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Abstract

Low population areas and low-income people often face unreliable public transport characterized by long waiting times. Meanwhile, a private vehicle in the same area, on average, will remain inactive for long periods of time. Recent research in shared mobility systems addresses this situation. Specifically, Demand Responsive Transport, DRT, a transport alternative between a bus and taxi, and which has many specification variations, has pioneered provision of an alternative transport solution geared to reach under-served minorities. Solutions to DRT trip scheduling and costing mechanisms usually include constraints specific to the variation of DRT specifications.

We aim to maximize use of a vehicle and we propose a design of a Community shared mobility service model that provides centralized management and ICT support in delivering multiple services in a vehicle. Our design adds time constraints of vehicle schedule to the DRT problem. We

also consider cost sharing mechanism.

We focus on reducing waiting time and propose a trip scheduling and cost sharing algorithm. We base our approach on a DRT heuristic algorithm. We also consider time windows. We propose a new cost sharing mechanism, based on traditional distance costing techniques but considering, seat capacity, an approach unique to the specifications of our design.

Key words: Shared Mobility, Demand Responsive Transport, Mobility as a Service

1. Introduction

Most cities all over the world are serviced by a system of public transport that includes train, bus and taxis [1]. Present public bus services in developing countries are, however, inefficient, unproductive, and unsafe characterized by long waiting time, delay on plying routes, long boarding time, overloading, discomfort and long walking distance from the residence/work place to bus stop [2][3][4]. For instance, buses in Dhaka, Bangladesh are mostly over-crowded, which is often not accessible for the elderly or disabled people as well as being unsafe for women due to eve-teasing. Moreover, the frequency of bus service (headway) is quite low. A research carried out in Dhaka city found that most of the city residents are satisfied with the cost of travel but very unsatisfied with the waiting time as they have to wait for the bus sometimes up to an hour [5]. Other transport alternatives like taxi, motorized vehicles and rickshaws are unaffordable for the average user especially as a frequent transport alternative.

The cost of a car is prohibitive for many living below the poverty line. In fact, in most developing countries, car ownership is considered a luxury many cannot afford. However, the benefits of a car cuts across all econom-

ic and social status. The need to move from one point to another for economic gain, health care, education or even personal reasons is valid for all, rich or poor. While those at the top of the pyramid can easily access these social services given their economic status, the people at the bottom of the pyramid (BoP, people with low purchase power), have distance and economic power limitations in accessing the social services [6].

Given the recent growth of the shared economy, potential exists to accelerate shared mobility strategies that address the specific mobility issues of low-income communities [7]. Historically, public transit, land use policy and planning have often resulted in significant mobility obstacles for low-income people in cities. Indeed, low-income communities typically face longer commute times and higher fares than their middle and upper income counterparts. An alternative approach to the public transport deficit is to focus on the causes of mobility [8] and reduce the frequency of transit. The primary need for mobility is to access social services like healthcare, education and commercial gain. Addressing this, a scheduled community car based on a Demand Responsive Transportation (DRT) model can fulfil this need by bringing the services to the low-income people [7]. DRT is a form of transport between bus and taxi services involving flexible routing and scheduling vehicles by incorporating transport requests from customers. Several DRT scheduling, dispatching and routing approaches have been researched, however, there has not been enough discussions in the area of multiservice DRT approach.

Posing a hypothesis that a demand responsive transport based solution would provide quality transport (in time and comfort) at an affordable cost, we designed a multiservice community car model that provides centralized management and background ICT support of the vehicle operations and services. We called this concept Social Services on Wheels. The Social Service on Wheels (SSW) concept was designed by Kyushu University in collaboration with Grameen Communications to bring ICT based

services to unreached communities. SSW is managed by Mobility Server. Users send their transit and service requests to the system managed in the central office in the back end. These requests are met by a vehicle being sent to offer the transport or service requested. SSW delivers services and provides transportation to passengers in the front end. The community shared mobility service, front-end community service, comprises a vehicle, service delivery point, personnel and an array of smart devices. The service delivery at the front-end is both schedule based and demand based, targeting different users in urban and rural settings. Scheduled services targets office workers and college students and healthcare delivery.

