Proceedings of the Annual General Donald R. Keith Memorial Conference
West Point, New York, USA
May 2, 2024
A Regional Conference of the Society for Industrial and Systems Engineering

Michie Stadium Operations Revision

Abby Brancato, Aidan Gaines, Gabriel Neel, Robert Sundy, and Kenneth McDonald

Department of Systems Engineering,
United States Military Academy,
West Point, New York 10996

Corresponding author's Email: aidangaines@gmail.com

Abstract: Sporting events face challenges from emerging threats, and Gameday operations and security must adapt. This report details a Systems Engineering capstone team collaborating with the Army West Point Athletics Department (AWPAD) to optimize event operations for football games at Michie Stadium. A three-phased analysis process is used to identify and redefine the problem statement and develop a solution to refine the system to streamline spectator movement and provide timely information. The introduction highlights the historical significance of venue operations and emphasizes safety. The methodology section describes research and stakeholder analysis techniques, functional analysis techniques, value modeling, and solution design. The analysis section goes through the findings and their significance, the tools developed for the problem definition phase, and the resulting solutions developed.

Keywords: Sporting Events, Security, Problem Definition, Solution Design

1. Introduction

For six Saturdays every year, the Corps of Cadets, and thousands of visitors come to West Point to watch the Army Black Knights play football at Michie Stadium. West Point's strategic location as a defensive position during the American Revolution presents unique issues with limiting stadium infrastructure and navigability. On game day, these issues present challenges with stadium flow, stadium security, and fan satisfaction. This capstone plans to evaluate Michie Stadium in its operations, analyze ways to optimize the system, and provide solutions to the primary stakeholder, Dr. Dan McCarthy, to improve the perceived weaknesses to the game day environment at West Point. This article will summarize the efforts made throughout the semester to include research, of both background and current operations, methodology, analysis of findings, and the conclusions from the problem definition phase, solution design, and decision-making phases.

2. Background

Sporting events are prime targets for emerging threats. The management of gameday operations and vehicle control has undergone constant adaptation to address these threats. The successful implementation of advanced security measures, optimized vehicle control strategies, and comprehensive emergency operation plans is guided by the knowledge and insights gathered from various sectors. Therefore, organizations must learn from the historical evolution of gameday operations to adapt and innovate, ensuring the safety and success of future sporting events. When selecting or constructing venues for major sporting events, safety is paramount and must address natural and man-made threats (Giddy 2019). Climate change-induced natural threats, like extreme weather events, require mitigation strategies such as heat policies and infrastructural upgrades (Giddy 2019). Man-made threats, exemplified by historical attacks on the Olympic Games, demand rigorous security measures, including advanced security protocols (Fussey and Coaffee 2012). Continuous optimization of security measures, with a focus on preventing terrorism, remains crucial (Sparf and Petridou 2018). Integrated security and risk management in game day operations are imperative for ongoing safety. The selection and construction of venues should prioritize safety, considering diverse and evolving threats (Giddy 2019). Michie Stadium's challenges highlight the need for proactive security measures. Comprehensive strategies that address both natural and man-made threats enhance the overall spectator experience and contribute to increased retention and revenue, especially for institutions like West Point. The popularity of sporting events, particularly in major stadiums, has given rise to a dedicated industry. However, the high attendance also makes these venues potential targets for terrorist attacks, both on the ground and from the air, with motives ranging from radicalization to sending messages to specific groups (Stern 2011). Understanding evolving terrorist techniques is crucial for effective risk mitigation (Department of Statista Research 2022). Mitigating these threats is complex due to budget constraints and technological advancements, such as "smart bombers" and potential drone use (Gehring 2014). Continuous adaptation of security measures is essential. A structured approach like the Sports Event Security Assessment Model is significant, involving key personnel interviews, threat identification, and vulnerability assessment (Hall, et al. 2007). Recognizing the multifaceted roles of sporting events in society, venues must institute policies to limit items fans can carry, fostering a secure atmosphere (Taylor and Toohey 2011). The risk of terrorist attacks on sports venues requires a continuous understanding of evolving techniques and the implementation of comprehensive security measures. Crowd management for large events involves comprehensive preparations for safety, considering factors like perceived force, information quality, and space. Understanding crowd behavior is crucial to minimizing risks, emphasizing the importance of safety components (Alkhadim, et al. 2018). Studies recommend optimizing communication through barriers, gate control, and signage to positively influence crowd behavior (Feng and Miller-Hooks 2014). Pre-event planning requires expert knowledge, past experiences, and logistical plans covering transportation, security, and stakeholder representation. Effective communication through signs, screens, and maps is crucial during execution. Considerations include understanding visitor demographics, venue location, and event type, with stricter rules for indoor events due to emergency exit limitations (Martella, et al. 2017). Event operations are categorized into normal and emergency conditions, highlighting challenges such as limited entry points and evacuation shortcomings during emergencies. During events, the focus is on assessing crowd conditions, prioritizing safety, and addressing design and communication challenges (Still, Papalexi and Fan 2020). Constant assessment is crucial for proper execution. Emergency Operation Centers (EOCs) at major events undergo continuous improvement for optimal performance. Defined by the World Health Organization (WHO), EOCs include functions like Command, Planning, Operations, Logistics, Intelligence, and Finance and Administration to ensure efficiency (World Health Organization 2013). The command function, led by roles like the Facility Manager and Public Communications Officer, provides centralized leadership. Planning involves data analysis, action planning, and predicting event evolution (World Health Organization 2015). Operations and logistics offer tailored coordination and resource management. Security at major events involves surveillance, checkpoints, and response personnel to ensure venue safety (Samatas 2007). The medical services sub-system, crucial for event duration, includes a hierarchical structure for efficient coverage (Grissom, Murdock and Culberson 2006). Maintenance involves personnel maintaining facilities, and the parking sub-system addresses traffic issues with off-site parking and transit systems, promoting efficient spectator arrival (Xu 2021) (Ruan, et al. 2016).

