



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 6.078

(Volume 6, Issue 3)

Available online at: www.ijariit.com

Applications of Operations Research in theme parks

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ABSTRACT

The growth of Theme Parks and their impact on the Indian Economy have attracted considerable attention in recent years. Theme parks represent major development in contemporary leisure and recreation. In this research paper, a review of the application of operations research methods in the theme park industry is provided. The operation efficiency of theme park attractions using the data envelopment analysis, The installation area, installation cost, and annual repair cost are set as input factors and the number of annual users and customer satisfaction as output factors. The results show that the roller coaster-type attractions were less efficient than other types of attractions while rotating-type attractions were relatively more efficient. However, an importance performance analysis on individual attraction's efficiency and satisfaction showed that operational efficiency should not be the sole consideration in attraction installation. In addition, the projection points for input factors for efficient use of attractions and the appropriate reference set for benchmarking are provided as guideline for attraction efficiency management.

Keywords— Theme park, Operation research, Product, Ride fare, Staffing

1. INDUSTRY REVIEW

Most amusement parks charge benefactors day by day confirmation, and this makes up most of their created income. Notwithstanding rides and gathering excitement, amusement stops likewise commonly offer games, cookout territories, and refreshment stands. Amusement park rides are typically mechanical rides or water rides, and have limitations dependent on age and stature to guarantee wellbeing. The amusement park industry regularly just works during a bit of the year because of climate conditions that influence a significant number of their areas. It is expected to remain one of the primary destinations for visitors and rides enthusiasts. New theme parks being planned across Europe, Asia and the Middle East are likely to provide new leisure opportunities for people. Trends in consumer lifestyles, increasing household spending on outdoor activities continue to redefine growth in theme parks industry.

The Global market for theme parks is forecasted to reach US \$44.3 Billion by 2020 driven by the recovery in leisure spending, rise in international tourism and growth of the middle-class population, Asian-Pacific led by China is expected to emerge as the fastest growing market with a CAGR of 12.2% over the analysis period.

Small organizations organize obliging neighbourhood markets, or potentially offering one of a kind attractions that buyers can't discover in every park. Large amusement park enterprises have economies of scale in advertising and working expenses, and they additionally have the accounts to assemble or buy progressively famous and costly rides to draw more supporters.

1.1 Features of a theme park

Level 1: The Core Product: It is the most fundamental level and is what the visitor is really buying. The product consists of benefits sought by the visitors but they are intangible in nature, such as Excitement, Atmosphere, Fun, and Value for money / Variety of on-site attraction.

Level 2: The Supporting Product (Tangible Product): Supporting product is extra products to offer the added value to the core product itself and to help to differentiate it from the competitors (other theme parks). The supporting product includes: Rides, activities and shows, Catering outlets, Souvenir shops, clean, pleasant and safe environment that visitors can enjoy their experiences.

Level 3: The Facilitating Product (Augmented Product): It is not the core product that visitor is buying, but it helps to make the experience more satisfying and enjoyable. This includes all the additional services and facilities that enhance the visitors' experiences, and they are both tangible and intangible in nature such as on-site transport (shuttle bus) to move visitors around the theme park, facilities for the visitors with special needs and physical challenges such as ramps and elevators for access by wheelchairs and baby strollers, lockers for visitor convenience and safekeeping of belongings, car parking facilities etc.

For our review we are taking Wonderla, Bangalore. It is one of the largest chain of amusement parks in India. The park features a wide variety of attractions including 55 land and water rides. Wonderla Bangalore has a full-fledged dance floor with a twist, electronically controlled rain showers. Wonderla also has attractions specially designed for children it has conference facilities for up to 1,000 persons and features five restaurants with a total seating capacity of 1,150.

2. LITERATURE REVIEW

A theme park is, literally, a "park with a theme," and can be defined as a full-day tour site for families (Kyriazi 1976). Theme parks often have what is called "attractions," which refer to rides that provide fun, out-of-the-ordinary experiences for visitors to enjoy, with the help of other thematic elements and equipment within the park. The goal of a theme park is to attract as many visitors as possible, however, it has been reported that crowdedness can deter more people from visiting the park. Neuts and Nijkamp (2012) found a negative relationship between perception of crowdedness to visitor number based on case-study of a city in Belgium, and this negative relationship was further studied by Eroglu (2005), Miller and McCool (2003), and Mehta (2013), who found that consumers either give up using or tend to avoid facilities they know will be crowded.

