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Dedication

It is our pleasure and great privilege to present the fifty-second issue of the Academic Journal of Research and Scientific Publishing to all researchers and doctors who published their research in the issue, and we thanks and appreciate to all contributors and supporters of the academic journal and those involved in the production of this scientific knowledge edifice.

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The Quality of Crowd Management and Its Impact on the Experience of Event Visitors in Riyadh Season

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Abstract

This research aims to measure visitors' satisfaction and investigate how crowd management plans and service quality affects visitors' satisfaction in the Riyadh Season mega-event, To understand how visitors' experiences at the Riyadh Season affect their return intentions, To examine how health and safety practices affect visitors' experience and satisfaction at the Riyadh Season. Whereas the events that attract many people necessitate the organizers to have a crowd management plan and robust safety procedures to minimize possible risks. Whether sporting events, celebrity events, or major festivals, many people gathered in one place can have fatal consequences if not properly planned and controlled. Crowd management is essential for tourist attraction sites, especially for destinations that attract many visitors.

A cross sectional survey approach was used to gather information and achieve the study purpose. Survey questionnaire was distributed to 542 participants through Google survey. Quantitative analysis using SPSS was performed on the data collected. The findings showed that service quality positively impact customer satisfaction. Similarly, quality health and safety measures enhance customer experience and satisfaction. The result also found that satisfaction with Riyadh season events increased their return intentions.

Keywords: The Quality, Crowd Management, Experience, Event, Visitors, Riyadh Season

1. Introduction

Tourist destinations and other events often attract large crowds, putting pressure on event organizers to ensure the well-being and safety of all attendees. An excellent example of a big event is the Tomorrow land, one of the largest congregations of people in the world. Held in Belgium, this large-scale annual electronic dance music festival aims to connect global populations and unite future generations by creating lasting friendships and beautiful memories. The theme and main stage are changed every year to allow for innovative designs and new agendas. This mega festival has several stages to accommodate more attendees and provide diverse entertainment alternatives. Freedom, Garden of Madness, Harbor House, The Moose Bar, and Rose Garden comprise some of the destinations within Tomorrow land. In 2022, Tomorrowland attracted over 600,000 attendees, with over 800 artists performing on 16 stages (Barrionuevo, 2022). The idea of Tomorrowland has been replicated in many other countries, including Brazil and France. The Riyadh Season is another state-sponsored annual sports and entertainment festival that promotes non-religious tourism by celebrating Riyadh, technology, and the Saudi people/culture (Al-Khaldy et al., 2022). Sports events, entertainment activities, and product promotion gatherings comprise other large-scale events common in many locations globally. “Managing the movement of people in a hassle-free manner, managing crowds on peak days, ensuring the safety and security of attendees, and effective crowd management planning, should be the key focus areas to ensure an incident-free mass gathering events” (Kanaujiya & Tiwari, 2022, p. 263). This research explores the quality of crowd management and its impacts on the experience of event visitors in the Riyadh Season.

1.1. Research Aim

When individuals plan to visit various destinations and events, they expect to have the best time and form unforgettable memories. The objectives are jeopardized when event organizers fail to deliver quality services and effective crowd management. Besides, unruly crowds and undesirable outcomes, such as injuries and fatalities, create unwanted experiences and inform the intention not to return to particular tourist attraction sites. This research aims to examine the quality of crowd management and its impact on visitors' experiences and return intentions for future Riyadh Seasons.

1.2. Research Questions

- RQ 1** How do crowd management and service quality affect visitors' satisfaction in Riyadh Season?
- RQ 2** How does visitors' experience affect their return intentions at the Riyadh Season?
- RQ 3** How do health and safety practices affect visitors' experience and satisfaction at the Riyadh Season?

1.3. Hypotheses

The following alternative hypotheses guide the study.

- Ha1.** Crowd management and service quality significantly affect visitors' satisfaction in Riyadh Season.
- Ha2.** Visitors' experience at the Riyadh Season significantly affects their return intentions.
- Ha3.** Health and safety practices adopted at the Riyadh Season significantly affect visitors' experience and satisfaction.

1.4. Research Objectives

1. To measure visitors' satisfaction and investigate how crowd management plans and service quality affects visitors' satisfaction in the Riyadh Season mega-event
2. To understand how visitors' experiences at the Riyadh Season affect their return intentions
3. To examine how health and safety practices affect visitors' experience and satisfaction at the Riyadh Season

2. Literature Review

Event organizers and tourism promoters aim to plan and execute events in a way that increases the competitiveness of their events. Holding mega-events is increasingly becoming an effective method of driving tourism and marketing destinations. Local communities take pride in successful mega-events since such an outcome yields desirable results, such as higher income and more city visibility. Besides, hosting large events, such as the Olympics and the World Cup, costs fortunes in event organization and infrastructure. For these reasons, it is in the interest of event organizers to deliver fulfilling experiences to visitors and increase the return rate. This literature review explores the theoretical framework and the quality of crowd management from the context of visitor satisfaction, the influence of experience on visitors' return rate, and health and safety.

3. Theoretical Framework

The convergence and contagion theories comprise the two models forming the theoretical framework of this research. The convergence theory argues that crowd behaviors exhibited by people in a crowd are informed by preexisting beliefs and values (Thonhauser, 2022). In other words, people portray collective behavior when they subscribe to similar opinions, goals, and tastes. Therefore, like-minded individuals are likely to behave the same way when converging in one venue. The convergence theory posits that groups are formed by individuals who think the same way and have similar interests. For example, a group that exhibits violence must have a significant number of violent members in it. Otherwise, a group with peaceful members usually dissuades violence through robust policies and laws. Individuals behave similarly in a group because they have compatible motivations (Thonhauser, 2022). Crowd situations can trigger the collective misbehavior of adherents if similar interests drive the members. The convergence theory best explains the behavior of crowds in sporting events since fans supporting a particular team view rival fans as enemies, whether in victory or defeat.

While individuals affect the crowd in the convergence theory, the crowd influences individuals in the contagion theory. According to La Macchia and Winnifred (2016), being part of a crowd causes members to behave in a particular way due to emotional and irrational influences. In other words, crowd situations exert hypnotic influences on individuals so that they stop their rational thinking and follow other members' behavioral paths. This account explains why belonging to a particular group can result in emotionally-charged behavior.

Moreover, the anonymity of belonging to a crowd and the frenzy associated with many multitudes create an infectious outbreak of irrational behavior. The contagion theory explores the social-psychological aspects of group behavior by explaining how attitudes and moods move from one person to another through rapid acceptance (La Macchia & Winnifred, 2016). When individuals agree to become members of a group, they cease to be rational beings and, instead, become members with a collective mind. For this reason, individuals can engage in conduct they could not otherwise exhibit in private. This transformation can be disastrous for event organizers and crowd managers since well-mannered people can easily be influenced to become unreasonable, impulsive followers. The spread of negative attitudes and social aggressions in a crowd situation can impact tourists' experiences, satisfaction, and decision to return to the event. The convergence and contagion theories of crowd management encapsulate crowd dynamics when people act like a group.

Mega-Events and the Riyadh Season

Different cultures across the globe have embraced the idea of events and festivals since time immemorial. However, mega-events are a new trend that has gained popularity in recent decades. Commercial entities and governments host mega-events for branding and destination marketing purposes. Saudi Arabia and many other countries invest in mega festivals to attract positive outcomes, including creating employment and generating foreign exchange (Jago et al., 2010). Big events promote destinations by increasing competitiveness since more visitors translate into more spending. According to Al-Khaldy et al. (2022), mega-events can improve visitor attractions and compensate for off-peak tourism seasons. They enhance the influx of local and international visitors, improve local economies, and deliver many other advantages to the host cities and countries. Since mega-events often attract millions of attendees, organizers should acknowledge the possibility of stressing the local environment and infrastructure. It is also possible for mega-events to produce undesirable outcomes and fail to generate the expected benefits. Therefore, organizers should plan meticulously to address potential issues that prevent mega-events from realizing the expected benefits.

The Riyadh Season is a mega festival that runs over the five winter months in Riyadh. This city-wide celebration is hosted by the local General Entertainment Authority (GEA), and it includes a spectrum of entertainment activities, including virtual reality games, theatrical productions, firework shows,

music performances, and scenery watching (Al-Khaldy et al., 2022). The Riyadh Season is one of the many initiatives by the Saudi Arabia government to boost tourism and the economy. It also corresponds to Crown Prince Mohammed bin Salman's Vision 2030, which targets to transform the Kingdom. The festival is divided into different zones, each with a unique entertainment agenda. An artificial lake in Riyadh is also a major attraction in the Riyadh Season since it enables visitors to board submarines and boats. The Riyadh Season also includes live music performances from over a hundred renowned artists from different countries across different stages with cutting-edge sound systems. "Since its beginning, the number of visitors to the Riyadh Season has increased from 10 million in 2019 to 11 million in 2022, and about 10% of the visitors were international tourists belonging to 125 countries" (Al-Khaldy et al., 2022, p. 2). With more fun activities aimed to be included in Riyadh Season, this mega festival is projected to attract more local and international visitors in the coming years.

Crowd management is essential since people arrive in their millions to the different Riyadh Season zones. This study investigates the quality of crowd management in Riyadh Season and its impact on visitors' experiences. Existing literature confirms that organizing bodies at the Riyadh Season ensure visitors receive high-quality services in transportation and accommodation domains (Al-Khaldy et al., 2022). Visitors' experiences can determine their intentions to visit or return to the Riyadh Season and other attractions in Saudi Arabia. Munar and Jacobsen (2014) argued that "information sharing and social interaction among visitors could play an important role in tourists' decisions and their intentions to visit a destination" (p. 2). The connection between the Riyadh Season and national goals, such as Vision 2030, mandates the organizing bodies to ensure a high level of service quality to keep visitors entertained and yearning to return for subsequent mega festivals.

Crowd Management

Crowd management is the practice of controlling people gathered at events to prevent the occurrence of undesirable outcomes and disasters. This practice became manifest during the COVID-19 pandemic, whereby organizations and the government closely monitored social distancing and crowd behavior to prevent the spread of the deadly virus (Durán-Polanco & Siller, 2021). Notably, crowd management is a challenging task when handled by one individual. Instead, effective crowd management brings together the input of local authorities, emergency services, event planners, and the crowd itself (Martella et al., 2017).

More importantly, effectively managing crowd behavior calls for meticulous planning and the availability of enough resources, which often requires initiating plans in advance. Event organizers must collaborate with other experts to predict possible risks and create contingency plans to avoid unpleasant surprises.

Although event organizers spend considerable time and resources in comprehensive preparations, things can still get out of hand. Besides, some of the crowd disasters happened with robust plans in place. This argument corresponds to the contagion theory of crowd management since crowd behavior can be easily influenced from orderliness to irrationality. Tourist destinations and event organizers should strive to gather valuable information about expected, actual, and preferred crowd behavior (Gong et al., 2020). Attendees' age, gender, and other dynamics, such as access to alcoholic beverages, can help predict how the crowd will likely behave. Some of the best crowd management practices include using barricades, signage, and stanchions to maintain an orderly traffic flow. Interventions to monitor crowd behavior in real-time through technological means can enable early detection and quick corrective action to prevent disruptions and bad experiences.

Following outlined rules is at the core of effective crowd management. There is no denying that most events start and finish without issues. However, a significant fraction of tourist events encounters problems, mostly due to blatant disregard for established rules. According to Zhang et al. (2017), the risk of injury and fatalities increases when a few individuals fail to obey simple rules in a mega-event. Although there is considerable research on crowd management, little is known about its impact on visitors' experiences in mega-events. Moussaïd et al. (2011) noted that "even successful modeling approaches, such as those inspired by Newtonian force models, are still not fully consistent with empirical observations and are sometimes hard to calibrate" (p. 6884). Therefore, there is a need to explore this subject to discover better crowd management practices.

Visitor Satisfaction

Attractions are the main drivers of tourism. Without places that people are attracted to, tourism would hardly exist. According to Sukiman et al. (2013), when a person decides to explore a particular destination, they conduct research and mentally attempt to visualize it. This imagination provides the magnetism and motivation needed to initiate the idea of traveling domestically and internationally.

Although the element of attraction contributes significantly to tourism, other dynamics ensure the sustainability of tourism. In particular, the availing of essential tourist facilities and other provisions that enhance visitor experience ensures the continuity of tourism and event organization through visitor satisfaction (Sukiman et al., 2013). The tourism product is not one element but a combination of elements needed during a trip, including entertainment, transportation, accommodation, and food. These goods and services create a set of subjective experiences for event visitors, and event organizers must be careful not to make mistakes that result in unmet needs and undesirable experiences.