We investigate how to make our community shared mobility service approach more efficient and focus on trip and cost scheduling. The solution should provide transport alternative between bus and taxi based on introduced time constraints of vehicle prior schedule and a cost constraint that considers a quorum, minimum number of passengers for the service to be offered.

2. Demand Responsive Transportation

Demand Responsive Transportation are a new-generation means of transportation that conforms to the wishes of its riders [9]. Fixed-route buses travel along a fixed route according to a time schedule, stopping at each designated bus stop. Because the system is easy to understand, passengers have little trouble using the system. On the other hand, the fixed-route bus has many disadvantages. For example, because the operate according to a fixed time schedule, it is not possible to simply get on at a time of your convenience. For example, practically anyone has had experiences like, "I had to wait at the bus stop for ten minutes" or "There's no really good bus for me to get to that meeting". And there is the fact that quite frequently, the bus will run its designated route at designated times

even though there are no passengers. This is certainly not good for the environment, and means that there is quite a lot of waste in operating the bus system.

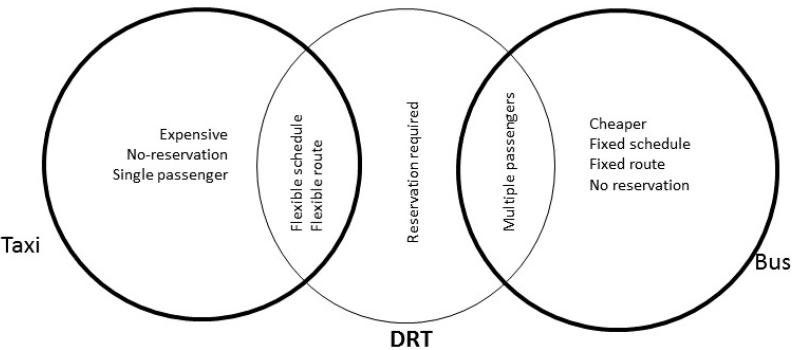


Figure 1 Distinguishing Demand Responsive Transport from taxi and bus service

Demand Responsive Transportation is a relatively new concept that resolves that combines flexibility of taxi services with low cost nature of bus services (Figure 1). Demand Responsive Transportation operate in a way that meets the demand of its riders, picking them up at the times and places they request. DRT services have another special characteristic; ride-sharing. Ride sharing is when passengers who are travelling along similar routes share the same vehicle. Taxis can take a maximum of four passengers from an origin to a destination. But because DRT has the ride-share function, they can deviate from their route slightly and pick up additional passengers. This is one aspect that differentiates them from taxis. DRT can help buffer metropolitan areas from traffic congestion.

DRT models distinguish from traditional shared mobility services in that they incorporate flexible routing, flexible scheduling, or both. These services operate much like jitneys of the past but are enhanced with information technology [10]. Existing micro transit operators target commuters, primarily connecting residential areas with downtown job centers. Micro

transits use of smartphone technology avoids traditional and costly methods of booking rides, such as call centers or even booking websites. The use of advanced technology has the potential to lower operating costs for services that target special populations, such as disabled, older adults, and low-income groups.

2.1. The DRT Problem: Effectiveness of Demand Responsive Transport

Initial approach to DRT was telematics based, users would call an operator who would manually check vehicle availability, assign a passenger to a suitable vehicle trip and inform the driver on the trip information. Since then, advancements in use of internet technologies have automated most of the DRT operations as discussed in the previous section. The automation problem having been solved to some extent, the DRT problem is now how to make the system more effective in time and cost. Lots of literature has been covered in approaches in scheduling DRT using, time windows, agent-based solutions, genetic algorithms, exact and searching algorithms including heuristic algorithms. Cost effectiveness for DRT, however, has not been extensively researched as DRT solutions are usually heavily subsidized.