3. Methodology

A three-phased analysis process consisting of the phases problem definition, solution design, and decision making is used to address the problem. The desired output of the problem definition phase is a redefined problem statement. To get there, there are three components to this phase: stakeholder analysis, functional analysis, and value modeling. Research and stakeholder analysis is used to understand the problem being solved, identify the people and organizations that are relevant to the problem, and determine the needs, wants, and desires of the relevant people and organizations. Methods of research and stakeholder analysis include literature reviews, interviews, and a Findings, Conclusions, and Recommendations (FCR) matrix. An FCR matrix is a progressive matrix that lists all findings from the research, which is grouped and drafted into conclusions, then generalize the conclusions into recommendations. Following research and stakeholder analysis, the next part of the problem definition phase is functional analysis. Functional analysis methods include a functional hierarchy and a functional flow diagram. A functional hierarchy is used to identify the functions and subfunctions of the system, guides the development and design of the concept, and helps to identify performance measures. Functional flow diagrams are used to define the relationships between the functions. They depict how the functions flow throughout the system. After functional analysis, value modeling is used to provide an initial methodology for evaluating workable solutions for the system. A qualitative value model is a complete description of the qualitative values of the key stakeholders. The steps for generating a qualitative value model are identifying the fundamental objective, functions, objectives, and value measures. Once value measures are defined, a quantitative value model is made, which is a mathematical model that can be used to evaluate how well candidate solutions attain the stakeholders' values. Functions are created for each value measure to convert the value measure scores of the potential candidate solutions to a value and then weight the value measures based on their importance to the problem and final solution. The total value for each alternative solution can then be computed by summing each value score multiplied by their corresponding weight (Driscoll, Parnell and Henderson 2023).

Once the problem statement is redefined using the identified problems and desired outcomes for the system, the solution design phase begins. In the solution design phase, alternative candidate solutions are developed and presented to the decision maker along with their corresponding risks and uncertainties and methods for mitigation. Solution design begins with idea generation, which can be done through methods such as brainstorming. Once ideas are generated, they are then refined and then turned into alternatives. The alternatives are put through the feasibility screening process and those that do not meet stakeholder needs, wants, and desires are removed, and those alternatives that are feasible become candidate solutions. Once candidate solutions are produced, they continue to be refined and improved through value modeling and simulating. The candidate solutions are scored using the quantitative value model that was developed during the problem definition phase, then sensitivity and risk analyses are conducted. Sensitivity analysis determines if changes in any of the value measures would change the preferred solution by varying one weight while keeping the other weights the same (Driscoll, Parnell and Henderson 2023). In the end, the candidate solution that scored the highest will be recommended to the stakeholder as the best solution.