Maximizing visitor satisfaction is integral for successful event organization and fruitful business in tourism. According to Sukiman et al. (2013), “the evaluation of the physical products of destination (instrumental performance), as well as the psychological interpretation of a destination product (expressive attributes), are necessary for human actions, which could be represented as travel satisfaction and destination loyalty” (p. 79). Notably, expressive experiences influence visitor satisfaction more since they tap on people’s emotions. In contrast, instrumental performance is inclined toward cognitive orientation. When viewed from a business standpoint, instrumental performance and expressive experiences affect the demand and supply of tourism attractions, and they combine to determine overall visitor satisfaction.

Different authors have defined tourist satisfaction. According to Sukiman et al. (2013), “tourists’ satisfaction with a destination is the degree to which a tourist’s assessment of the attributes of that destination exceeds his or her expectations for those attributes” (p. 80). Cheng et al. (2022) argued that “visitor satisfaction is a visitor’s cognitive-emotional state after experiencing the services, facilities, or other attributes provided by a destination” (p. 144). Based on these definitions, visitor satisfaction is a post-purchase construct that measures the degree to which a person likes or dislikes a tourist offering after experiencing it. “In many cases, tourism satisfaction and perceived quality have much in common since visitors evaluate the quality of the service according to factors such as comfort, friendliness, security, cleanliness, accommodation, transportation, and infrastructure” (Carlos Castro et al., 2017, p. 281). Notably, satisfaction is accurately measured by comparing pre-travel expectations with actual experiences. Besides, travelers have specific vacation needs and preconceptions about a destination and experience dissatisfaction when tourism products fail to meet their expectations.

Overall, visitor satisfaction is the judgment that individuals make after encountering tourist offerings, and it differs from person to person since everyone has unique tastes and preferences.

Although visitor satisfaction is a heterogenous construct, several factors are known to influence it. Some common variables that affect the level of satisfaction include price, perceived quality, equipment, staff and procedure, and service efficiency (Lei et al., 2022; Sukiman et al., 2013). Event organizers and tourist destinations should do their best to ensure that most factors likely to affect customer satisfaction are properly implemented. Research by Adinegara et al. (2017) revealed that service quality is the main factor determining visitor satisfaction, which indicates that guest satisfaction is the cardinal driver in tourism and event management. The bottom line is that different tourists look for different factors when determining the best and worst destinations.

Influence of Experience on Visitors' Return Rate

The experience visitors have with crowd management during events and festivals significantly impacts their satisfaction levels and their likelihood of returning to the same event or destination in the future. The quality of crowd management plays a crucial role in shaping visitors' experiences, preventing crowd misbehavior, ensuring safety and security, and ultimately influencing their decision to return (Jin et al., 2019). This section explores the influence of experience on visitors' return rate and the importance of effective crowd management in achieving high visitor satisfaction.

The concept of revisiting intention can be compared to the consumer attitudes and willingness to buy. According to Manangiuli et al. (2019), "the willingness to buy is defined as a possibility when a buyer intends to buy a product" (p. 474). People commit to buying something after researching more about it or experiencing it. They tend to choose some products over others, even when most qualities seem equal. Purchase differs from purchase intent since the latter is a follow-up decision informed by individual buying interest. Besides, consuming attitudes are psychological tendencies whereby a person expresses favor or disfavor towards a specific consumption-related entity. In tourism, revisiting intention is how likely a traveler or event attendee is likely to return to a given destination or switch to an alternative location.

Revisit intention has been a subject of research for many years. Maintaining existing visitors is more important than looking for new attendees in destination marketing. "Many researchers conclude that repeat tourists prefer to remain at a destination longer, indulge in

consumer activities more intensively, are more fulfilled, and propagate favorable words of mouth, thus requiring much lower marketing costs than first-time visitors” (Showkat et al., 2021, p. 41). Several factors determining revisit intention include potential attraction, perceived value, service conduct, and satisfaction. It is paramount that tourist brands and event organizers enhance their reputations by considering attendees’ interests so that tourists develop the urge to revisit the destination. Besides, experience determines satisfaction, which directly informs revisiting tourists’ decision-making process. Satisfied tourists hardly accept alternative destinations since they order services from the initial provider. On the other hand, dissatisfied visitors develop a bad taste towards a destination and quickly accept new offers from alternative providers.

The attractiveness of a vacation spot is a major factor in how visitors spend their time there and whether or not they will return. Visitors might be captivated and moved by a place’s natural beauty, such as breathtaking scenery, pristine beaches, or towering mountains (Park et al., 2019). Tourists may also fully immerse themselves in a destination’s rich history due to the existence of cultural heritage and historical sites. In addition, thrilling water sports and tranquil hiking routes may provide enough opportunity for exploration and rest. There is a high chance of returning when there is enough to enjoy to the extent that a visitor does not exhaust the tourist products. In contrast, tourists hardly visit destinations where they have exhaustively covered everything there is to see.

According to Nguyen Viet et al. (2020), service quality is another crucial factor influencing tourists’ experiences and intention to return. Hotels, motels, and vacation rentals are essential in making a visitor’s stay enjoyable. Facilities like clean public areas, comfortable rooms, and valuable services like swimming pools, spas, and fitness centers ensure a pleasurable stay. Tourists’ impressions of a destination can also be significantly influenced by the quality of its transportation infrastructure, including public transit and the availability of rental cars.

Interactions with local communities and the hospitality of residents also shape tourists’ experiences. Friendly residents who are proud of their heritage and willing to share it with guests may help them feel at home and make lasting impressions. Interacting with locals in this way, whether through cultural performances, local cuisine, or guided tours, creates a genuine and engrossing experience (Park et al., 2019).

The experience of interacting with locals and gaining insight into their customs can make a lasting impact, snowballing the probability that they will return and further explore the local culture.

The quality of crowd management influences tourist satisfaction. Visitors are more likely to enjoy an event if they perceive it as well-organized, safe, and well-managed. However, if crowd management is inadequate, and visitors experience problems like congestion, lengthy wait times, or a lack of security, their experience is likely less than satisfactory. For visitors to have a positive experience, the features of the location they visited must surpass their expectations (Chen et al., 2020). Visitors are more likely to leave a destination satisfied if they find the service, comfort, friendliness, security, cleanliness, lodging, transportation, and infrastructure above average. Therefore, the success of the Riyadh Season depends on the city's ability to provide first-rate transportation, accommodation, and crowd control services to its visitors.

Understanding the influence of experience on visitors' return rate is essential for event organizers and tourist destinations. By delivering positive experiences through effective crowd management, organizers can increase visitors' return rates and promote the event's long-term sustainability. Moreover, happy guests are more inclined to spread the word about the event's success. The significance of providing high-quality services and experiences to event attendees cannot be overstated. The influence of experience on visitors' return rate is a crucial aspect to consider in crowd management. Visitors' experiences during an event can greatly impact their decision to return in the future. Visitors are more likely to return and endorse an event if they have had a positive experience characterized by effective crowd control, well-organized amenities, and a feeling of safety. Overcrowding, lengthy lines, and a lack of safety precautions are examples of what might turn tourists off and ruin an otherwise successful event or venue (Feliciani et al., 2022). The success of crowd control strategies is connected to happy tourists. When crowds are managed effectively, business runs smoothly, interruptions are minimal, and everyone enjoys their time. When guests' needs for security and comfort are met, they are more likely to have a good time and form favorable impressions of the event or tourist destination.

There are a variety of approaches that destinations can use to cultivate an atmosphere that leads to memorable experiences and repeat visits. First, a destination's cultural and natural resources must be protected and maintained. Preserving the destination's allure and ensuring its long-term viability by investing in infrastructure and environmental conservation is possible.

Secondly, developing high-quality tourism services should be prioritized (Nguyen Viet et al., 2020). Service providers in the tourism industry can benefit from ongoing training and professional development programs that raise industry standards and guarantee a continually pleasant experience for visitors. Positive encounters between tourists and locals can also be supported by encouraging participation in and pride in one's community. Tourists get a sense of the community's warmth and spirit if local businesses are supported, cultural activities are promoted, and public gatherings are held.

The influence of experience on visitors' return rate in the context of crowd management is a significant aspect to consider for event organizers and tourist destinations. Effective crowd management practices prioritizing visitor safety, efficient operations, and a positive atmosphere can greatly enhance visitor satisfaction and increase the likelihood of return visits. By investing in robust crowd management plans, utilizing technology, and promoting collaboration among stakeholders, event organizers can create memorable experiences that attract visitors and encourage them to revisit in the future. Therefore, delivering fulfilling experiences and ensuring visitor satisfaction are critical factors in the success of events and tourism growth.

Health and Safety

A large part of event management entails ensuring event attendees' and staff members' health and safety. Besides, the responsibility for the safety and health of event attendees rests with the organizers (Toneva, 2022). It is no good for destinations and mega events to spend fortunes organizing mega festivals if the arenas are not safeguarded from safety and health issues. Holding big events entertains the audience and facilitates memory creation so that they consider returning and providing positive reviews. If the attendees go home with injuries or near-death experiences, they may neither recommend the event to their friends nor have plans to return. In contrast, an event that caters to the health and safety of attendees gives the attendees numerous reasons to return. For this reason, event organizers and destination marketers should aim to project possibilities and take measures to address potential issues and mitigate risks.

Several examples can reinforce the idea of health and safety in mega events and the need for appropriate crowd management practices. The Internet is filled with stories about inpatient individuals pushing to see celebrities or get closer to the stage, resulting in people dying in horrible circumstances. Recent issues with events in Europe and Asia underscore the integral role of crowd management.

Wee and Suhartono (2022) described an incident involving soccer fans in Indonesia. In particular, fans invaded a soccer match in October 2022 at Kanjuruhan Stadium in Malang, causing a deadly stampede. The home fans were unhappy to lose to a rival team, and the anger spilled out, leading to a crash. Unfortunately, the response by the police caused more harm than good. In an attempt to control the unruly crowd, the police fired teargas, causing a deadly rush for exits. Teargas was not the best solution since the police did not envisage the possibility of a stampede. Although teargas is often used in crowd management, it is best used in open spaces, where protesters can disperse and run in different directions without causing commotion. Causing panic aggravates unrest instead of prioritizing the health and safety of visitors.

Crowd mismanagement can also negatively impact the health and safety of visitors. Incidents in European airports and airlines caused delays and confusion, which are recipes for disasters and dangerous outcomes. Yeginsu (2022) reported that aviation workers held strikes demanding higher salaries and working conditions, paralyzing operations at many European airports. As mentioned previously, effective crowd management calls for the concerted effort of different stakeholders and proper coordination of all activities. In situations where flights are delayed or canceled without notice, travelers get stranded at the airport. More importantly, some travelers may be on their way to fulfill urgent medical appointments. The absence of enough workers caused the bypassing of established bypass procedures, such as failing to check baggage before loading it into airplanes (Yeginsu, 2022). As witnessed in previous plane hijacking incidences, allowing unchecked baggage into the airplane is a recipe for disaster. Finding sustainable ways to address worker concerns is a better approach since it ensures the safety and health of travelers.

Stampedes and disasters are the most common safety concerns for mega-events. According to Kanaujiya and Tiwari (2022): Based on earlier experiences, the causes of stampedes and disasters can be classified into structural collapse, fire accidents and behavior of crowd, security, no clear evacuation plan, and lack of coordination between stakeholders and less known and understanding of emergency plan of traffic diversion to the enforcement agency (p. 264),

The aspects that complete a wholesome and fulfilling visitor experience include structurally strong arenas and proper safety protocols. Structural collapse arises when the amount of live load exerted on a structure, such as a stadium, exceeds the stress limit, causing the

structure to fail. Such instances are common when the structural integrity of buildings is substandard. For example, a section of a stadium in El Espinal collapsed during a bullfight, leaving four dead and hundreds injured (Pozzebon, 2022). Crowd management practices can also lead to preventable accidents. “Lack of proper planning and feedback from multi-stakeholders, under deployment of security personnel, lack of in-depth training and briefing regarding crowd control, emergency plan and technology use affect security personnel’s capacity to face the challenge in case of disaster” (Kanaujiya & Tiwari, 2022, p. 265). Safeguarding the safety and health of event attendees requires careful planning and examining the structural integrity of venues.

