
13. Arthur, B. (n,d.). “The Difference Between Quality Assurance and Quality Control”, Dialogue.
https://www.dialog.com.au/open-dialog/the-difference-between-quality-assurance-and-quality-control/

14. Hasan, R. (2021). “IT Project Quality: Tools”, Techniques. 1-46
15. Schwalbe, K. “Information technology project management (Ninth edition.).” Cengage. (2019)
16. Types of software testing: Different testing types with details. Hackr.io. (n.d.). Retrieved October 9, 2021, from https://hackr.io/blog/types-of-software-testing.
17. Andrea Di Stefano AI Researcher from website:https://www.itransition.com/blog/ai-in-sports