4. Analysis

Research and data collection is vital to figuring out where to start looking for solutions. First, literature reviews were conducted to broaden the group's knowledge on various potential threats at stadiums, emergency operations and security, stadium operation centers, and people control. For further research, interviews were conducted with the stakeholders. The stakeholders interviewed were the client, Dr. Dan McCarthy, the associate athletics director, Shane Bell, and the assistant athletic director to team operations, Mike Resnik. These interviews provided insight on the stadium layout and operations, points of friction during Game Day, and understanding on the current system. Additionally, game day operations were shadowed for two Army Football games at Michie Stadium and one New York Giants game at MetLife Stadium. This provided different perspectives of game day operations in a professional stadium as compared to Michie Stadium. These findings were then turned into conclusions to better understand the problem. From those conclusions, recommendations were created for the stakeholders. The findings, conclusions, and recommendations were all compiled into an FCR Matrix. From the recommendations, a fundamental objective was created (Figure 1).

A qualitative value model was created with the functions, objectives, and value measures (Figure 1). The functions identify what the solutions will address and what system aspects need to be improved upon. These objectives were chosen because they cover the friction points during game day operations. The value measures were chosen to quantify each objective and provide a tangible method of improvement for each objective and corresponding function.

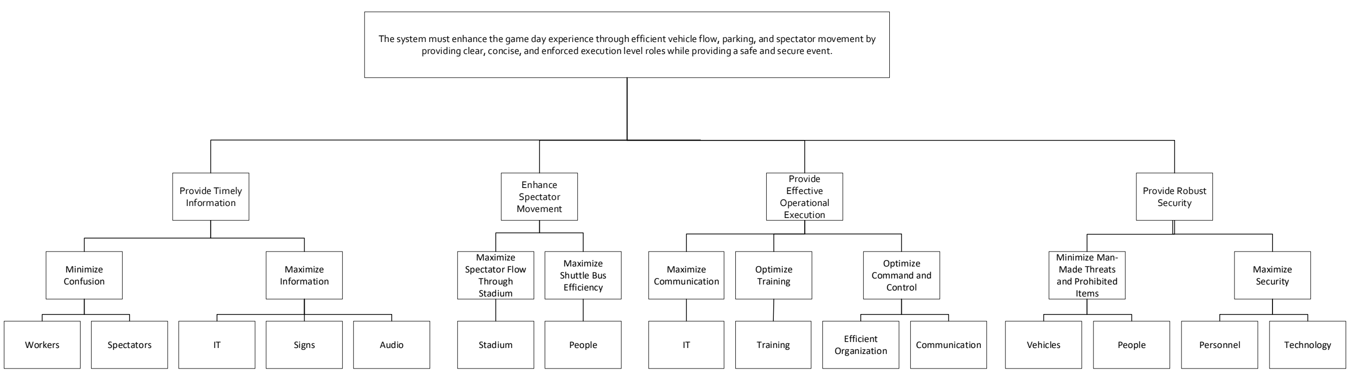

Figure 1. Qualitative Value Model

The value measures for each objective were assigned and then scored with several design parameters which are different possible solutions for each value measure. Each design parameter scored 1-3 or 1-4 depending on how many were under each value measure. These scores were then combined with the stakeholder feedback to generate a swing weight matrix which was used to make global weights for the value measures which is the percentage of the total system swing weight a single swing weight has. From this, candidate solutions were generated and scored based off the product of swing weights and their respective global weights which equaled their value. We conducted sensitivity analysis on all the value measures and found none of them had a significant impact on changing the values of the candidate solutions. The candidate solution that generated the most value was selected for implementation. This candidate solution was named "Most Efficient" and generated 79.42 units of value. For reference, the current system generates 0 units of value, and the ideal solution generates 100. This can be seen in the stacked bar chart below in Figure 2. The design parameters for this candidate solution (Most Efficient) involve extending the gates outwards to improve flow, enacting a clear bag policy, improving the signage around the stadium, improving the training workers receive, improving the medical and weather protocols, and using better technology to better disseminate information to the fans. Moving forward, this is the candidate solution that is implemented in the solution design phase.