Another fundamental factor that contributes to visitor satisfaction is the ability to navigate the event venue easily. Well-designed signage, clear directions, and efficient crowd flow management can significantly enhance visitors’ experience and reduce frustration. There should not be any bottlenecks or other impediments to visitors as they make their way around the venue. Strategies for managing large crowds must consider how many people are expected to attend, how to keep them under control, and how to ensure they have access to restrooms, food, and medical care. In addition, providing sufficient safety measures is of utmost importance while managing crowds (Chen et al., 2020). The safety and security of guests should be a top priority. Thus, precautions have been taken against accidents, crises, and other threats. For example, hiring trained staff members capable of managing crowd situations, implementing emergency response plans, and providing clear communication channels to inform visitors of any changes or updates are integral to successful tourist trips (Jin et al., 2019). In addition to safety, the overall atmosphere and ambiance of the event play a significant role in visitors’ satisfaction and the likelihood of returning. Attendees have a good time if there are comprehensive crowd control measures and people keep their cool without following crowd behavior. However, crowd problems like aggressive behavior or disagreements between attendees can ruin the experience for everyone. Therefore, event organizers managing events with large numbers of attendees must understand the possible latent risks and dangerous fatal consequences if effective planning is ignored.

3. Methodology

This chapter describes the methodology that was used in this research. The adopted methodology to accomplish this study uses the following techniques: the information about the

research design, research population, questionnaire design, statistical data analysis, content validity and pilot study.

3.1. Research Method

Cross-sectional survey research was selected as the ideal methodology for this project. This quantitative research approach is suitable since this research entails examining different variables, including visitors' satisfaction, return rate, and health/safety. Besides, crowd management and its impact on visitors' experience are social phenomena that can be communicated using numbers and statistics since they focus on "how" and "why" questions. Understanding the impact of crowd management on visitors' experience also requires the input of many participants rather than a small sample. Lastly, the cross-sectional quantitative research was selected due to the possibility of generalizing findings, examining causal relationships, and predicting future results, especially when the sample is representative of the study population.

3.2. Data Collection and Analysis

To collect the needed data for this research, secondary resources, including books, journals, statistics and web pages, were used in addition to preliminary resources that were not available in secondary resources through distribute questionnaires on study population. The questionnaire was administered to the 542 participants online via Google surveys. Collected data was presented in tables and charts. Descriptive and inferential data analysis methods were used to explain underlying phenomena and make predictions, respectively. The findings were used to justify or reject the hypothesis and answer the research questions.

The study is classified as descriptive and analytical studies, which is the method on which the researcher relies to obtain accurate information depicting social reality and contributing to the analysis of the phenomenon. The descriptive study aimed to collect accurate information about a group, society or phenomenon, formulate generalizations or findings related to "The Quality of Crowd Management and Its Impact on the Experience of Event Visitors in Riyadh Season," and develop a set of recommendations related to the results of study. Additionally, a sample random was used to collect data, and the researcher used SPSS V26 to analyze the data.

3.3. Target Population and Sample Size

The target population for this research is the visitors who purchase tickets and attend the Riyadh Season mega festival. The individuals can be Saudi natives or international visitors. The researcher aimed to invite at least 542 participants to respond to the online questionnaire.

3.4. Research Instrument

The research instrument for this study is the survey. A four-sectioned questionnaire was developed, and it contains close-ended questions. The questionnaire was provided with a covering letter explaining the purpose of the study, the way of responding, the aim of the research and the security of the information in order to encourage a high response. The questionnaire included multiple choice question: which used widely in the questionnaire, The variety in these questions aims first to meet the research objectives, and to collect all the necessary data that can support the discussion, results and recommendations in the research. The sections in the questionnaire are the following:

Section 1: Demographic data

Section 2: Visitor satisfaction aspects

Section 3: Influence of experience on visitors' return rate

Section 4: Health and safety

The respondent in section three and five can answer the items with a number from 1 to 5 where (5) represents the highest acceptance degree about an item and (1) represents the lowest acceptance degree about it as illustrated in table 1.

Table 1: Respondent Scale

Level	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Scale	1	2	3	4	5
Mean Range	1.0-1.8	1.8-2.6	2.6-3.4	3.4-4.2	4.2-5.0
Weight mean	20%-36%	36%-52%	52%-68%	68%-84%	84%-100%

Pilot study

Content Validity of the Questionnaire

Content validity test was conducted by consulting two groups of experts. The first was requested to evaluate and identify whether the questions agreed with the scope of the items and the extent to which these items reflect the concept of the research problem. The other was requested to evaluate that the instrument used is valid statistically and that the questionnaire was designed well enough to provide relations and tests between variables.

The two groups of experts did agree that the questionnaire was valid and suitable enough to measure the concept of interest with some amendments.

Statistical Validity of the Questionnaire

To ensure the validity of the questionnaire, two statistical tests should be applied (Brains et al., 2011), The first test is Criterion-related validity test (Pearson test) which measure the correlation coefficient between each item in the field and the whole field. The second test is structure validity test (Pearson test) that used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one field and all the fields of the questionnaire that have the same level of similar scale (Kramer et al., 2009).

Criterion Related Validity - Internal Consistency. Internal consistency of the questionnaire is measured by a scouting sample, which consisted of thirty questionnaires, through measuring the correlation coefficients between each question in one field and the whole field. Table 2 below shows the correlation coefficient and p-value for each field items. As show in the table the p-values are less than 0.05 or 0.01, so the correlation coefficients of this field are significant at $\alpha = 0.01$ or $\alpha = 0.05$, so it can be said that the paragraphs of this field are consistent and valid to be measure what it was set for.

Table 2: The correlation coefficient between each item in the field and the whole field

Section 2: Visitor Satisfaction Aspects			Section 3: Influence of Experience on Visitors' Return Rate			Section 4: Health and Safety		
Item no	Pearson coefficient	p-value	Item no	Pearson coefficient	p-value	Item no	Pearson coefficient	p-value
1	.818**	0.000	1	.768**	0.000	1	.829**	0.000
2	.891**	0.000	2	.857**	0.000	2	.772**	0.000
3	.884**	0.000	3	.896**	0.000	3	.875**	0.000
4	.845**	0.000	4	.720**	0.000	4	.717**	0.000
5	.920**	0.000	5	.811**	0.000	5	.781**	0.000
6	.883**	0.000	6	.880**	0.000	6	.740**	0.000
7	.931**	0.000				7	.646**	0.000
8	.802**	0.000				8	.735**	0.000

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

Structure Validity of the Questionnaire. Structure validity is the second statistical test that used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one field and all the fields of the questionnaire that have the same level of Likert scale. As shown in table 3, the significance values are less than 0.01, so the correlation coefficients of all the fields are significant at $\alpha = 0.01$, so it can be said that the fields are valid to be measured what it was set for to achieve the main aim of the study

Table 3: Structure Validity of the Questionnaire

No.	Section	Pearson coefficient	p-value
1	Section 2: Visitor Satisfaction Aspects	.809**	0.000
2	Section 3: Influence of Experience on Visitors' Return Rate	.729**	0.000
3	Section 4: Health and Safety	.768**	0.000

**Correlation is significant at the 0.01 level (2-tailed).

Reliability of the Research

Reliability of an instrument is the degree of consistency with which it measures the attribute it is supposed to be measuring. The test is repeated to the same sample of people on two occasions and then compares the scores obtained by computing a reliability coefficient. For most purposes, reliability coefficient above 0.70 are considered satisfactory. Period of two weeks to a month is recommended between two tests Due to complicated conditions that the consumer is facing at the time being, it was too difficult to ask them to responds to our questionnaire twice within short period. The statistician's explained that, overcoming the distribution of the questionnaire twice to measure the reliability can be achieved by using Kronpakh Alpha coefficient and Half Split Method through the SPSS software.

Half Split Method

This method depends on finding Pearson correlation coefficient between the means of odd rank questions and even rank questions of each field of the questionnaire. Then, correcting the Pearson correlation coefficients can be done by using Spearman Brown correlation

coefficient of correction. The corrected correlation coefficient (consistency coefficient) is computed according to the following equation (Eisinga et al., 2012):

Consistency coefficient = $2r/(r+1)$ (where r is the Pearson correlation coefficient)

The normal range of corrected correlation coefficient $2r/(r+1)$ is between 0.0 and + 1.0. As shown in Table 4 the reliability coefficient was calculated and ranged from (0.830 – 0.960), and the general reliability for all items equal 0.869. It can be said that according to the Half Split method, this reliability is considered high; the result ensures the reliability of the questionnaire

Table 4: Split-Half Coefficient Method

No.	Section	person- correlation	Spearman-Brown Coefficient
1	Section 2: Visitor Satisfaction Aspects	0.923	0.960
2	Section 3: Influence of Experience on Visitors' Return Rate	0.816	0.899
3	Section 4: Health and Safety	0.71	0.830
	All sections	0.768	0.869

Cronbach's Coefficient Alpha

This method is used to measure the reliability of the questionnaire between each field and the mean of the whole fields of the questionnaire. The normal range of Cronbach's coefficient alpha value between 0.0 and + 1.0, and the higher values reflects a higher degree of internal consistency (Ritter, 2010). As shown in Table 5 the Cronbach's coefficient alpha was calculated and ranged from (0.827 – 0.953). The general reliability for all items equal 0.923. This reliability is considered high; the result ensures the reliability of the questionnaire.

Table 5: Cronbach's Alpha for Reliability

No.	Section	No. of items	Cronbach's Alpha
1	Section 2: Visitor Satisfaction Aspects	8	0.953
2	Section 3: Influence of Experience on Visitors' Return Rate	6	0.836
3	Section 4: Health and Safety	8	0.827
	All sections	22	0.923

Statistical Analysis Tools

The researcher used in the data analysis both qualitative and quantitative data analysis methods. The data analysis was conducted using (SPSS 26). The researcher used the following statistical tools:

- 1) Pearson Correlation Coefficient for Validity and correlation between variables (Brains et al., 2011).
- 2) Cronbach's Alpha for Reliability Statistics (Ritter, 2010).
- 3) Frequency and Descriptive analysis as mean and standard deviation.
- 4) One sample t-test to test the difference between the mean of item and "3."

Pilot Test Results

A reliable questionnaire is critical in ensuring the consistency, accuracy, and dependability of research findings. Voellinger et al. (2010) define reliability as the extent to which a questionnaire generates consistent results over time. This paper aims to establish the reliability of the questionnaire by examining the internal consistency of the items and the consistency of the responses.

Data

The reliability of the questionnaire was tested using the data file "Reliability data.sav," which includes 30 responses. Some questions in sections 1 and 2 were answered twice by the same respondents but at two different times. This outcome is because they measured different constructs. Their reliability was evaluated using the test-retest method instead of the internal consistency method of Cronbach Alpha.

Demographic Data

One way to ensure the reliability of questionnaire responses is by employing the test-retest method. This technique involves administering the same set of questions to the same group of respondents at two different times and then comparing their responses to determine consistency. The test-retest method is particularly appropriate for demographic-related questions since these questions are unlikely to change over time, and the respondents' answers are expected to remain stable. Correlation analysis between the two sets of responses was used to determine the consistency of the responses statistically. A near-perfect positive correlation between the two responses indicates high consistency.

Correlation analysis using Statistical Packages for Social Sciences (SPSS) was used to examine the consistency of the responses. For instance, to examine the consistency of gender response, correlation analysis between the first set of responses (Gender) and the second set of responses (Gender 2) was conducted.

The procedure above demonstrates how to check for consistency in responses to the gender variable. The same procedure is applied to test the consistency of other demographic variables. The results of the correlations are presented in Table 6.

Table 6: Correlation Results for Section 1 questions

		Correlation with the Second Set of responses
Gender	Pearson Correlation	1.000**
Age	Pearson Correlation	1.000**
Marital	Pearson Correlation	1.000**
Education	Pearson Correlation	1.000**
Ticket rank	Pearson Correlation	1.000**
Riyadh	Pearson Correlation	1.000**

Source: SPSS Output

Table 6 presents the results of the correlation analysis conducted to test the consistency of responses to the demographic questions. The table shows that the correlation coefficients for all demographic variables, including gender, age, marital status, educational level, ticket rank, and Riyadh visits, are close to 1. This correlation indicates a high degree of consistency and reliability in the responses provided by the participants. Specifically, the perfect correlation coefficient of 1 indicates that the respondents provided the same answer to the demographic questions at both time points, indicating that the measurement is stable over time. The high reliability of the demographic variables suggests that they can be used confidently in subsequent analyses and that the results are likely to be valid.

Visitor Satisfaction Aspects

Section 2 of the questionnaire includes the first five questions that measure visitor satisfaction. However, these questions do not precisely measure a single construct and allow multiple choices. Therefore, to examine their reliability, the test-retest method, as demonstrated above, is used for questions 1, 2, and 5, while the Cronbach Alpha method is used for questions 3 and 4. Questions 4 and 5 measure the same satisfaction construct using a 5-point Likert scale

with satisfaction levels as scale anchors. Table 7 shows the correlation results, Table 8 presents the Cronbach Alpha reliability results, and Table 9 presents the item's total statistics.

