Feasibility Study of the Bicycle Sharing System as a Mode for Internal Movement of Employees : A Case Study

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Abstract

Bicycle sharing systems allow people to hire a bicycle from a docking station for short-distance movement, typically one way, providing a substitute to the conventional means of movement, that is, private or public carriers (autos, taxies, etc.). In an integrated manufacturing industry, employees generally use private vehicles or company transport for internal movement within the organization, and the organization has to invest huge sums of money for purchasing or hiring of vehicles or has to pay T.A to the employees using their own means of transport. This paper attempted to show the effectiveness and feasibility of the bicycle sharing system in an integrated industry, which has a scattered layout. We also showed its effect on the cost of internal movement of employees in terms of fuel expenses.

Keywords : **bicycle sharing, scattered layout, feasibility, employee fitness, pollution control**

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The bicycle sharing system is a concept in which one can hire a bicycle from a docking station for short-distance movement ; typically, a one way journey without worrying about the ownership of the bicycle. The user is allowed to hire a bicycle from one docking station and is responsible to return it to the same or a similar docking station. After paying the initial subscription fee (annually, monthly, weekly, or daily), users typically have low-cost or free access to the bicycles for a fixed duration of an hour or two. They are only responsible for the safety of the bicycle when it is in their custody and for the damage due to miss handling of the bicycles.

In an integrated manufacturing industry, the internal movement of employees comprises of movement of employees from one mill to another mill ; from quarters/ hostel to mill at the beginning of shifts ; from mill to quarters/ hostel during lunch and returning to work ; from mill to quarters/ hostel at the end of shifts. On an average, each individual covers a distance of about 10 km (approx) in a single day.

Generally, the management of these internal movements of employees in such an industry is a cost consuming process in terms of fuel cost and hiring cost. The company has to manage a fleet of vehicles or has to pay travelling allowance to those who use their own means of transport. Generally, a company hires vehicles on contracts from outsiders ; otherwise, it owns some vehicles for the same purpose, which also adds to the maintenance cost in terms of manpower and consumables. This system - the bicycle sharing system - is somewhat helpful in reducing

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the air pollution caused due to these vehicles and also acts as a means of providing physical exercise to the employees. The bicycle sharing system is a very simple system, and it also helps to reduce the cost incurred due to managing a fleet of vehicles. Bicycles can be picked up at any cycle stand or docking station and returned to any other station within the industry, making them appropriate for the above mentioned internal movement.

Literature Review

There have been four generations of public use of bicycles ; the earliest well-known community bicycle programme was started in the summer of 1965 by Luud Schimmelpennink in association with the radical group Provo in Amsterdam, The Netherlands. Ordinary bicycles, painted white, were provided for public use. Anyone could find a cycle, ride it to his or her destination, and leave it for the next user. However, things did not go as planned as bicycles were thrown into the canals or appropriated for private use. The program collapsed within days (DeMaio, 2009). That was the first generation and the beginning of this system.

The second generation of bicycle-sharing program was started in Farsø and Grenå, Denmark, and in 1993 in Nakskov, Denmark. The programs were small, with Nakskov's having 26 bicycles at four stations. In the year 1995, nearly about 30 years after the introduction of the first bicycle-sharing program, the first large-scale second generation bike-sharing program was launched in Copenhagen as Bycyklen, or City Bikes with many improvements over the previous generation. The bicycles used in this generation were specially designed having some features, which made them easy to identify, but due to anonymity of the users, the problem of theft was not removed (DeMaio,2009).

This gave rise to a new generation of bicycle sharing, that is, the third generation of cycle sharing with some advance features to track the identity of the users. The first of this kind was started as Bikeabout in 1996 at Portsmouth University in England, where students could use a magnetic stripe card to rent a bicycle. This and the following third generation systems were smartened with a variety of technological improvements, including electronically locking racks or bicycle locks, telecommunication systems, smartcards and fobs, mobile phone access, and on-board computers (DeMaio, 2009), but this system was limited only to the European countries prior to 2008.