From this Research Paper we have studied that the impact of waiting time on customer satisfaction is not very clear. Traditionally waiting has been viewed as a negative measure and studies in the operations management show a monotonic relationship between waiting time and customer satisfaction. While few customers tolerate or desire long waits, it appears that in some situations customer experience and some waiting enhances perception of service, and thus minimizing the waiting time is not necessarily a desired objective. Although long waiting time is undesirable, even low waiting time, tend to have a negative impact as well. (Ahmadi, 2016) Another customer survey proved that beyond the threshold level of average no of rides, further rides provided little improvement in customer satisfaction. It is seen that the marketing myopia of a Theme Park is said to be an "Entertainment Perspective", it is not just riding that needs focus, areas like dolphin show, parades, Halloween theme, Holiday Themes etc. Needs more focus as well? In addition, even rides with different name attract more attention, like Nitro, Colossus, and Ninja Etc.

The Variety of special shows offered is the second class of attraction at the theme park. From an operational viewpoint, these can be viewed as batch processes with the cycle time determined by the show's characteristics. The batch capacity is essentially fixed and short-term operational decisions concern the no of shows and the corresponding schedule.

In this research paper, we have studied that ride design and management is number one factor that attract visitors as per IAAPA. The main expenses of Theme park are on the construction and renovation of rides. Hence, a ride designed to handle maximum expected demand and avoid long lines is required. A neural network approach is used to understand relationship between queue length, group size and throughput in ride. It is used to meet optimality of people in rides. Theme parks often attempt to ensure that their visitors are occupied with theming shows, or TV monitors while they are waiting. Parks also manage customers' expectation by posting estimated wait times this helps to engage the customer while they are in queue.

The author uses two methods to optimize ride management. In first method, a weighted average method is used, as all rides are not equally desired but this method lacks flow management. Second Method imposes actual transition probabilities.

Ticket pricing to maximize the profit of tickets is required. As huge amount of capital investment is required to update and build new attractions. The fixed cost in a theme park is more than the variable cost. To increase the number of visitors an Annual pass is issued which helps to stimulate the demand in the low seasons. The annual passes come with many restrictions which do not allow the visitors to visit the park during the block days at discounted price. To increase the revenue theme parks, sell merchandise, food, and beverages. Theme park tickets are bundled with the hotel rooms to increase the revenue. Ticket pricing are based on traditional revenue model which helps to change the prices of tickets as per season, day of week, advance booking. One solution may be to rely on an algorithm that generates a minimum ticket price (bid price) for each day and then blocks all discount levels below the minimum ticket price.

Theme parks have hotel rooms based on their themes which helps them to attract a large group of customers and it helps them to increase revenue by tapping the corporate market. The theme park with accommodation facility has an average stay of 2.8 days and theme park without hotel has an average stay of 1.7 days. Operation research helps the management to decide the rate of the rooms as per the season, demand, and weekend. A proper inventory assignment is necessary to maximize the revenue Decomposition and deterministic linear programming approximations are formulated and have been successfully used in practice. (YILDIRIM, 2010)

In this research paper it has been studied that the theme park industry is a large and growing market demanding huge investments in technology, partnerships, service delivery, and integration. Theme parks market is expected to attain a phenomenal upsurge in growth as consumers spend more on leisure due to rise in disposable income.

The theme parks industry itself is undergoing rapid transformation. Social media has introduced a free forum for visitors to comment on all aspects of park experience. The industry is projected to grow at a healthy rate looking at the attendance numbers and increasing per-head expenditures which extends to food and merchandise. However, theme parks can further increase their revenues by

incorporating other forms of leisure entertainment like gaming and casino provisions into their plans. Theme parks can also improve guest satisfaction by reducing wait times through technology and providing a more pleasant experience while waiting.