Table 7: Correlation Results for Section 2 Questions

Correlation with the Second Set of responses		
Objective when attending	Pearson Correlation	1.000**
What to look for	Pearson Correlation	1.000**
Visit Riyadh Again	Pearson Correlation	1.000**

Source: SPSS Output

Table 7 presents the correlation results for questions 1, 2, and 5 in section 2 of the questionnaire, indicating the correlation between the first and second sets of responses. The table reveals that all the questions exhibit a correlation coefficient of 1, demonstrating high consistency and reliability. Therefore, the test-retest method confirms that questions 1, 2, and 5 in section 2 are reliable for measuring visitor satisfaction.

Table 8: Cronbach Alpha Results

Cronbach's Alpha	N of Items
0.911	2

Source: SPSS Output

Table 8 shows the results of Cronbach's Alpha for questions 3 and 4 in section 2 of the questionnaire. A Cronbach's Alpha value ranges between 0 and 1, with values closer to 1 indicating higher levels of internal consistency reliability. In this case, Cronbach's Alpha value is 0.911, close to 1, indicating high internal consistency reliability for questions 3 and 4.

Table 9: Item Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Satisfaction1	2.57	1.426	.838	.
Satisfaction2	2.37	1.275	.838	.

Source: SPSS Output

Table 9 tests the reliability of two items (Satisfaction1 and Satisfaction2) on a scale. The first column, "Scale Mean if Item Deleted," shows the mean score of the scale if the particular item is deleted from it. The second column, "Scale Variance if Item Deleted," shows the variance of the scale if the item is deleted. The third column, "Corrected Item-Total Correlation," shows the correlation between each item and the total scale score after controlling for overlap. The fourth column, "Cronbach's Alpha if Item Deleted," shows the Cronbach's alpha value of the scale if the item is deleted. In this case, both Satisfaction1 (question 3) and Satisfaction2 (question 4) have similar corrected item-total correlations, and if either of them is deleted, Cronbach's alpha value will remain the same. In addition, section 2 further asks questions regarding how visitors rate the services. Eight items attempt to measure the same construct of service quality. These items are measured on a 5-point Likert Scale using adequacy levels as scale anchors. Therefore, in this case, Cronbach's Alpha can be used to establish reliability. Table 10 shows the Cronbach Alpha test reliability results, and Table 11 shows the item total statistics.

Table 10: Cronbach Alpha Results

Cronbach's Alpha	N of Items
0.577	8

Source: SPSS Output

Table 10 shows the results of Cronbach's Alpha for how visitors rate service items in section 2 of the questionnaire. The Cronbach's Alpha value of 0.577 is below the commonly accepted threshold of 0.7, indicating that the items are not highly correlated. This Alpha suggests that the items may be measuring different constructs or that there may be issues with the wording or response options. Further examination and refinement of the items are necessary to improve the internal consistency of this section of the questionnaire. Table 11 on items' total statistics further examines each item.

Table 11: Item Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SQ1 (Item 1)	22.20	25.269	.056	.622
SQ2 (Item 2)	21.97	24.171	.250	.554
SQ3 (Item 3)	22.00	20.621	.458	.483

SQ4 (Item 4)	21.67	20.437	.509	.467
SQ5 (Item 5)	21.87	20.947	.486	.478
SQ6 (Item 6)	21.80	19.959	.577	.445
SQ7 (Item 7)	22.40	25.834	.082	.601
SQ8 (Item 8)	22.27	26.892	-.030	.640

Source: SPSS Output

Table 11 presents the item-total statistics, and the most crucial column is Cronbach's Alpha value of the scale if the item is deleted. The results indicate that if the first, seventh, and eighth items are deleted, the Alpha will improve to 0.622, 0.601, and 0.604, respectively. After deleting these items, Cronbach's Alpha will increase to 0.763, suggesting that these items require further scrutiny and modification to improve the scale's reliability.

Visitors' Return Rate

The items in section 3 of the questionnaire measure one construct: willingness to return. These items are measured using a 5-point Likert scale with agreement levels as scale anchors. Therefore, the internal consistency of these items can be evaluated using Cronbach's Alpha. Table 12 displays the results of the Cronbach Alpha analysis, while Table 13 presents the item total statistics.

Table 12: Cronbach Alpha Results

Cronbach's Alpha	N of Items
0.893	6

Source: SPSS Output

Table 12 shows Cronbach's Alpha and the number of items for visitors' willingness to return questions. The value of Cronbach's Alpha is 0.893, and six items are in the set of questions. The Alpha indicates high internal consistency or reliability of the items in measuring the construct of return rate.

Table 13: Item Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Cronbach's Alpha if Item Deleted
Willingness1 (item 1)	17.00	26.483	.731	.872
Willingness2 (item 2)	16.73	29.099	.753	.878

Willingness3 (item 3)	17.33	24.989	.854	.853
Willingness4 (item 4)	16.87	22.326	.864	.849
Willingness5 (item 5)	18.13	27.913	.499	.908
Willingness6 (item 6)	17.27	24.547	.700	.879

Source: SPSS Output

Table 13 presents the item total statistics results, focusing on Cronbach's Alpha if an item is deleted. The analysis indicates that the reliability of the section can only be improved by deleting or revising item number 5. Therefore, there is no need for further scrutiny of the items.

Health and Safety

The items in section 4 of the questionnaire measure one construct, namely health and safety. These items are measured using a 5-point Likert scale with agreement levels as scale anchors. Therefore, the internal consistency of these items can be evaluated using Cronbach's Alpha. Table 14 displays the results of the Cronbach Alpha analysis, while Table 15 presents the item total statistics.

Table 14: Cronbach Alpha Results

Cronbach's Alpha	N of Items
0.984	8

Source: SPSS Output

Table 14 shows Cronbach's Alpha and the number of items for health and safety questions. The value of Cronbach's Alpha is 0.984, and eight items are in the set of questions. The Alpha indicates the items' high internal consistency or reliability in measuring health and safety.

Table 15: Item Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Cronbach's Alpha if Item Deleted
HS1 (item1)	23.10	111.886	.892	.985
HS2 (item1)	23.53	102.189	.951	.980
HS3 (item1)	23.43	103.840	.931	.982
HS4 (item1)	23.47	98.809	.945	.981
HS5 (item1)	23.37	101.068	.948	.981

HS6 (item1)	23.47	98.533	.955	.980
HS7 (item1)	23.60	100.938	.941	.981
HS8 (item1)	23.63	98.792	.949	.981

Source: SPSS Output

Table 15 presents the item total statistics results. The analysis indicates that the reliability of the section can only be improved by deleting or revising item number 1. Therefore, there is no need for further scrutiny of the items.

Conclusion

The reliability analysis results indicate that the questionnaire items have generally high reliability, except for some items in section 2 that purport to measure service quality. These items do not exhibit high internal consistency and require further scrutiny. The items in section 3 measure a single construct and have high internal consistency. The reliability analysis provides important insights that can inform future questionnaire revisions.

4. Data Analysis and Discussion

Introduction

This section presents the findings from the data collected in relation to the research objectives. The section begins by analysis of demographic characteristics, then the descriptive characteristics. The results the engage in correlation analysis to test the hypotheses outlined in chapter 1.

Demographic Characteristics

Demographic analysis was performed to determine sample distribution in accordance to age group, marital status and education level.

Age Distribution

Majority of the respondents were between the age of 25-35 years (39.7%). Those who were between 18-25 years were 30.1% and those who were within the age group of 35-45 years were 20.5%. participants who were above 45 years represented 6.3% of the sample size while those who were under 18 years represented 3.5%.

Distribution by Gender

56.87% of the sample were males while 46.13% of the sample were female.

Distribution by Marital Status

55.17% of the sample were married, 36.90% were single while 7.93% were divorced.

Distribution by Education Level

39.11% of the sample had reached university level of education. 21.22% reached high school level, 21.22% had reached college level, 10.89% had reached masters degree level. The result also showed that 5.90% had reached middle school, 0.92 had reached PhD level and 0.74% had reached elementary level of education.

Service quality and Visitor Satisfaction Aspects

Attendance of Riyadh Seasons

87.3% of the sample indicated that they had attended Riyadh season while only 12.7% had not attended Riyadh season. Of the 87.3% who had attended Riyadh season, 55% used standard tickets while 33.9% used premium tickets. Only 11.1% used VIP tickets.

Satisfaction with Riyadh

Participants were asked to indicate the level at which they were satisfied with the Riyadh season. In accordance to service provision, 51.1% were satisfied while 19.2% were very satisfied. 26.8% were neutral. The result further showed that 1.8% were not satisfied and another 1.1% indicated that they were very upset with the service provision.

Additionally, the results showed that 37.3% were satisfied with the ticket cost and another 10.9% indicated that they were very satisfied with the ticket cost. 35.2% were neutral about the ticket cost. However, 0.9% were dissatisfied with the ticket cost, 12.2% were not satisfied with the same. Similarly, 0.2% were very dissatisfied and 3.3% were very upset with the ticket cost.

The result also indicated that majority of the participants (83.8%) would visit Riyadh season again. While 16.2% indicated that, they would not visit Riyadh season again.

Descriptive statistics on Riyadh Services and Ticket Cost

Participants were asked to rate the level at which they would describe different Riyadh services. Participants were presented with statements unto which they were to rate how they describe service provision and ticket cost in venues they visited during the Riyadh season. The findings are shown in the preceding subsections.

Access to services

Participants were asked to rate statements in accordance to the level at which they described services in the venue they visited. The findings is shown in table 16 below.

Table 16: Access to Services

Variable	Adequate	Enough	Excellent	Good	Reasonable	Not Enough
	%	%	%	%	%	%
Ease of identifying and reaching the event venue	0.6	40.6	10.5	14.4	22.5	11.4
Ease of access and navigation within the venue (disabled access and signage)	0.7	19.6	9.6	20.7	34.7	14.8
Knowledge of foreign language by staff members	0.7	27.9	9.8	20.3	30.6	10.7
Behavior and courtesy, availability of staff members	0.4	33.2	15.1	19.4	24.7	7.2
Competency of staff members	0.4	28.4	13.3	18.6	32.8	6.5
Staff members' ability to understand and provide customized and personalized services	0.4	26.6	13.3	17.7	35.6	6.5
The cleanliness of the sites	0.6	25.1	14.4	17.5	34.5	7.9
Food court's accessibility	0.7	23.4	14	20.5	36.9	4.4

Return Intention

Participants were asked to rate the level at which they agree or disagree with statements related to whether they are willing to attend the Riyadh venue again. The findings are shown in table 17 below.

Table 17: Return intentions

Variable	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	%	%	%	%	%
I will attend the event again if the number of attendees is reduced to manageable levels	8.9	22.9	29.3	28.2	10.7
I will attend the event again if the security personnel are empowered to screen attendees for contraband and deny entry to disruptive people	15.7	24.9	41	11.1	7.4
will attend the event again if there is an adequate deployment of security personnel	12.9	25.8	29	14	18.3
I will return for a similar event if the organizers adhere to health and safety protocols	14.6	22.1	33.9	20.5	8.9
I will return to an event if I receive a memorable experience and value for my money	17.2	24.9	28.2	19.7	10
I will attend the event again if organizers install appropriate signage, such as exit routes, and make adequate first aid and emergency arrangements	15.5	24.5	32.7	18.5	8.9

Health and safety on visitor's experience and satisfaction

Analysis was performed to rate the level at which participants agreed with health and safety preferences as indicated in the statements. The findings are shown in table 18 below.

Table 18: Health and safety on Visitors' experience and satisfaction

Variable	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	%	%	%	%	%
I am happy to attend events with meticulous emergency plans, proper public health protocols, turnstiles, and enough security personnel	15.7	29.5	19.4	25.5	10
I prefer events with onsite emergency responses, including fire extinguishers, alarm systems, and standby ambulances	17.2	29.9	27.9	14.2	10.9
I feel satisfied when organizers separate the spectators who can potentially clash using clear demarcations	15.3	26.6	26.2	19.2	12.7
I feel reassured when the event manager confirms that the event has insurance coverage to take care of any arising health risks	16.6	26.2	28.8	20.8	7.6
I will consider attending an event for which I have seen effective safety awareness campaigns and proper crowd management to prevent falling and being trampled upon	15.9	23.8	28.2	22.1	10
I am happy to attend an event for which a risk assessment has been conducted using a health and safety checklist to identify COVID-19, weather, fire, equipment, and other hazards	15.5	23.6	26.9	22.7	11.3
The best tourism event is family-friendly since I care about children's safety	15.7	25.3	32.3	20.7	6.1

I will only eat food at an event if I am assured that the catering company did due diligence to observe hygiene, handle allergies, and prevent foodborne illnesses	17.3	21.8	34.1	19	7.7
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Correlation Analysis

A correlation analysis was performed to understand the strength and direction of relationship between experience in service provision, ticket cost and customer satisfaction. The correlation analysis further sought to understand the association between ticketing and service provision with visitor's likelihood of returning to Riyadh season.