2.2. Trip Scheduling Approaches

Guidelines for computational experiments to test heuristic methods have been identified in [11]. To evaluate the capacity and optimum service time interval of a demand responsive transit feeder service [12] used three step local search algorithm for the vehicle routing problem with a heterogeneous fleet of vehicles and soft time windows. In [13] an insertion heuristic for scheduling Mobility Allowance Shuttle Transit (MAST) services was developed. In their work, a MAST system is characterized by

the flexibility to allow vehicles to deviate from the fixed path in order to serve customers within a service area. A set of simulations are performed. The results show that the insertion heuristic approach developed could be used as an effective method to automate scheduling of Demand Responsive Transport. The impact of complicating constraints on the efficiency of insertion heuristics for the standard vehicle routing problem have been discussed in [14]. The complicating constraints identified were significant as they affect the feasibility and the efficiency of the schedule. The constraints considered were the time windows, shift time limits, variable delivery quantities, fixed and variable delivery times, and multiple routes per vehicle.

Jaws et.al [15], described a heuristic algorithm for a time constrained version of the many-to-many Dial-A-Ride Problem (DART). The algorithm described as the Advanced Dial-a-Ride Problem with Time Windows with service quality constraints, identifies feasible insertions of customers into vehicle work-schedules. An incremental cost of each insertion is evaluated through an objective function. The cost is the weighted sum of disutility to the customers and of the operating costs. The solutions provided did not have any optimal solutions to compare with as no exact algorithms existed to solve problems of similar size. In [16], authors analyze heuristic algorithms for the single vehicle many-to-many dial-a-ride problem (DARP), i.e. designing a route for a vehicle carrying customers between specified pick-up and delivery points to minimize the total travel distance.

Approaches to real time demand responsive transport have been researched based on time constraint. The concept of estimating bus passenger waiting times from incomplete bus arrivals data has been explored in [17] whereas the impact of real-time bus arrival information using the passenger wait time perceptions at bus stops has been evaluated in [18]. In [19], authors performed the travel time studies by using global positioning system (GPS) and geographic information system (GIS) technologies.

Concerning travel time schedules, the ability to select certain occupations in specific industries is relative to the ability to select work schedules [20]. Some jobs that need to start during off-peak hours might indirectly prevent employment of those who cannot reach the employment locations at that time. Demand-responsive services are most likely to receive the highest ranking among all flexible transport services. The commuting patterns of newly built towns are discussed intensively [21]. Research has found that the proportion of people working or studying in urban area is proportional to the age of the new town. Moreover, cross-district commuting to work is more prevalent than to school. Comparison of weekend and weekday activity patterns found that the weekend travel patterns are quite different from weekday travel patterns in many aspects such as time of day, mode, and the total volume [22].

3. Social Services on Wheels

The Social Services of Wheels (SSW) concept was designed by Kyushu University and Grameen Communications Global Communication Center (GCC) to provide safe mobility and reliable access to basic social service for low-income subjects in unreached communities [23][24]. It consists of back-end of data servers and a front-end community service comprising a vehicle, service delivery point, and an array of smart devices. The front-end smart devices communicate with the back-end using mobile network coverage and Internet. The SSW back-end comprises of GramWeb software applications and database. The GramCar software schedules various services and GramHealth software processes medical records such as patient Electronic Health Records (EHR) and ePrescriptions. Registered SSW clients and service records are stored in the Gram database. The SSW front-end consists of a vehicle, service delivery points, and smart devices used to access and attain social services. The vehicle is a minibus (Toyota

Hiace) and provides scheduled transport to female college students. A service delivery point is the physical environment where SSW team interacts with its rural clientele and provides four services: portable health clinic, blood grouping, online IT service and training, and purchasing opportunities (ecommerce and product delivery). The smart devices include: medical sensors used in the Portable Health Clinic briefcase, blood grouping devices, tablets for IT services, and price catalogue for online purchasing. The SSW operation model is based on a Village Car Entrepreneur (VCE) who manages a small team (driver, healthcare worker and IT assistant) and ensures that services are delivered at specific points within an agreed timetable. Service delivery is dependent on the vehicle daily and weekly schedule. On a daily basis, the vehicle picks up female students from pre-defined collection points and drops them at the college. It then picks up the medical experts, ICT experts and social goods providers from nearby urban centers and drops them at a service point (a small room or desk). On a weekly basis, the vehicle visits six mobile service points in six different days a week; hence the community gets access to the social services once a