Recent upsurge in disposable incomes of population, recovery from the global economic recession crisis, and steady population growth over the forecast period are expected to serve as major drivers for the theme parks market. Another factor which is driving the market growth is the innovations in shape and experience delivery of rides which is accompanied by the renovation of parks from old-fashioned to modern theme-based parks. Growing popularity of social media platforms such as Facebook, Instagram, and Twitter has led to increased photo-sharing activity as people are keen to inform their friends & followers about their experiences. Theme park decision-makers place the equipment and spaces in such a way that customers are able to click pictures in strategically placed locations.

On the other hand, some factors which come as a challenge to market growth are high initial capital investments and deciding a suitable layout structure for the theme parks. Based on demography, the market can be segmented by targeted age groups. Thematic segmentation can be attained by considering individual interests like science theme-based parks, music/art theme-based parks and other themes.

In this newspaper article, it has been mentioned that Indian theme parks market grew at rate of 10.25% in the year of 2016. Indian theme park industry is being compared internationally where the valuation of theme park is near Rs.2.7 lakh crore. Future estimate of the Indian industry has also been mentioned and is being to grow at a rate of 19.1% and touch Rs.6980 crore by 2021 because it has been found out that consumers are going to spend more money on leisure activities. Expert has also said that India is a price sensitive country so the ticket price will remain low to attract more customers so it will be the role of government to attract investments in this industry and give subsidies for future growth. (Gaur, 2017)

In this article it has been mentioned how the operations research is used to maximize the profit in Disney theme parks. The magic kingdom at Walt Disney in Florida is one of the most visited theme park in the world with 18.6 million visits in 2013. The operation research and management has helped to increase per capita spending from \$95 to \$131 in 2014. In this article, it has been mentioned that roller coasters are a large contributor to the success of the theme park industry as a global tourism export.

Now, the digital era has introduced a new spin on roller coasters: incorporating virtual reality (VR) into the experience. This combines the real and the virtual. While guests sitting at their seats and enjoying the thrill of the roller coaster, they are provided with a VR headset that introduces an alternate reality like you are underwater, or even in outer space. Since the introduction of the first VR-enhanced roller coaster in 2015, more than 30 percent of European manufacturers have made VR additions to one or more of their operational roller coasters.

Findings suggest that if this trend continues, it will soon become the practice to apply VR on old roller coasters and make them favourite again which would lead to theme parks drawing the crowds again. (INVERSE, August 22, 2018) In this article it has been mentioned that according to the Indian Association of Theme Parks and Industries, the domestic theme park industry is estimated to grow to at least Rs 4,000 crore by 2020. The main reasons for this forecast include rising disposable incomes and focus on safety standards and hygiene. (IBEF, February 28, 2018)

In this article it has been mentioned that theme park is a kind of theme parks whose landscape, attractions, rides and other entertainment is based on a single or multiple theme. Theme parks can be either categorized as national or international based on their target visitors or as educational parks (Disney's Epcot), family owned parks (Knott's Berry Farm) and regional parks (Six Flag, Texas). The global theme park industry has the potential to grow further over the coming years. The main factors driving this growth would be increasing tourism spending, increasing urban population, growing middle class population, rising GDP worldwide and continuous technological up-gradation in theme parks. The majority of future growth lies in Asia Pacific region, due to poor park-population ratio, rising income levels and increasing expenditure on leisure activities in this region. Yet global theme park industry faces some challenges such as availability of alternatives, adverse effect of slow economic growth and seasonality. (The Business Journals, 2016)