Service Quality and Visitor's Satisfaction

A correlation analysis was performed to determine the association between service management and visitors' satisfaction. The findings are shown in the table 19 below.

5. Discussion

The results from analysis performed shed light on the quality of crowd management and its impact on experience of event visitors in Riyadh season. Data was collected from the Riyadh season visitors and as such the sample characteristics provided a highlight on the demographic characteristics of the visitors. In this case, the results indicated that majority of the visitors are within the age range of 18 – 35. Notably, the results showed that older people especially those who were 45 years and above had minimal attendance of Riyadh season events. It was deduced that people within the age range of 18 – 35 are more likely to socialize, explore and connect with others. Consequently, according to Gorbato and Chuvatkin (2020), they are more likely to attend events and visit attraction sites. Notably, as people grow older, their level of socialization gradually slows and the need to explore diminishes. This explains why older people, especially those who were 45 years and older had minimal attendance of Riyadh events. There was no significant gender difference among visitor of Riyadh events. The percentage of male population and female population was closely equal. In this case, the study deduced that attendance of Riyadh events is attractive to all despite gender. Besides, majority of the visitors were found to be married couples compared to those who were divorced or single. This shows that Riyadh events are more attractive to families than just individuals.

This explains why very few visitors of the event were divorced people. Besides, the proportion of single visitors was not close to those who were married.

The study further revealed that among those who visited Riyadh events, majority were at university level of education followed by college level of education. Very few visitors had completed their PhD level of education. The results from the education level confirms the findings that majority of visitors were within the age range of 18 – 35. At this age level, most individuals are at their university or college level of education. Accordingly, they love to explore, socialize and visit new places during their free time as indicated by (Latosińska & Ludwicka, 2010). Besides, individuals who are at their college or university level of education consider socialization and exploration important in their development and learning process. This explains why most visitors of Riyadh events were within college or university level of education. From the demographic analysis, it was thus clear that majority of Riyadh visitors are people within the age range of 18-35, were married and had college or university level of education. Notably, few visitors were 45 years and above. It was also noted that most visitors of Riyadh events paid for the standard ticket than premium or VIP tickets. Besides, the results revealed that more than half of the visitors paid for the standard tickets. Additionally, the result showed that very few visitors paid for the VIP tickets. Not even one eighth of the interviewed visitors paid for the VIP ticket. However, more than a quarter of the visitors had paid for the premium tickets. The results therefore indicate that majority of visitors preferred standard tickets and premium tickets than the VIP tickets.

Satisfaction to Riyadh events was analyzed in accordance to the quality of services as well as ticket costs. In essence, the study sought to understand the level at which visitors were contented with the quality of services provided as well as the cost of ticketing. The result showed that more than half of the visitors were satisfied with the quality of services provided at Riyadh events than those who were not satisfied. Slightly less than a quarter of the sampled population remained neutral about the quality of services provided at Riyadh events and those who were not satisfied were significantly low. Despite majority of the visitors being satisfied with the quality of services, those who remained neutral about the matter need to be treated as significant. In this case, event managers need to tighten quality of the services to ensure that the diverse needs of visitors are met. The result further showed that most visitors were satisfied with the quality of ticketing provided in Riyadh events than those who were not satisfied.

However, a significant proportion of visitors remained neutral on whether they were satisfied with the cost of ticketing or not. Besides, the proportion of those who remained neutral and those who were satisfied with the cost of were very close. The result thus explains a significant level of uncertainty on the satisfaction with ticketing costs at Riyadh events. Notably, the uncertainty with the ticketing cost could be further explained when majority of visitors go for the standard tickets than the VIP or premium tickets. It is therefore imperative for the event managers to seek further clarification on why most visitors feel uncertain about the quality of ticketing as well as why most visitors prefer standard ticketing. Despite the uncertainty of the ticketing cost, more than three quarters of the visitors indicated that they will visit Riyadh events again. The high likelihood of visiting the events can be explained by the satisfaction of service quality provided at the events.

Analysis was performed to determine service domain under which they felt were satisfactory as well as those that were unsatisfactory. A frequency analysis was performed to understand proportion of visitors that felt service quality was adequate or not enough. The results showed that ease of identifying and reaching the event venue as well as behavior and curtesy of staff members was adequate and satisfactory. However, ease of navigating within the venue, accessibility of food courts, cleanliness of the sites and staff's ability to understand and provide customized and personalized services were just reasonable. Additionally, knowledge of foreign language among staff members were also reasonable. The findings indicate that staff competence level was not adequate enough but only reasonable to provide services to customers (see table 16).

5.1. Discussion of Hypotheses

To test the hypotheses formulated in chapter one of the study, a correlation analysis was performed to determine the association between service quality and visitors' satisfaction, visitors' experience and return intentions as well as health and safety practices and visitors' satisfaction. The hypotheses tested included;

- Ha1.** Crowd management and service quality significantly affect visitors' satisfaction in Riyadh Season.
- Ha2.** Visitors' experience at the Riyadh Season significantly affects their return intentions.
- Ha3.** Health and safety practices adopted at the Riyadh Season significantly affect visitors' experience and satisfaction.

Service Quality and Visitors' Satisfaction.

Visitors satisfaction was measured using eight components (see table 19). Each component was measured in a Likert scale of 1 – 6 where 6 was the highest score and 1 is the lowest score. The lowest score indicated dissatisfaction and the highest score indicated high satisfaction. The results showed a weak positive relationship between ease of identifying and reaching the event venue and visitors' satisfaction ($\rho = 0.033$). However, the relationship was insignificant ($P > 0.05$). This shows that ease of identifying and reaching the venue had insignificant impact on visitors' satisfaction. Additionally, the result showed a significant strong positive relationship between access and navigating within the venue and visitors' satisfaction ($\rho = 0.171$). The relationship was found to be significant at 95% confidence level ($P < 0.05$). It was therefore deduced that access and navigation within the venue significantly impacted visitors' satisfaction with the event.

There was a significantly strong positive relationship between knowledge of foreign language and customer satisfaction ($\rho = 0.108$, $P < 0.05$). This shows that staff's knowledge of foreign language significantly impacted customer satisfaction at the Riyadh events.

The result also found an insignificantly weak positive relationship between staff behavior and curtesy and visitors' satisfaction ($\rho = 0.082$, $P < 0.05$). the insignificant weak relationship shows that staff curtesy and behavior had insignificant impact on visitors' satisfaction of the events. The study further noted a significantly strong positive relationship between staff competency and visitors' satisfaction ($\rho = 0.159$, $P < 0.05$). The results indicate that staff competency significantly impact visitors' satisfaction at Riyadh events.

There was a strong significant positive relationship between staff ability to provide customized and personalized services with visitors' satisfaction ($\rho = 0.170$, $P < 0.05$). The result indicates that staff ability to provide customized and personalized services significantly impacted visitors' satisfaction. There was a significant strong positive relationship between cleanliness of the sites and visitors' satisfaction ($\rho = 0.156$, $P < 0.05$). This shows that cleanliness of the sites significantly impacted visitors' satisfaction at the events.

Finally, the result showed a significant strong positive relationship between food courts accessibility and visitors' satisfaction ($\rho = 0.129$, $P < 0.05$). This indicates that accessibility to food courts significantly influenced visitors' satisfaction at the events.

Out of the eight components of service provision that were analyzed, only two had insignificant impact on visitors' satisfaction with the events. In this case, it was deduced that service quality significantly impacted customer satisfaction during Riyadh events. However, the management should give limited focus on staff curtesy and ease of identifying and reaching the events since they had limited impact on visitors' satisfaction.

Experience and Return Intentions

A correlation analysis was performed to determine the association between visitors' experience at the events and return intentions. Six factors associated with customer experience was measured on a Likert scale of 1 – 5 where 1 was the lowest score and 5 was the highest score. The result showed a strong positive relationship between all the six factors and return intentions among the visitors ($P < 0.05$) (see table 20). This shows that the following factors significantly increase visitors return intentions to Riyadh events.

1. Number of attendees are reduced to manageable level
2. Security personnel are empowered to screen attendees
3. Adequate deployment of security personnel
4. Organizers adhere to health and safety protocols
5. Visitors receive a memorable experience and value for my money
6. Organizers install appropriate signage.

In short, it was found that visitors' experience at Riyadh season events positively influence their return intentions

Health and Safety on Visitors Experience and Satisfaction

Health and safety at Riyadh events are an important consideration to visitors. In this case, it was important to understand how adoption of health and safety measures affect visitors experience and satisfaction. Seven factors were used to measure health and safety preferences to visitors and understand the level at which they affect their experience and satisfaction at Riyadh season events. Similarly, the result showed a significant strong positive relationship between the seven factors of measurement and visitors' experience and satisfaction at the events ($P < 0.05$) (see table 21). This means that the following health and safety preferences enhance visitors' satisfaction and experience at the events.

1. Events with meticulous emergency plans, proper public health protocols, turnstiles, and enough security personnel

2. Events with onsite emergency responses
3. Events where organizers separate the spectators who can potentially clash using clear demarcations.
4. Events where there is insurance coverage.
5. Events with effective safety awareness.
6. Events with events with risk assessment plans.
7. Events that are family-friendly.
8. Events where food catering has done due diligence to observe hygiene

In this case, it was evident that health and safety practices adopted at Riyadh season events significantly enhance visitors' experience and satisfaction.

6. Conclusion

This section presented results and findings from the data collected. It was realized that service quality was important in enhancing visitors' satisfaction with Riyadh season events. Similarly, visitors were more likely to return to the events if they had better experience of the events. Notably the analysis indicated that adequate health and safety measures improved visitor's experience and satisfaction with the Riyadh season events. However, the result showed visitors' uncertainty with the ticket costing approaches. Most participants preferred the standard tickets that the premium and VIP tickets. It is important for the event management to consider their ticket costing approaches,

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Design and Development of Grid-Connected Solar PV Power Plant Using PVsyst

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Abstract:

As we know, the biggest problem that threatens today's world is climate change and global warming. Alongside that, Afghanistan does not have a reliable source of power, and people who live in cities do not have full access to electricity. So, we need immediate access to electricity. Therefore, among all other renewable sources, the only one that is feasible in the target area and could solve this problem soon is investing in a solar PV power plant. This study aims to develop a standard procedure for the design of grid-connected solar PV systems using PVsyst software. The project began with a broad database of meteorological data, including global daily horizontal solar irradiance, and also a database of various renewable energy system components from different manufacturers. This paper will explain the grid solar power limited in the year 2023. The photovoltaic power plant has a solar radiation of 6.22 KWh/Sq./day, covering 162.66 acres of land. The operating module temperature varies from -40°C to 85°C, with a tilt angle of 32 degrees. The various power losses (PV losses due to irradiation level, temperature, soiling, inverter, wiring, power electronics, grid availability, and interconnection) amount to 2006 KWh/m², with a total production of 60513314 KVAh/year, and the performance ratio is calculated from simulation, giving an annual PR of 75.16%.

Keywords: Design, Development, PVsyst, Grid connected, Solar PV power plant.

1. Introduction:

According to the US Energy Information Administration, there is a projected 56% increase in global energy demand between 2010 and 2040, primarily driven by the rapid economic growth in Asia (Cronshaw, 2015). Since prehistoric times, man has attempted to capture sun energy for lighting, cooking, energy, and military requirements. The design of sun devices to concentrate solar energy on enemy cults has been attempted since antiquity by the ancient Greeks, Egyptians, and subsequently Muslims (Abas et al., 2018). The life and energy cycles on earth are propelled by energy drifts that are enabled by solar radiations. The sun, which is 93 million kilometers from Earth, produces energy by a massive thermonuclear fusion event. The photosphere and core of the sun have temperatures between 5500 °C and 20,000,000 °C. Each second, the sun's core converts around 657 million tons of hydrogen isotopes into 653 million tons of helium (Abas et al., 2019). In a solar power plant that is connected to the grid, the solar panels generate DC power, which is then converted into AC power and provided to the grid for distribution and use. Since solar radiation is at its strongest during the day, it may be possible to get the most electricity possible from the PV system (Caldera et al., 2021),

(Rahman et al., 2021). The depletion of conventional energy resources is running at no time these days. Beside that, Carbon dioxide (CO₂), one of the three major greenhouse gases, has increased in atmospheric concentration since pre-industrial times, and scientific evidence confirms its direct association with climate change (Lin & Jia, 2020). Furthermore, the cost of energy is rising, so, for this purpose solar energy is inexhaustible source that, is abundant, pollution free, distributed throughout the earth and recyclable. In addition, It is crucial to refer to up-to-date reports and reliable sources for the latest information on global energy demand trends. It is important to acknowledge that highly developed countries are actively striving to transition to cleaner energy sources and may have different energy objectives compared to regions experiencing rapid economic growth (Delloso et al., 2021). Afghanistan has a very good state for the development of solar power plant particularly its south regions and mainly to the high mean daily. It has more than 300 sunny days, the target power plant is going to be installed at one of the southern province of Afghanistan, Kandahar city and the surveyed place is located at Aino-Mina town of Kandahar city. At the moment Kandahar city, receives its energy from Kajaki dam from Helmand province and faces with many shortages even during the summer season. So, this project would fulfill the current and future demands of energy of this town based on its master.