The bicycle sharing system began its extension outside Europe in the year 2008, when many non European countries started implementing this system. The following list of countries were among the first few non-European nations to implement this system (DeMaio, 2007, 2008) :

- **Brazil:** Rio de Janiero-Samba, São Paolo- UseBike;
- **Chile:** Santiago - b'easy;
- **China:** Beijing - Beijing Bicycle Rental, Hangzhou - Hangzhou Public Bike, and Shanghai;
- **New Zealand:** Auckland -nextbike;
- **South Korea:** Changwon- Nubija;
- **Taiwan:** Kaohsiung City - Kaohsiung Public Bicycle Rental; and
- **U.S.A.:** Washington, D.C. -SmartBike D.C.

Bike-share has seen explosive, global growth over recent years. As of April 2013, there were around 535 bike-sharing programmes around the world, made of an estimated fleet of 517,000 bicycles. In May 2011, there were around 375 schemes comprising of 236,000 bikes. So, these 2 years saw a doubling of bike sharing globally.

In India, Mumbai operates two schemes, and the Ministry of Urban Development is preparing to launch a 10-city public bike scheme as part of its “Mission for Sustainable Habitat”. In Bangalore, the ATCAG system has implemented a bicycle sharing program aimed primarily to solve the last-mile problem for users of the Bangalore

Metro. Namma Cycle is a bicycle sharing system being implemented in the Indian Institute of Science (IISc, Bangalore) campus and the surrounding neighborhood. Bicycles are made available at select locations in a community/city allowing people to have ready access to these public bicycles. Namma Cycle is a semi-automated bicycle sharing system that was inaugurated in August 2012 with 100 cycles and 6 stations. In 15 months of operations, it completed around 16000 trips averaging 1000 trips in a month. Namma Cycle uses a free and open software system, ECBike developed by Gubbi Labs to manage the entire bicycle rental operations (Gautam, 2012).

The bicycle sharing system is not very popular in India, but many countries are continuously trying to implement this system; Indian agencies are also working to implement this system in cities as well as in many universities across the country. The present paper is an attempt to assess the feasibility of implementing the bicycle sharing system in an integrated manufacturing industry (steel industry located in India).

Methodology and Data Collection

Two steps were taken to check the feasibility of the system and this project. In the first step, the prospective employees were considered. The acceptability of the system among the employees was obtained by a survey conducted with them in which various questions were posed to them related to their day to day activity and needs.

In the second step, the company's point of view and the employees's point of view were considered . From the company's perspective , a cost benefit analysis of the project and utilization of existing facilities was done. The profit from the proposed system and savings with respect to the present scenario were calculated, that is, the existing modes of internal movement and the payback period of the system was calculated. The following equations were used to evaluate the company's perspective :

(i) Calculation for Initial Setup Cost

Let, number of bicycles required = N_b

Cost of one cycle = C_b

Therefore, the total cost of bicycles = $N_b * C_b$ ..... (1)

Setup cost of new cycle stand = C_s

No of new stands proposed = N_s

Therefore, the total setup cost of stands = $N_s * C_s$ ..... (2)

The initial onetime setup cost (1) + (2) = $N_b * C_b + N_s * C_s$

(ii) Recurring Cost

Maintenance cost/ month of each cycle (2%) = .02* C_b / months/ cycle

Total annual maintenance cost/ = . 24$N_b * C_b$.....(3)

Additional manpower needed (12 hour shift) = $2 * N_s$

Salary of one manpower/ month for cycle stand = $2 * N_s * P$

where,

P is the salary of one man/ month.

Manpower cost (12 hour shift)/ annual = $24 * N_s * P$ ..... (4)

Total Recurring cost/ year = (3) + (4) = $0.24 N_b * C_b + 24 * N_s * P$

(iii) Money Inflow into the System

Let the number of employees register for the subscription = Ne
The amount of money charged from each employee = r
Therefore, the net money inflow in the system = $Ne*r$ …….. (5)

(iv) Profit from the System

The source of income for the system is the money obtained from the subscription fee from the users. Therefore, the net profit from the system is calculated by obtaining the net difference of the subscription fee from the employees and the cost incurred in operating the system, that is, the difference of the equations (5) & (4).