3. OR TECHNIQUES

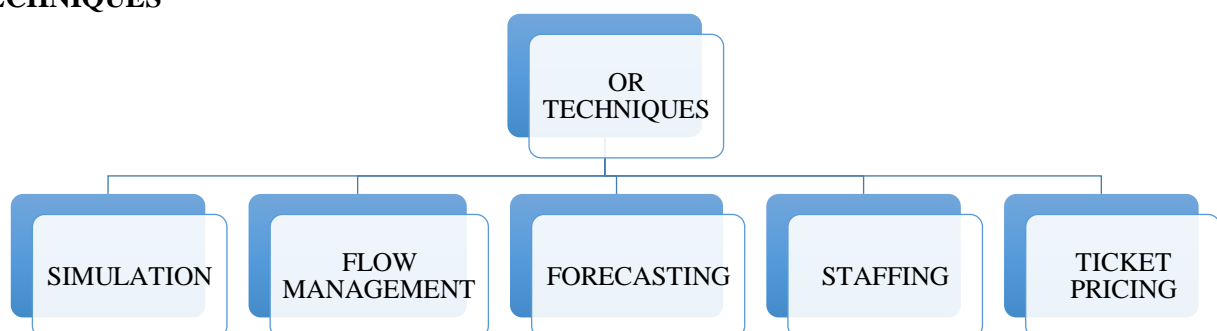


Fig. 1: OR Techniques

3.1 Staffing

Theme parks widely use simulation for staffing. Simulation offers many benefits prior to making physical changes, including identifying potential bottlenecks and testing new concepts or designs that can increase the overall capacity of the facility. If the

number of customers is more at a particular ride or place, the theme parks accordingly allot more people to that place. A lot of prior scheduling is also practiced. A lot of past data analysis also helps theme parks understand systems and customer behaviour to enhance satisfaction.

3.2 Flow Management

Flow management means controlling movement of people that is the next destination they will move to. In theme park flow management is used to increase their sales by directing people to store subconsciously.

3.3 Simulation

Simulation is a process of designing a model of real system and conducting experiments with this model for the purpose of understanding the behaviour for the operation of the system. Simulation helps a lot in theme parks. It is majorly used to design queuing systems. A lot of factors are taken into consideration like average waiting time, queue length, capacity of the ride, etc. This allows theme parks to understand wait times at various rides. Theme parks use this to make major decisions like the location and utilisation of recreational facilities. It is used in effectively handling the crowd. (Sharma, 1997)

3.4 Forecasting

Forecasting serves as the base for theme parks. It helps the theme park to forecast the attendance. These forecast are strongly considered while setting park hours and performing strategic planning. Everything is forecasted to enhance customer experience.

3.5 Ticket Pricing

Ticket pricing helps the park to decide the prices for tickets to prevent revenue leakage. To counter this problem and to maintain a flow of customers, parks provide annual passes, discount on bulk booking, and heavy discounts during off-season etc. an algorithm is developed to ascertain the nearest best possible price of the ticket to maximize the revenue. The prices in theme park varies as per the season, day of week, demand level, and ticket purchase time.

3.6 Accommodation

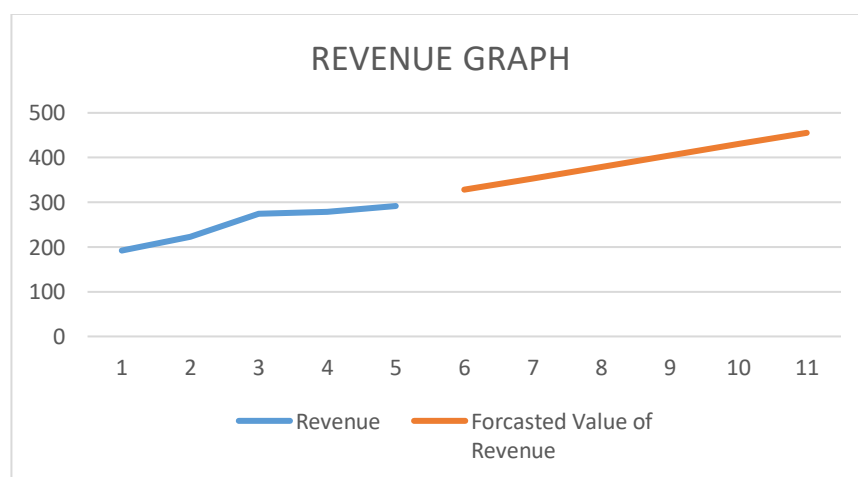
Accommodation plays an important role in the revenue of theme parks. Disney and Six Flags generated around 23.76% and 19.85% of revenue via accommodation respectively. (Wiley Encyclopaedia, 2010)A study done on 29 theme parks in Europe over the advantage of providing accommodation in theme parks concluded that 21 of the theme park have resulted an increase in there revenue significantly since introduction of accommodation. (Dickson & Ford, 2005)

4. OBJECTIVES

- Trend analysis of revenue and profit figure of the theme park Wonderla, Bangalore
- Replacement Theory applied in Equipment replacement