The hindrance factor is low conversion efficiency and high installation cost. Combination of series and parallel of solar modules made arrays, but the amount of energy which is going to be produced by the solar panels depend on weather-condition or simply atmospheric conditions for instance (temperature, and solar irradiation).

2. Materials and Method

This particular study aimed to determine the optimal configuration of a grid-connected solar PV plant for the utility electric distribution cooperative situated in Kandahar, Afghanistan. Solar power is accessible universally; however, in order to maximize the efficiency of a solar panel or array, it is crucial to align or "orient" it precisely towards the radiant energy of the sun. This is because increased surface area exposed to direct sunlight leads to higher output from the photovoltaic panel (Hay, 2016). The designated land area for this PV farm is at least 162.66 Acres and includes all necessary components. The simulation process exclusively relied on PVsyst software, which is widely utilized by professionals for reliable analysis and simulation of solar PV installations (Rout & Kulkarni, 2020), (Saraswat, 2016), (Satish et al., 2020), (ur Rehman et al., 2020), (Siregar & Hutahuruk, 2020), (Soualmia & Chenni, 2016), (Hamouche & Shabat, 2019). In here the overall objective in designing a solar power plant through providing land is to use land by solar at most and maximum level, in order to produce more and be cost effectively. To offer it somehow cheap we have to know how much space do we have and find out the available data regarding solar energy in the target place and the size of the power plant with the specifications of the system and components that is used in the power plant, also its evaluation criteria, and design optimization.

System Design

For designing the system, we already select one of the well-known software that has used in most of the academic publication and with the most reliable data's that is PVsyst, version of 7.3.1, (Gao et al., 2016), (Pawluk et al., 2019), (Banik & Sengupta, 2021), (Muthulingam et al., 2015), (Loganathan et al., 2014), (Daneels & Salter, 1999). Also, the components which are used in a power plant is simply classified into two broad categories, 1) Major components, and 2) Minor components and figure 1, indicates a full view of a PV power plant that includes all the components.

Major Components

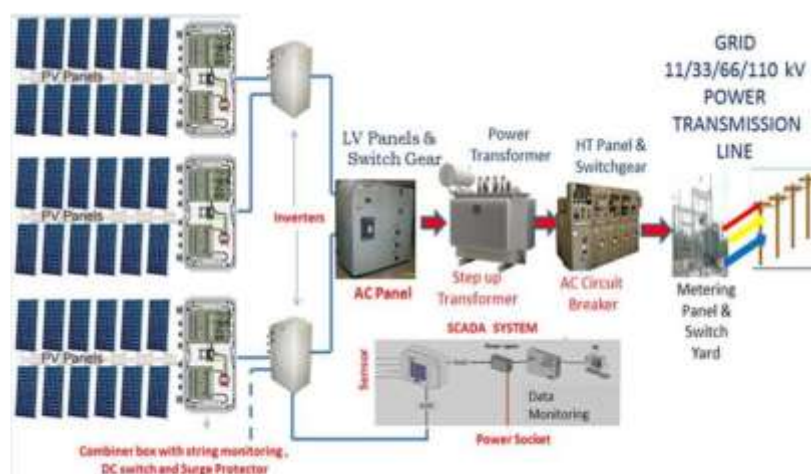
1. Solar PV Model
2. Grid tie inverter
3. Grid system

Solar PV modules are the technologies that convert solar energy into useful energy directly and a grid tie inverter is an inverter which gives and can receive electrical energy from the grid or national utility and a grid system is a system that produced energy is given to the national utility.

Minor Components

1. Dc array junction Box
2. Control room
3. Cables
4. Earthling
5. SCADA (supervisory control and data acquisition system)
6. Water facilities
7. Fencing system and Road inside the plant
8. Mounting structures

9. Fig-1: schematic diagram of a solar power plant



Minor components are the small or supportive components that is used in a power plant and a DC array junction box combines all the output wires from modules and in return give us two wires and is used to reduce the amount of output wires to make it suitable for inverter input and a control room is a place where the whole power plant is controlled technology and human resource

facilities. Also, cables are used to combine and transmit produced energy from various arrays and to give it to the grid.

Moreover, earthing is used for safety and control of the system from lightening, SCADA is a software for distance control of the system (Piyatadsananon, 2016). Water facilities, fencing and mounting structures are used for cleaning, saving solar park for irresponsible people and animals interventions and mounting structures to keep the panels the panels with the required tilt angle. Furthermore, we need to understand the sunshine hours that is usable, the cloudy and days with no sunshine and all meteorological data (wind power, temperature, sunshine hours, natural disaster and so on). The location that is not to be near to high rise buildings and agricultural field along with the present and future demand should be considered, also the system performance, total cost and system protection and easy maintenance are all the factors that is need to be considered while designing (Pawluk et al., 2019).

DC Side PV Plant

This side includes the PV modules that is used in power plant and modules are used in series and parallel and while connecting modules in series the voltage of the array is increasing with the constant current of a panel in an array and the total should be greater than inverter minimum, (MPP) maximum power point voltage but total open circuit voltage at minimum Module tem should be smaller than inverter Max voltage , while in parallel connection the total current is increasing with the constant voltage of a panel in an array. Moreover, Max current shall not be more than Inverter Max Input current and number of Array combiner boxes – with or without string monitoring based on number of inputs selected for each box, also main junction boxes should be equal to the number of inverter inputs.

AC Side PV Plant Design

AC side cables are required for commissioning and connecting ac components with regards, and switchgear is used for control, protect and distribute the power within the plant and with the grid that LT or low voltage usually operates between 415V to 1000Volts and MV operates 1000Volts to 33KV also power transformer is used to increase the voltage up to the grid voltage. Moreover, high tension switchgear is used for power transition and distribution and operates between 33KV and hundreds KVs, with electronic protecting equipment's and metering system and transmission lines are used to transmit the produced energy to the consumers.

3. Technical and Site Data

3.1 Site Location

The selected area is located at Aino-Mina, Kandahar city of Kandahar province, with a Latitude 31.65° N and longitude 65.77° E, 162.66 Acre land is specified at a distance of almost 15km from the city of Kandahar Province. And on the selected area no wild life and archeological monuments are in danger. And the site is well save and well connected to the sub road.

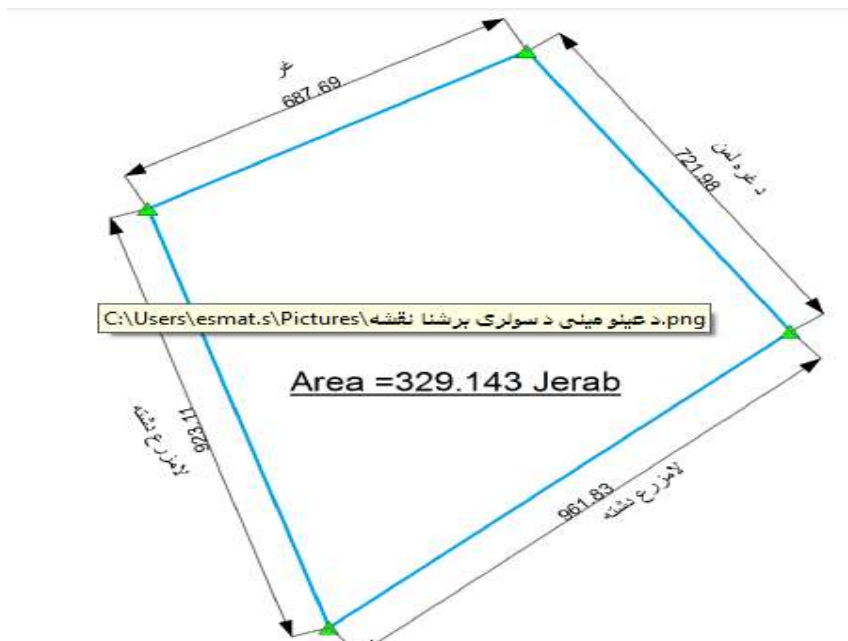
Here are some other aspects of selected area:

1. Wild animals: No wildlife is reported to be present in this area.
2. Health risk: No health hazards are caused by solar plant. In fact, the solar plant is environment friendly.
3. Archaeological and Historical places: There are no archaeological monuments or historical places in this area.

Figure-2 shows the province that the power plant is going to be installed and Figure-3 shows the specific area and land which is going to be used for Solar PV power plant.

Figure-2: Kandahar Province, Afghanistan



Figure 3: selected site

The site is located far away from high rise buildings and agricultural fields and has a polygonal shape which two sides of the site is in touch with hill and mountain with a length of 721.98 meter and 687.69meters respectively, and two other sides of the site are locked by non-agricultural fields with lengths of 961.83meter and 923. 11meters. The detailed estimate and properties are along hereby.

3.2 Solar PV selection

Solar PV Technology converts sun's natural energy to useful electrical energy. Photo Voltaic modules are made of mono crystalline / polycrystalline solar cells connected in series and parallel modes. Type of solar panel used in this project is poly crystalline.

Mono crystalline solar panels are the most efficient type of solar panels but are also the most expensive. Their performance, somewhat is better in low light conditions. We have selected Trina Company and poly crystalline because the weather is hot in the selected area and mono is not efficient in hot sites and the overall efficiency of the selected PV module is about 15.29% with a warranty of about 25 years which is shown in Table-1.

Fig-3: Poly crystalline Solar Panels**Table-1: solar panel specification**

PV module	
Manufacturer	Trina Solar
Model	TSM-300PEG14
(Original PVsyst database)	
Unit Nom. Power	300 Wp
Number of PV modules	116592 units
Nominal (STC)	34.98 MWp
Modules	4164 Strings x 28 In series
At operating cond. (50°C)	
Pmpp	31.37 MWp
U mpp	912 V
I mpp	34384 A
Total PV power	
Nominal (STC)	34978 kWp
Total	116592 modules
Module area	228774 m ²
Cell area	204325 m ²

Table-1 show us the specification of the selected with panel for the power plant, which this module is manufactured by the Trina Solar and it has a total of 300wp nominal power and operated between -40 and 85 degrees of Celsius and its maximum system voltage is 1000volt, so that more modules are easy to be connected in series. In the power plant a total of 116592 PV modules will be used and with a nominal power of 34.98Mwp. Furthermore we have 4164 strings and 28 in series which covers a total of 228774 square meter area.

3.3 Inverters Selection

Inverters are devices which convert DC current into AC current and there are various types of inverters off-grid and hybrid or on-grid inverters. Off-grid inverters are used for low and local systems like residential systems and up to watts and few Kws.

But hybrid is used for utilizing from two sources like solar & grid or solar and battery with/without grid, while on-grid inverters are used in places where all are huge portion of produced energy is given to consumers. Here we have selected on-grid inverter of German company by the name of SMA with a capacity of 2.5MW each that operates in MPPT mode and overall 12 inverters are selected in this plant, so, figure-4 shows the selected inverter and table-2 shows its specifications.

Fig-4: Sunny Central 2500-EV inverter



Table-2: inverter specification

KVA rating	2500KVA
Input DC voltage	1500V
Input DC current	3200A
Output AC voltage	550V
No. phases	3
Type	GEC
Efficiency	Approximately 95-97%
No of inverters	12

The table indicates the rating capacity of the selected inverter that is 2500KVA and it has input DC voltage and current of 1500V and 3200A respectively. Its output is AC with a voltage of 550V, 3-phase and efficiency of 95-97%.

3.4 Combiner Box Selection

There are wires which are coming from panels or strings and PV modules are pre-wired almost with connectors and its junction box/combiner box that collect together wires and gave us two wires in a conduit.

And this box usually contains some safety materials like, fuse or breaker for each string and a surge protector the selected junction box is shown in figure-5 and its specifications in Table-3.