Profit = $12*Ne*r - (0.24N_b * C_b + 24 * N_s * P)$ …….. (6)

(v) Savings with Respect to the Existing System

Avg. mileage of motor vehicle = X km/hrs
Avg distance covered by each employee/ day = Y km
Total distance cover by Ne user = $Ne * Y$ km
Saving of petrol/ day = $(Ne * Y)/X$
Annul petrol consumption to be reduced = $(Ne * Y)/X$ *360
Approx. petrol price = ₹ 80
Monetary saving of petrol / day = $(Ne * Y)/X$*80
Monetary saving of petrol/ annum = $(Ne * Y)/X$* 80*360

Total monetary saving of employees/ annual (Ne) = $(Ne * Y)/X * 80 * 360$ ……..(7)

(vi) Total Saving with Respect to the Existing System (P_s)

The total saving with respect to the present system is calculated as the difference of the sum of money inflow from subscription and the saving w.r.t the present system to the money incurred in operating the system.

Total saving w.r.t existing system= = $\{(Ne * Y)/X * 80 * 360\} + \{12 * Ne * r - (0.24N_b * C_b + 24 * N_s * P)\}$ ..... (8)

(vii) Payback Period of the System

The payback period of this system is calculated as given below (Pandey, 2009) :

$$\text{Payback period} = \frac{\text{setup cost}}{\text{profit}}$$

$$= \frac{N_b * C_b + N_s * C_s}{P_s} \quad \text{..... (9)}$$

Analysis of the Case

Analysis from the Employees' Point of View

The survey was conducted among the employees to find the acceptance of this project among them. The sample of

Table 1. Gender of the Employees

Gender	No of employees	%
Male	386	96.4
Female	14	3.6

Table 2. Age Group of the Employees

Age Range	No of employees	%
Below 30 yrs	88	22
31 - 40 yrs	144	36
41 - 50 yrs	144	36
51 - 56 yrs	20	5
57 - 59 yrs	4	1
60 yrs& above	0	0

Table 3. No of Physically Active Employees

Response	No of employees	%
Active	157	39
Inactive	243	61

Table 4. No of Employees who Supported Physical Activity

Response	No of persons	%
1.*Disagree*	0	0
2	0	0
3	25	6.25
4	43	9.3
5.*Strongly agree*	332	83

Table 5. Employees - Did They Exercise ?

Response	No of persons	%
Yes	80	20
No	320	80

the employees was taken randomly from different departments - the sample respondents were from different age groups, and had different job profiles in the sample organization. The duration of the survey was from August - October 2014. Various questions related to the respondents' age, sex, present health condition, details about their physical activity, movement within the plant, means of transportation used within the company premises, and so forth were included in the survey. The survey was sent to around 590 employees of the company, out of which 400 accurate responses were received (response rate was around 67.5 %). The aim of this survey was to check the acceptance of the bicycle sharing system among employees, and to identify the number of expected bicycle sharing system users (if it gets implemented in the future).

The details regarding the gender of the employees are given in the Table 1. It can be seen from the Table that the majority of the respondents (i.e., 96.4%) were men. From the Table 2, it can be seen that the majority of the respondents were in the age groups of 31- 40 years and 41- 50 years. Hence, employees upto the age group of 40 years were considered as the target age group for this project. Next, the survey questioned the employees about their physical activity levels (Table 3). This question was posed to the employees to identify the percentage of employees who were physically active during the working hours. The purpose of this question was to identify suitable persons who were potential candidates to use the bicycle sharing system, since employees who are physically active during the working hours may not opt for this system. Hence, the employees who were physically inactive during their working hours were our targets for the bicycle sharing system. Since they were not active while working, they were more likely to accept this system.