Table 1: Trend analysis

Year	Revenue	Forecasted Value of Revenue	Profits	Forecasted Value of Profit
2015	192.12	-	50.63	-
2016	223.43	-	59.82	-
2017	274.99	-	33.91	-
2018	278.34	-	38.5	-
2019	291.66	-	55.41	-
2020	-	328.305	-	44.126
2021	-	353.704	-	42.95
2022	-	379.103	-	41.774
2023	-	404.502	-	40.598
2024	-	429.901	-	39.422
2025	-	455.3	-	38.246



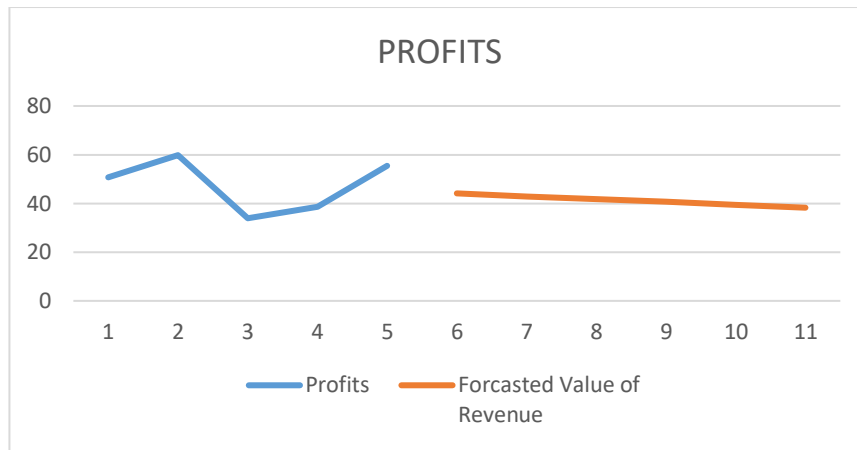


Table 2: Replacement theory

Name of Equipment	Name of Ride	Cost of Equipment
Recoil	Reverse Rollercoaster	₹ 20,00,000.00
Flash Tower	Drop Down Tower	₹ 10,00,000.00

RECOIL		Cost = 2000000				
Year	Running Cost	Resale Value	Cumulative Cost	Depreciation	Total Cost	Average Cost
1	₹ 50,000.00	₹ 17,00,000.00	₹ 50,000.00	₹ 3,00,000.00	₹ 3,50,000.00	₹ 3,50,000.00
2	₹ 51,000.00	₹ 15,00,000.00	₹ 1,01,000.00	₹ 5,00,000.00	₹ 6,01,000.00	₹ 3,00,500.00
3	₹ 53,000.00	₹ 14,00,000.00	₹ 1,54,000.00	₹ 6,00,000.00	₹ 7,54,000.00	₹ 2,51,333.33
4	₹ 56,000.00	₹ 13,50,000.00	₹ 2,10,000.00	₹ 6,50,000.00	₹ 8,60,000.00	₹ 2,15,000.00
5	₹ 60,000.00	₹ 12,00,000.00	₹ 2,70,000.00	₹ 8,00,000.00	₹ 10,70,000.00	₹ 2,14,000.00
6	₹ 65,000.00	₹ 10,30,000.00	₹ 3,35,000.00	₹ 9,70,000.00	₹ 13,05,000.00	₹ 2,17,500.00
7	₹ 71,000.00	₹ 8,10,000.00	₹ 4,06,000.00	₹ 11,90,000.00	₹ 15,96,000.00	₹ 2,28,000.00
8	₹ 78,000.00	₹ 5,60,000.00	₹ 4,84,000.00	₹ 14,40,000.00	₹ 19,24,000.00	₹ 2,40,500.00
9	₹ 86,000.00	₹ 3,10,000.00	₹ 5,70,000.00	₹ 16,90,000.00	₹ 22,60,000.00	₹ 2,51,111.11
10	₹ 95,000.00	₹ 60,000.00	₹ 6,65,000.00	₹ 19,40,000.00	₹ 26,05,000.00	₹ 2,60,500.00