Fig-5: junction box



Table-3: specification of selected junction box

Model	GPRO-GD10X
Maximum DC Input Range	1500V
No of DC Inputs	1 - 52
Maximum Input Fuse* Rating, A	6/10/12/15/20/30
Maximum string current per fuse holder with all string fuse**	Reduction factor 0.55
Conductor Size	4 – 10 Sq.mm
No of DC Outputs	1
Maximum DC Current, A	Unto 630A
Isolator/MCB*, A	100/250/315/400/500/630
Surge Protection Device (SPD)*	1500V DC, Class C/Class B/ Class B+C
Operating Temperature	-25 to 55
Enclosure Type	Transparent Top Cover
Protection Type/Protection Class	IP65/65
Connectors* @ Output	MC4/MC3
Cable gland clamping range, mm	17-50mm

Wall mounting	Yes
Bus Bar*	Yes
Operating conditions	Temp : -20 to +55 Deg. C ; RH : 0 – 95% non Cond
Type of Protections(As per Clients requirement)	Short-Circuit, Surge
International standards followed	IEC 60364
Disconnection switch	Optional
Design Life	25years+

The above table shows all the required specifications of selected junction box, it can handle up to 1500V as an input voltage and up to 52 input wires are can be used. Also, maximum current of 630A and input cable size of 4-10 square mm with -20 to 55 degrees of Celsius operating temperature. And it has been designed for more than 25 years which is well selection for our power plant.

3.4.1 Selection of Junction Box/Combiner Box

At first it's a need that string's voltages be verified and for this purpose we need to find out V_{oc} and V_{max} of each string, in the following equations V_{oc} indicates open circuit voltage and V_{max} shows maximum voltage of each module respectively, also N refers to number of modules in a string.

- i. One string $V_{oc} = N * V_{oc/module} = 27 * 45.9 = 1239v$
- ii. One string $V_m = N * V_{m/module} = 37.2 * 27 = 1004 v$

By considering the safety and V_{oc} of strings we select a combiner box which its input voltage be 1500V and input current of 630A and we have a total of 104 wires which includes positive and negative wires that comes from a string to a junction box, $I_{max/jb}$ shows the maximum current that we give to our junction boxes and $I_{sc/module}$ indicates the short circuit current of each module.

$$\text{iii. No- connected string in one junction box} = \frac{I_{max/jb}}{I_{sc/module}}$$

$$\text{No- connected string in one junction box} = \frac{463 A}{9.07 A} = 51 \text{ strings in parallel in one junction box}$$

- iv. string needed for 1 inverter = $\frac{\text{Total no of string}}{\text{Total no of inveter}} = \frac{4164}{12} = 347$
- v. No of JB needed for one inverter = $\frac{\text{No-string in one inverter}}{\text{No of string in one JB}} = \frac{347}{51} = 7JB$
- vi. Total no of junction boxes needed for the project = No of junction boxes \times No of inverters
= $7 \times 12 = 84$ Junction Boxes.

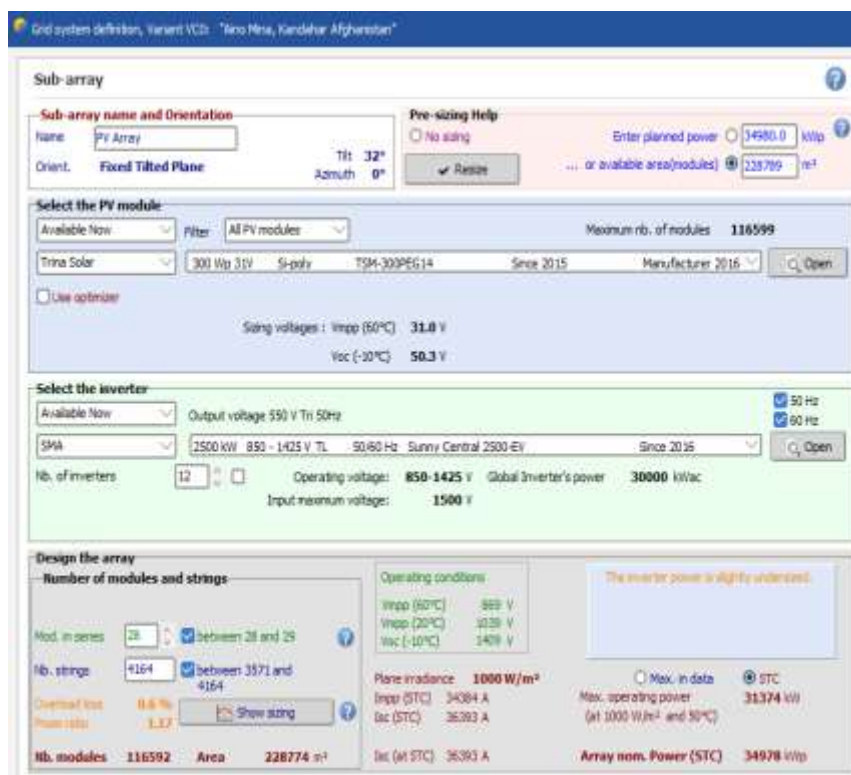
As far, as inverters are having just two lines as inputs, so we are in need of selecting a combiner box for each 7-junction boxes.

Design Based on Software

Pvsyst software which is a reliable software has been chosen for design of the system and we are providing to the software the land that is exclude of extra spaces for internal roads, safety towers of the plant, distances between the rows and

Control room and this is a need for testing and commission of the system to have a preliminary data of feasible power generation. The system and plant performance along with the efficiency of the selected components are calculated based on the given data to the software and we design the system based on the described and in hand data of all the components.

Fig-7: system Design



The screenshot displays the 'Grid system definition' window in PVSyst software, titled 'Tano Nisa, Kandahar Afghanistan'. The interface is divided into several sections:

- Sub-array:**
 - Sub-array name and Orientation: Name 'Pv Array', Orient. 'Fixed Tilted Plane', Tilt '32°', Azimuth '0°'.
 - Pre-sizing Help: 'No string' selected, 'Enter planned power' '34980.0 kWp', '... or available area/modules' '228779 m²'.
- Select the PV module:**
 - Available Now: Filter 'All PV modules', Maximum no. of modules '116599'.
 - Module: 'Trina Solar', '300 Wp 31V', 'Si-poly', 'TSM-300PEG14', 'Since 2015', 'Manufacturer 2016'.
 - Use optimizer: ☐.
 - String voltages: V_{mp} (60°C) '31.0 V', V_{oc} (-20°C) '50.3 V'.
- Select the inverter:**
 - Available Now: Output voltage '550 V Tn 50Hz'.
 - Inverter: 'SMA', '2500 kW', '850 - 1425 V TL', '50/60 Hz', 'Sunny Central 2500-EL', 'Since 2015'.
 - Nb. of inverters: '12'.
 - Operating voltage: '850-1425 V', Global inverter's power '30000 kWac'.
 - Input maximum voltages: '1500 V'.
- Design the array:**
 - Number of modules and strings: Mod. in series '28' (between 28 and 29), Nb. strings '4164' (between 3571 and 4164).
 - Operating conditions: V_{mp} (60°C) '30.9 V', V_{mp} (20°C) '31.39 V', V_{oc} (-10°C) '50.8 V'.
 - Plane irradiance: '1000 W/m²'.
 - Imp (STC) '34384 A', Isc (STC) '36393 A'.
 - Max. operating power (at 1000 W/m² and 50°C) '31374 kW'.
 - Array nom. Power (STC) '34978 Wp'.

4. Results and Discussion

Table Monthly Mateo values

Geographical Site
Kandahār
Afghanistan

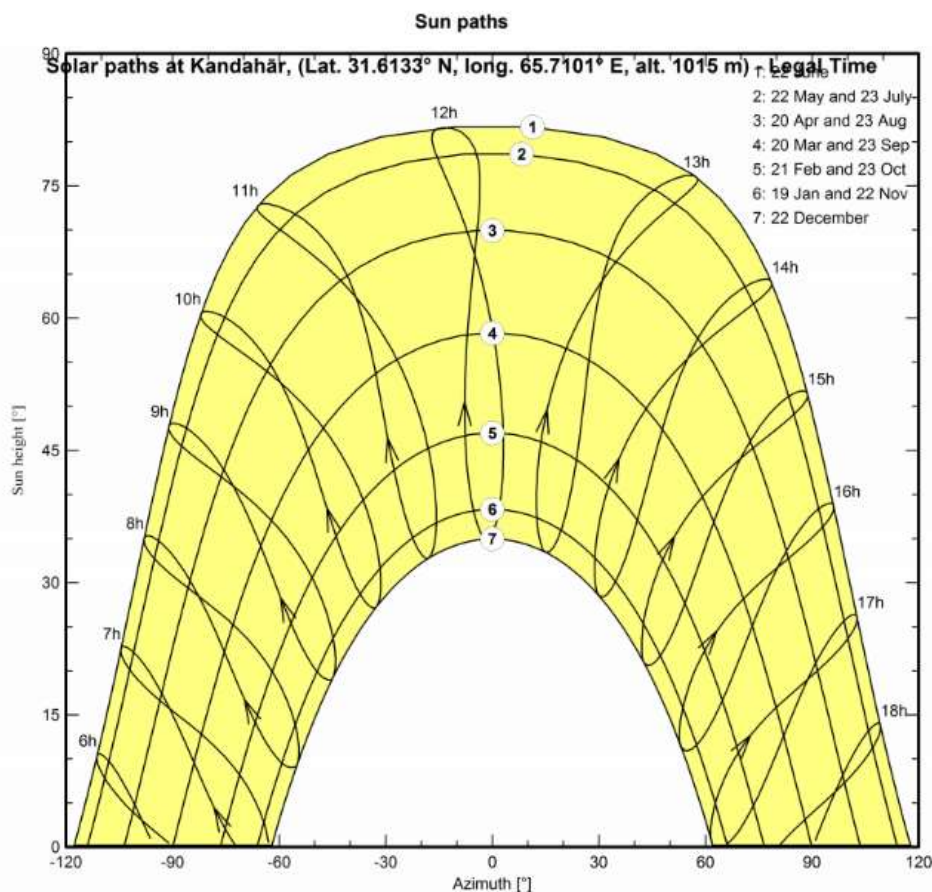
Situation
Latitude 31.61 °N
Longitude 65.71 °E
Altitude 1015 m
Time zone UTC+4.5

Monthly Meteo Values

Source NASA-SSE satellite data 1983-2005

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
Horizontal global	112.5	128.2	167.1	186.9	214.5	217.8	212.4	202.7	180.3	162.1	118.8	102.6	2005.9	kWh/m ²
Horizontal diffuse	27.3	29.7	45.9	55.5	62.9	62.4	66.0	58.0	44.1	31.3	26.7	25.7	535.5	kWh/m ²
Extraterrestrial	179.4	200.5	269.9	306.0	344.5	343.6	349.9	327.9	278.9	238.7	184.8	166.8	3190.9	kWh/m ²
Clearness Index	0.627	0.639	0.619	0.611	0.623	0.634	0.607	0.618	0.646	0.679	0.643	0.615	0.629	ratio
Ambient Temper.	6.1	8.4	13.9	20.8	26.2	30.3	30.6	29.2	25.9	19.4	13.7	8.5	19.4	°C

Chart-1: Solar Paths at Kandahar



All the features which is given are based on the geographical location of the plant and metrological data of the target place, panels orientation, shading information, array configuration, loss parameters and etc.

4.1. Main Results of Simulation

The system is designed with fixed angle and its proposed production will be 67339MWh/year. Specific production: Nominal power of the array is divided by the produced energy (P_{nom} at STC). By considering irradiance conditions for instance orientation, site location, meteorological conditions that could indicate potential of the system. So, specific production is equal to 1738Kwh/Kwp/year and with a 75.16% performance ratio. Some values are listed in Table-3 as below yearly like temperature as an average and a total of irradiation or energies.