From the Table 4, it can be inferred that a majority of the sample respondents agreed with the statement that "Being physically active is necessary for good health" . Hence, the respondents who believed that physical activity was necessary for good health were our target employees. The next question asked the sample

Table 6. Time Spent on Workout

Response	No of persons	%
½ hr	64	80%
½-1 hr	3	4%
1-2 hrs	5	6%
More than 2 hrs	0	0

Table 7. Reasons for Not Doing Exercise

Response	No of persons	%
Don't have enough time	140	44
Don't have enough energy after work	40	12.5
Don't have enough facility	120	37.5
Don't know what to do	14	4.4
Don't care much about it	6	1.8

Table 8. Job Profile of the Employees

Response	No of persons	%
Office work	95	23
Field work	65	16
Mixed	240	60

Table 9. Employees Traveling to Different Departments

Response	No of persons	%
Yes	197	49
No	203	51

respondents whether they exercised regularly or not ; 80% of the respondents revealed that they were not able to include exercise in their daily routine (Table 5). Hence, it can be interpreted that 80% of the respondents would benefit from the bicycle sharing system as they would get some form of exercise as they traveled within the company premises.

The next question asked the respondents whether they exercised regularly. Only 20% of the sample respondents exercised regularly (80 respondents out of 400 respondents). It can be inferred from the Table 6 that majority of the employees who exercised spent less than half an hour in exercising daily. However, experts recommend at least 45 minutes of moderate exercise daily to maintain sound health. Next, the respondents were asked about the reasons as to why they were unable to include an exercise regimen in their daily schedule (Table 7). It can be observed from the Table 7 that majority of the respondents who did not exercise were unable to do so due to two reasons: paucity of time and they did not have enough facilities for exercising . Hence, the proposed bicycle sharing system is an excellent medium for getting exercise ; it would be a boon for the employees who are unable to include an exercise regimen in their daily schedule.

The survey next questioned the respondents about their job profile. It can be inferred from the Table 8 that only 16 % of the respondents were engaged in field work, which means they were directly involved in doing physical work ; these people did not require any additional physical activity, as their nature of work was sufficient enough to keep them healthy. However, the remaining 60% of the respondents were engaged in moderate physical activity, and 23% of the respondents had sedentary jobs. Hence, the proposed bicycle sharing system would be quite beneficial for employees who had a moderate - sedentary life style.

Table 10. Average Daily Movement of Employees

Distance (Km)	No of persons	%
0-2	0	0
2-4	35	9
4-6	14	3.5
6-8	76	19
8-10	226	56
More than 10	49	12.25

Table 11. Employees Feel the Need to Stay Fit

Response	No of persons	%
Yes	383	96
No	17	4

Table 12. Employees' Choice of Physical Activity

Response	No of persons	%
Walking	73	18.25
Running	45	11.25
Cycling	119	29.75
Others	163	40.75

Moving ahead, the survey questioned the respondents whether they visited different departments of the organization for official work ; 49% of the respondents replied in affirmative to the posed question (Table 9). Hence, those employees who often visited other departments either used the company's vehicle or their own vehicle to travel around the campus, and they were paid the traveling allowance for moving around (in case they used their own vehicle). The proposed system would save a lot of traveling allowance allotted by the said company. In addition, the organization would not have to maintain a fleet of vehicles to ferry the employees from one department /block to the other department/block.The employees were also questioned regarding the distance traveled by them during the office hours (Table 10). From the Table 10, it can be concluded that the average distance traveled by the company employees per day was 8.2 km; this distance includes the movement within the plant premises, and the distance traveled from home to the plant and vice- versa.

Lastly, the employees were questioned about whether they felt the need to stay fit? and if they felt the need, then what were the best ways in which they could stay fit. It can be inferred from the Table 11 that almost all the employees of the plant believed that they needed the opportunity to stay fit. The Table 12 reveals that majority of the respondents opted for other alternatives which included gyming, swimming, and so forth. However, these alternatives are costly ones , would require huge investments and also, the operating cost is high. The second most opted alternative was cycling, that is, around 30 % of the plant employees thought that cycling was a great alternative to stay fit, and if they were provided an opportunity to cycle around the campus, they would readily accept the same.