Flash Tower		Cost = 1000000				
Year	Running Cost	Resale Value	Cumulative Cost	Depreciation	Total Cost	Average Cost
1	₹ 15,000.00	₹ 7,00,000.00	₹ 15,000.00	₹ 3,00,000.00	₹ 3,15,000.00	₹ 3,15,000.00
2	₹ 19,000.00	₹ 5,75,000.00	₹ 34,000.00	₹ 4,25,000.00	₹ 4,59,000.00	₹ 2,29,500.00
3	₹ 23,000.00	₹ 4,75,000.00	₹ 57,000.00	₹ 5,25,000.00	₹ 5,82,000.00	₹ 1,94,000.00
4	₹ 29,000.00	₹ 4,25,000.00	₹ 86,000.00	₹ 5,75,000.00	₹ 6,61,000.00	₹ 1,65,250.00
5	₹ 36,000.00	₹ 3,50,000.00	₹ 1,22,000.00	₹ 6,50,000.00	₹ 7,72,000.00	₹ 1,54,400.00
6	₹ 45,000.00	₹ 2,50,000.00	₹ 1,67,000.00	₹ 7,50,000.00	₹ 9,17,000.00	₹ 1,52,833.33
7	₹ 55,000.00	₹ 50,000.00	₹ 2,22,000.00	₹ 9,50,000.00	₹ 11,72,000.00	₹ 1,67,428.57

5. CONCLUSION

Despite the increase in revenue and profits during 2015-19, a decrease in profits over the coming years has been forecasted. This is due to various reasons. Over the course of these years, the cost of operations is bound to increase. Also, the number of rides in Wonderla is only 10, which makes it a less attractive destination in comparison to its competitors like Imagica. Also, the location is in the complete outskirts of Bangalore making it a hard commute especially given the traffic in Bangalore. Also, maximum footfall occurs during holidays, which causes even heavier traffic. Another factor is the staff, majority of the staff won't adequately know Hindi, which makes it hard for customers who hail from outside of Karnataka and hence, degrading the entire experience.

The Replacement Theory in Operations Research is used in the decision-making process of replacing a used equipment with a substitute, mostly a new equipment of better usage. The replacement might be necessary due to the deteriorating property or failure or breakdown of particular equipment. Replacement theory is also used in the cases like existing items have out-lived their shelf life, or it may not be economical anymore to continue with them, or the items might have been destroyed either by accident or otherwise. The longer a deteriorating item is operated the more maintenance it requires to maintain efficiency. Furthermore, the longer such an item is kept the less is its resale value and with the advent of new technology, the more likely it is to be made obsolete by new equipment. If the item is replaced frequently, however, investment costs increase. Thus, the problem is to determine when to replace such items and how much maintenance to perform so that the sum of the operating, maintenance, and investment costs is minimized.

While applying replacement theory to Wonderla, total cost was calculated by adding cumulative maintenance cost and overall depreciation. Average cost was calculated by dividing the total cost with the number of years the equipment has been used. Hence

for the recoil, the minimum average cost is after the 5th year. Replacing the recoil before the 5th year would result in insufficient utilization of resources or even after the recommended time. Similarly, for the flash tower, the minimum average cost is after the 6th year. Replacing the flash tower before the 5th year would result in insufficient utilization of resources or even after the recommended time.

Operations Research helps with the management of theme parks. Without Operations Research and with poor management systems at the theme parks, it may lead to undesirable and long customer waiting time and inefficient utilisation of park capacity. Poor management systems may also lead to low footfall at some rides and lengthy queues at other rides. Customers also have varying degrees of tolerance for waiting in queues and this has to be taken into account while coming up with a management system. Thus, this shows that Operations Research is of great importance in Theme Parks. Operations Research is a part of the customer satisfaction process. Operations Research has helped in understanding customer needs, through simulation, forecasting, etc. Various models have helped gain exclusive profits. Marketing and strategic management issues in the theme park industry have been studied extensively, documented applications of operations research in the theme park industry are limited. To design rides simultaneous techniques are used and manage the wait time associated with rides as well as controlling the flow of the visitors via multi-agent systems. To manage park resources intelligently and increase visitor satisfaction, optimization techniques have been used. Finally, revenue management tactics have been applied to pricing tickets effectively to prevent revenue leakage. Theme parks like Walt Disney World have special conferences for data analytics to understand the fast and rapid changes, research right from the part where the customers enter to the part when the leave satisfied, and also the importance of operations research.

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