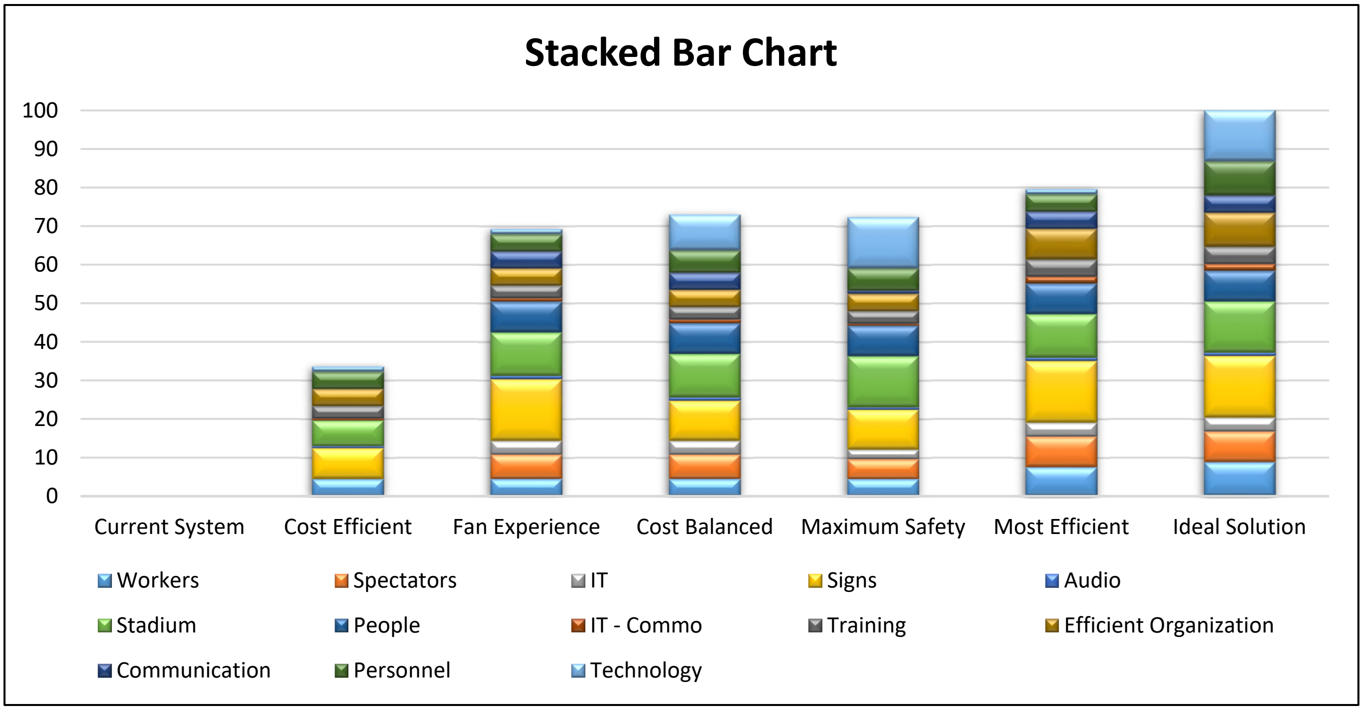

Figure 2. Candidate Solutions Stacked Bar Chart

Using the selected candidate solution, a new layout for the stadium and gates was designed and simulated in ProModel. For the new gate designs, a uniform security station was designed to be incorporated in all gates around the stadium. This new design centralizes every step of stadium entry into a single station to avoid multiple queues and ensure proper screening at gates which is not currently being done during gameday at all gates. This new design includes bag checks, metal detectors, and ticket checking. As a result of the stadium renovation and the new gate design, a new stadium layout is required. The new layout includes the loss of gate 2 to the stadium renovation and the combination of gates 5 and 6 into gate 4. In total, the new layout will have only 6 gates for spectators instead of the original 8. The new stadium design will also improve signage outside and around the stadium. To assist spectators in navigation, the group designed lamppost banners to be posted around the stadium. This will provide additional visual aid to spectators in areas where additional signage is needed. To improve the health and safety of the spectators, the new design adds a second first-aid station in the under-utilized storage area under sections 26 and 27 that will provide greater accessibility for fans and lower the risk of medical emergencies.

In addition, various safety and communication technologies will be implemented. Stair railing will be added by trimming the ends of the metal seats, doubling the width of the stairway aisles, allowing rails to be installed down the center, facilitating safe movement up and down the stadium. The app ALO.ai will be used to facilitate movement outside and inside the stadium through an improved communication network. The Weatherstem Varsity system will also be installed to improve weather assessment around the stadium with a radar system, lighting detector, and severe weather siren.