⇨ **Findings of the Survey :** From the survey, we were able to draw general conclusions about the 4200 employees working at the plant, which are as follows :

(1) Fifty eight percent of the employees came into our target age group, that is, 2436 employees.

(2) We can say that 61% of the employees had a sedentary life style (desk job); these employees are likely to support our system. Therefore, 1485 employees (approx.) come under our target.

(3) Almost all the employees believed that they required physical activity to stay fit.

(4) Only 20 % of the employees were able to take out time for a regular workout. Out of the remaining 80% employees, 82 % were unable to do so due to lack of time and facility, so they might benefit from the proposed bicycle sharing system, that is, 974 people were willing to have such a system which provided them an opportunity of workout without spending any time and much money.

(5) Approximately 30% of the employees believed that cycling was the best exercise to keep them fit. Therefore, about 300 employees were our target employees.

(6) Approx. average movement of employees within the plant premises was 8.2 km/ day. Thus, we can conclude that if we can implement this system, we would be able to save the travel cost of about 2460 km/ day.

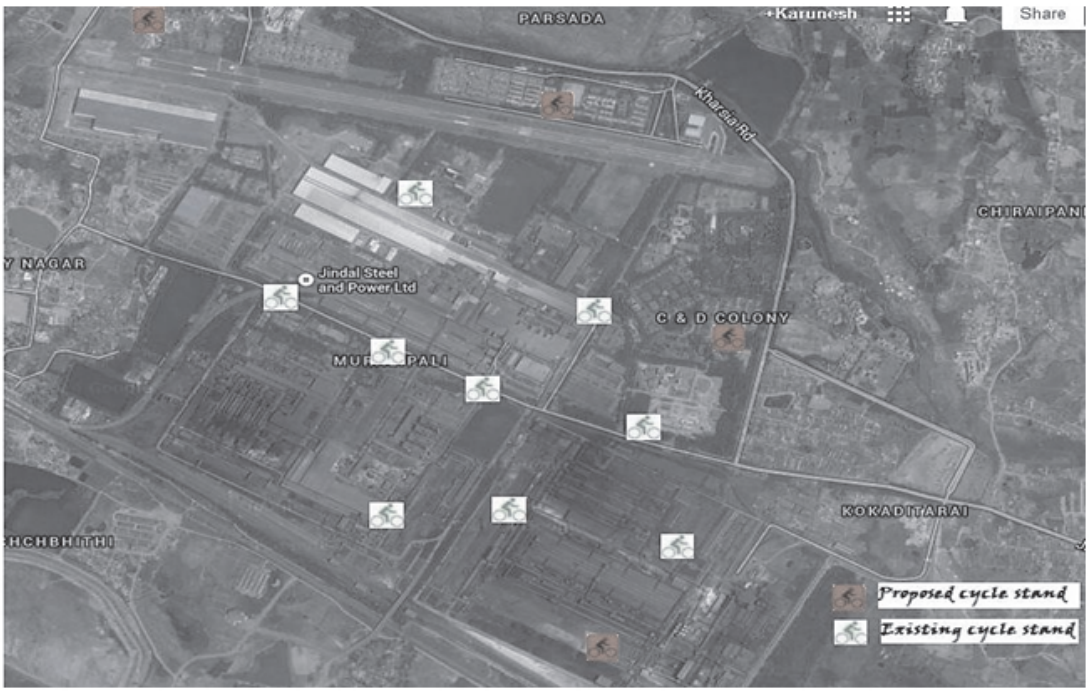
Analysis from the Company's Point of View

⇨ **Utilization and Requirement of Infrastructure for the System :** The proposed bicycle sharing system does not require any big infrastructure; the only requirement for the system is the required number of bicycles and cycle stands at the identified locations. The locations which are white in color are the existing cycle stands and the dark marks are the identified locations where there is need to set up the new cycle stands (see Figure 1).