Table-3: Main results

Balances and main results										
	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_User kWh	E_Solar kWh	E_Grid kWh	EFrGrid kWh
January	112.5	27.28	6.09	176.6	168.2	5208773	669600	257978	4846137	411622
February	128.2	29.68	8.37	178.9	170.4	5198012	604800	265448	4829466	339352
March	167.1	45.88	13.86	200.3	190.1	5637059	669600	309594	5217526	360006
April	186.9	55.50	20.80	193.6	182.9	5235549	648000	322671	4812275	325329
May	214.5	62.93	26.22	199.3	187.4	5231829	669600	315200	4356427	354400
June	217.8	62.40	30.27	192.4	180.7	4960738	648000	346938	4519124	301062
July	212.3	66.03	30.63	192.1	180.6	4967372	669600	325232	4143852	344368
August	202.7	57.97	29.16	201.1	189.8	5242572	669600	337202	4806839	332398
September	180.3	44.10	25.86	204.0	193.1	5367067	648000	299254	4648390	348746
October	162.1	31.31	19.39	214.3	203.9	5817967	669600	289769	5416182	379831
November	118.8	26.70	13.72	181.2	172.2	5132943	648000	269050	4764852	378950
December	102.6	25.73	8.50	168.0	159.7	4908611	669600	269210	4542697	400390
Year	2006.0	535.51	19.46	2301.8	2179.0	62908494	7884000	3607547	56905767	4276453

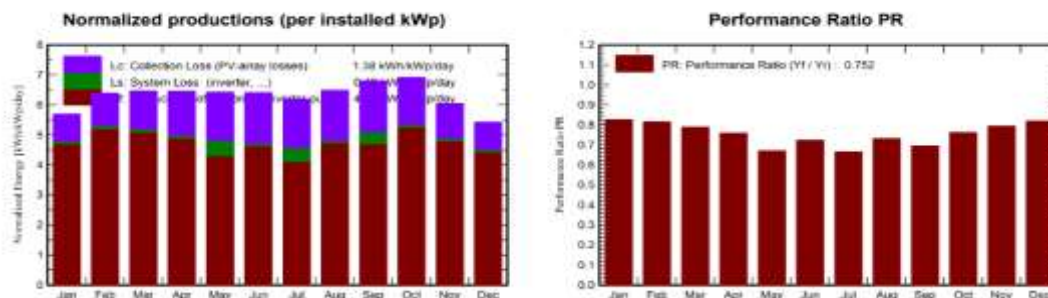
Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective Global, corr. for IAM and shadings	EFrGrid	Energy from the grid

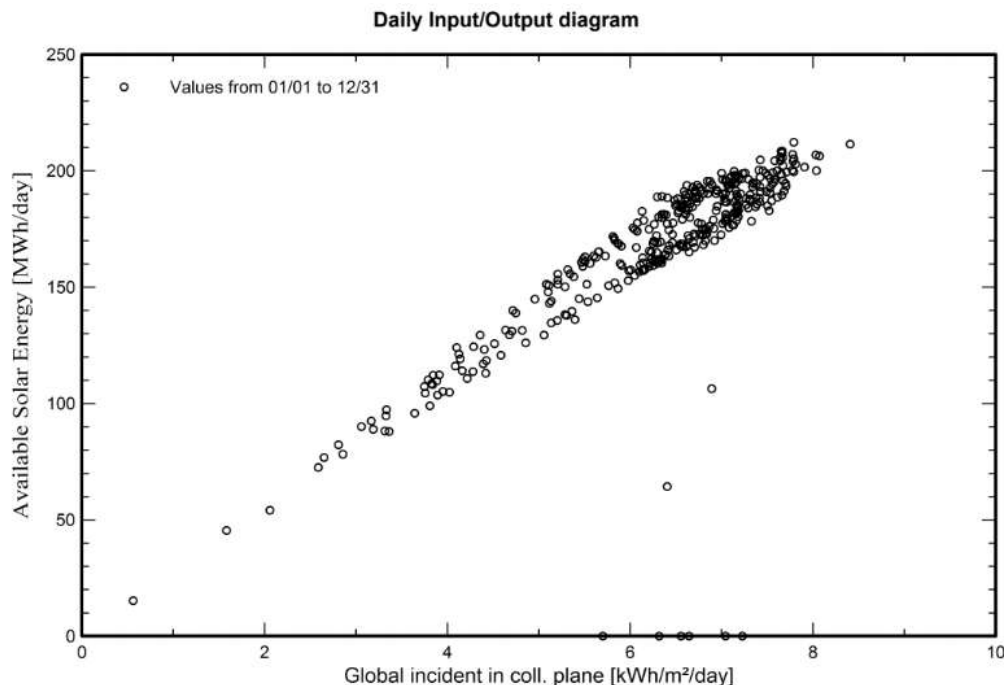
The above table shows yearly and average datas of global horizontal radiation, horizontal diffuse radiation, energy that comes from the sun and energy injected to the grid and from the table we can understand that energy injected to the grid is highest in October that is 5416182 Kwh and the lowest energy given to grid is 257978 Kwh.

Table-6: Main results

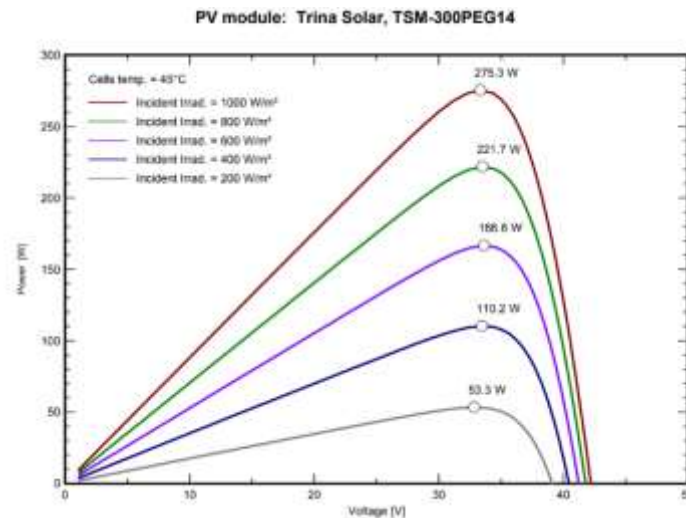
System Production			
Produced Energy	60513314 kVAh/year	Specific production	1730 kWh/kWp/year
Used Energy	7884000 kVAh/year	Performance Ratio PR	75.16 %
Apparent energy	58272913 kVAh/year	Solar Fraction SF	45.76 %

**Chart-1: Production per installed kwp: Nominal power with Performance Ratio**

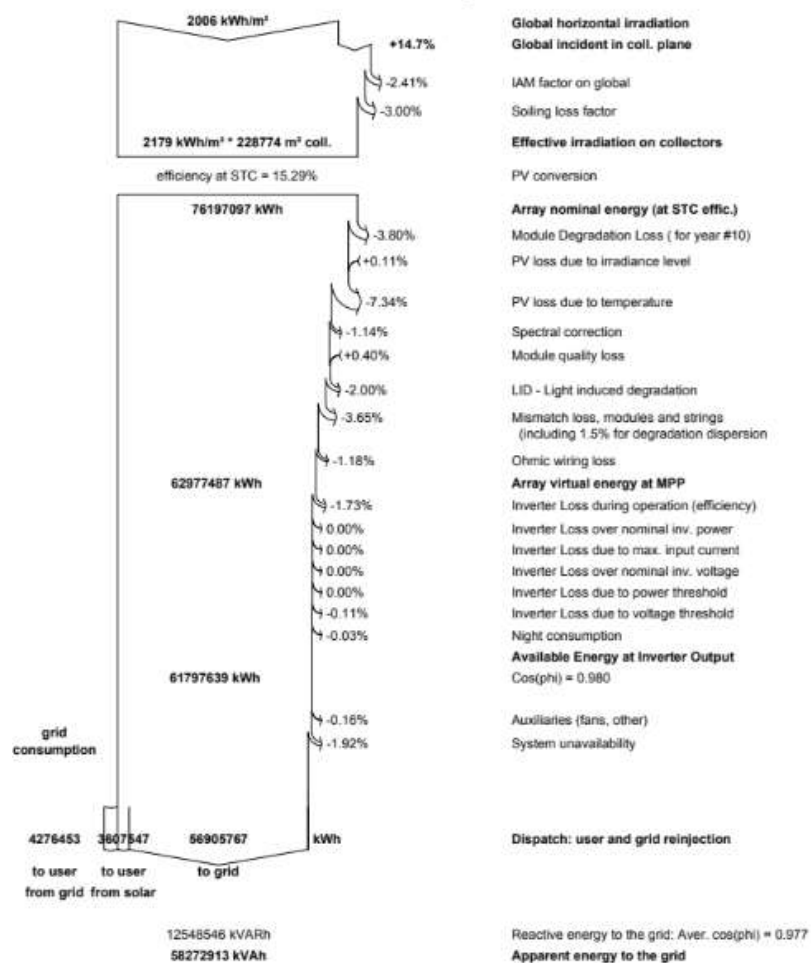
The above table clearly shows us the resulted energy over a year that is produced by the power plant and explains that 60513314KVAh/year is its produced energy and 7884000KVAh/year is its used energy and a total of 58272913KVAh/year is its apparent energy. Furthermore, it indicates the performance ratio of the power plant over a year which is 75.16%.

Chart-2: Daily System Output Energy

The figure indicates that in a day we can produce over 200MWh/day with the insulation of almost 9 Kwh/m2/day and plant efficiency of 75.16%.

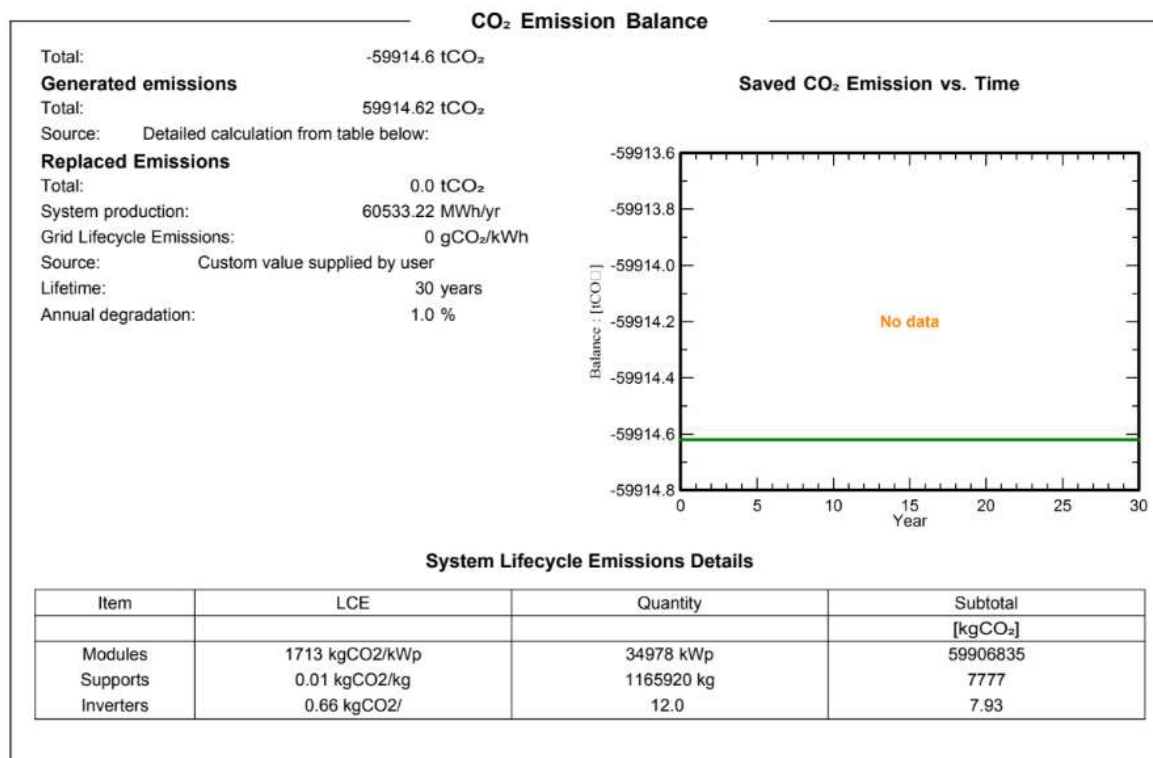
Chart-3: Power vs. Voltage

For the chart 3, we can clearly understand that at 39V and cell temperature of up to 45 degrees of Celsius the incident radiation yields 1000 watt per square meter.

Chart-4: Losses at Plant

From the chart-4, we can clearly find out all the losses that is occurring in the power plant and affects our energy that is going to be injected to the grid. And it indicates that from a total of 12548546 kVARh produced energy from the plant we can only contribute with the grid with an amount of 58272913 kVAh.

Chart-5: The restricted amount of CO₂ that will be mitigated



From the chart 5, we can clearly understand that if the same amount of energy 60533.22Mwh/year is going to be produced from any other source that contains CO₂ gases that will produce 59914.64 ton of CO₂ that by installing and developing this plant we could produce -59914.64 ton of CO₂ which is equivalent to 713Kg CO₂ /Kwp of modules for a period of 30 years with an annual degradation rate of 1%.

5. Conclusion

The project is plan to design at Aino Mina, Kandahar city and based on the given data to the PVsyst software, it has been understood that we can produce 1730Kwh energy per Kwp in a year. And a total of 116592 modules of Trina Solar with 300W_p capacity had been introduced to the system. Also, the power plant requires 12 inverters which is made of SMA Company with a total capacity of 2.5 MW each.

Moreover, by installing this system we could save 59914.6 tCO₂ for a period of 30 years. The power plant has an amount of 7884MWh constant load that is consumed by the different structures and lighting of the plant inside the power plant. Moreover, as the project is on-grid power plant it gives 58272913 KVAh from a total of 60513314 KWh/year.

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