ProModel simulations were conducted on each gate, with their former setups and with the proposed setups (Figure 3). Each gate was set to the same parameters to make up for the lack of numerical data. The fans arrived at each gate at an exponential distribution every 5 seconds for three hours. The fans came in groups of a normal distribution with the median being two fans and a standard deviation of 2 fans. The rate through gates and security were standardized at a rate with a normal distribution of 15 seconds and standard deviation of 5 seconds. Table 1 shows the results of the simulations.

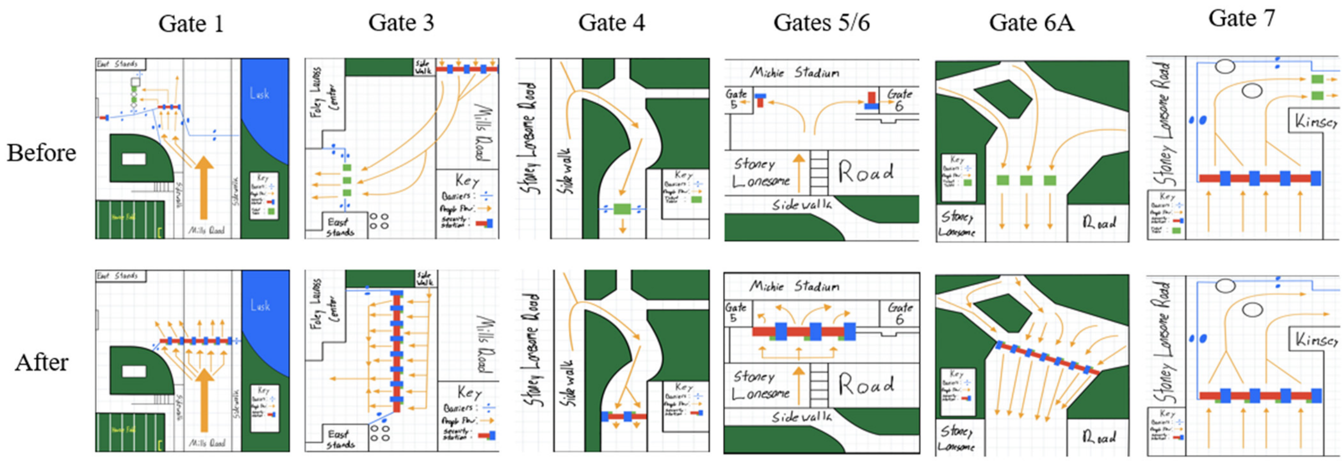

Figure 3. Stadium Gate Systems

In the results in Table 1, for the percent increase in time through the system, a negative percentage indicates a decrease in time through the system. For the percent increase of people through the system, a positive percentage indicates an increase in people through the system. For former gates 1,3,6a, and 7, the new configuration decreases the time in the system and increases the amount of people through the system. For gate 4, there is only a one percent increase in time in the system while increasing the amount of people through the system by 62%. The former gates 5 and 6 will later turn into gate 4 increasing the time in the system by 48% and only increasing the number of people through the system by 9%. Something notable about the gates 5 and 6 simulations, the fans were allowed to balk when gates 5 and 6 were separate, allowing for less time in the system. It was assumed that when balking, they would simply go to a shorter line nearby. Given the new setup of the stadium, balking the lines will be less feasible, causing the wait times to increase.

Table 1. ProModel Simulation

Gate	Average time in system - old configuration	Number people through system - old configuration	New Gate identifier	Average time in system - new configuration	Number of people through system - new configuration	Percent increase in time through system	Percent increase of people through the system
1	26.5	1411	1	11.7	3936	-77%	94%
3	27	3190	2	1.65	4901	-177%	42%
4	1.23	747	3	1.24	1417	1%	62%
5	2.7	1020	4	19.9	2420	48%	9%
6	5.6	1104					
6a	4.05	2768	5	2.6	4461	-44%	47%
7	25.2	1517	6	32.8	2880	26%	62%

5. Conclusion

The objective of this research was to identify potential shortcomings of Army gameday Michie Stadium operations and security and find areas that could potentially create solutions to enhance the gameday experience for fans who come to watch Army football. Following the completion of the problem definition phase, a redefined the problem statement was created. The redefined problem statement was approved by the client, Dr. McCarthy. The solution design phase generated alternative solutions and used value scoring to select an optimal solution. The optimal solution selected was then simulated on ProModel. The details of this project can be found in the Interim Tech Report written by CDTs Abby Brancato, Aidan Gaines, Gabriel Neel, and Robert Sundy.

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