⇨ **Cost - Benefit Analysis of the Proposed System :** The following figures were obtained from the survey :

(1) No of employees willing to opt for this system = 300. Apart from these employees, some visitors, security personnel, contract workers, etc. would also benefit from this system.

Figure 1. Existing and Proposed Locations of Cycle Stands



(2) As discussed, the total distance covered by the employees within the plant is 2460 km on an average. The cost of this distance can be reduced.

Let us suppose the no of bicycles required is 200
Market price of 1 cycle is ₹ 3000
Therefore, the total cost of Bicycle = ₹ 6 lakhs ……(From 1)
Setup cost of new cycle stand = ₹ 50000
Total setup cost of new cycle stands = ₹ 2 lakhs …… (From 2)
The initial onetime setup cost for the company = ₹ 8 lakhs

Total annual maint. cost = ₹ 144000 ……(From 3)
Manpower cost (12 Hr. shift)/ annual = ₹ 576000…….(From 4)
Salary of in charge of 4 cycle stands is only considered. The other stands were used by the existing system, we are just using that facility.
Total recurring cost = ₹ 720000

Subscription money charged from each employee = ₹ 300
Total subscription money/ annum= ₹ 1080000 …….. (From 5)
Profit from the proposed Bicycle Sharing System = ₹ 360000 ……(From 6)

Apart from the subscription money, the hiring charge from the visitors and the unregistered employees also adds to the income of the system. Here, we are not considering the sum which will come into the system due to the above mentioned reason.

Saving w.r.t existing system/ annum = ₹ 1574400…….. (From 7)
Profit w.r.t to existing system/ annum = ₹ 1934400…… (From 8)
Payback period of the system = 2.2 years …… (From 9)

We can use some of the strategies for reducing the recurring cost :

(1) We can reduce the maintenance cost by employing persons who are somehow capable of repairing bicycles at the cycle stands; this will cut the service charge of the mechanic.

(2) At some points in the plant, the cycle stands are located at the security gates, the security guard at the gate will carry out the job of issuing and submitting the cycle.

Conclusion and Implications

The bicycle sharing concept has been checked from the view points of both - the employees and the employer. During the survey, we observed that this system was easily accepted by the target age group employees, and the payback period for investment is only 2.2 years. In this case, the employees will get health benefits due to cycling, and the employer will get the cost benefit. Both are in a win-win situation. This indicates that the proposed Bicycle Sharing System is quite feasible for the sample integrated manufacturing industry.

The bicycle sharing system would allow flexible mobility options for spontaneous internal movement of the employees within the plant premises and would also help in reducing the pollution and expenses caused due to vehicles. Since this approach is the first of its kind in the world in an integrated manufacturing company, the company can gain reputation for this innovative approach and can also gain some carbon credits, which can be

utilized for some other purposes. Implementation of the bicycle sharing system would create a feeling of equality among the employees (as everyone would be using the same mode of transportation to move around), and this would motivate them with a sense of team spirit and oneness.

The system also provides a platform for much-needed physical exercise to the employees, which no other system will provide due to their busy working schedule. This will be effective in reducing obesity, risk of heart problems, high blood pressure, cholesterol levels, and so forth. Thus, adopting this system in an integrated manufacturing industry would be effective in removing many serious issues of employees as well as of the company; this can emerge as a trend setter in this field for other industries where similar problems are faced by both the company as well as the employees.

In the beginning, it may be difficult to pull employees from their comfort zone, but by adopting some measures like some promotional strategies and compulsion from the higher authorities, this system can emerge to be a great success. However, the proposed Bicycle Sharing System can only be implemented in large manufacturing industries because it requires massive internal movement. After implementation of the Bicycle Sharing System, many challenges will crop up - like the fleet of cycles would need to be maintained at particular cycle stands, which will require a mathematical model for redistribution of the bicycles at different cycle stands considering the demand of the bicycles. Cases of theft and seasonal changes will also affect the performance and use of bicycles. Therefore, the organizations will need to develop innovative strategies to overcome these challenges.

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