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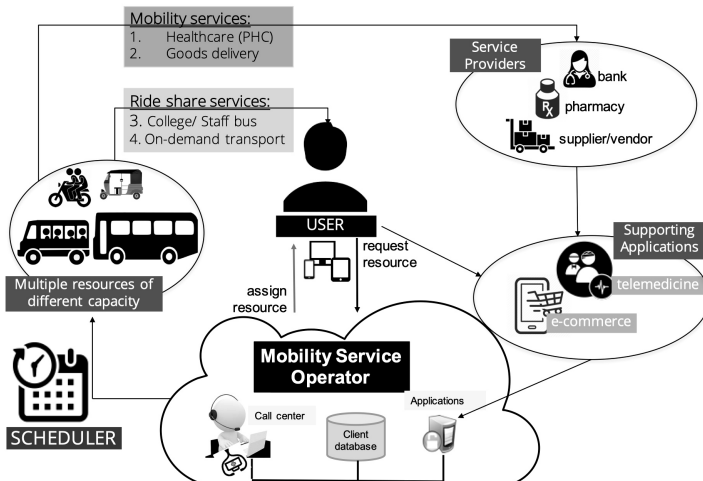


Figure 2 Community shared mobility service model

A centralized back-end data cloud can manage multiple instances of the front-end smart community service. The front-end includes a college bus service, health clinic, blood grouping testing, online learning, and online shopping managed by back-end servers. The level of technologies and the villagers experience with the ICT applications is different for each service (Figure 2). Access to education A college bus service provides access to education. The bus service is offered to female students to counteract the eve teasing and violence. The passenger signs up for the service online and checks the vehicle time schedule and any adjustments to the schedule online. The bus service will collect the female students from pre-determined pick up points and ferry them to their college.

The Portable Health Clinic (PHC) provides access to healthcare. A healthcare worker registers all patients and uses PHC medical sensors and a portable server to ascertain the level of morbidity (poor health). Based on a triage stratification algorithm, patients identified to be at risk are connected to an online doctor for a remote health consultancy. The patient online doctor consultancy involves the standard medical procedure with diagnosis and issuance of ePrescription. These Electronic Health Records are stored in the database and can be referred to in the future [25].

Wi-Fi tablets connected to the Internet provides access to learning. An ICT trainer gives instructions to villagers on how to use the Internet to search for information relevant to their lifestyles; such as agriculture information on which pesticides to use and when to plant and harvest their crops. It is intended to give certified online entrepreneurship training in the future.

A catalogue provides access to online purchasing opportunities. To overcome any illiteracy issue, a catalogue with pictures and prices are shown to the villagers. The customer selects which items he or she wishes to purchase and the driver makes the order online on the customers behalf. The

ordered products are delivered to the service point one week later by the SSW vehicle.

Whilst waiting at the Service Point, the SSW vehicle and driver are available for real-time DRT requests. To request the service, the customer needs to make an on-line booking. The customer is also notified of the cost and time limits online and confirms to accept the conditions. Over experiment period, on demand vehicle hire has been used to take patients to hospital and for wedding and social events.

3.1. Demand Responsive Mobility as a Service

To achieve the hybrid multiservice objective, the vehicle does a school and corporate office run in the morning as a scheduled service [26]. It also delivers healthcare service at a predetermined location based on user requests. During the idle time, the vehicle provides transportation on demand. Meaning that the vehicle will only operate at this time if there are passenger requests, Figure 3. Users pre-register for the scheduled services in advance. A ride (seat) is assigned to each new request as it arrives for both scheduled and on demand ride sharing options.

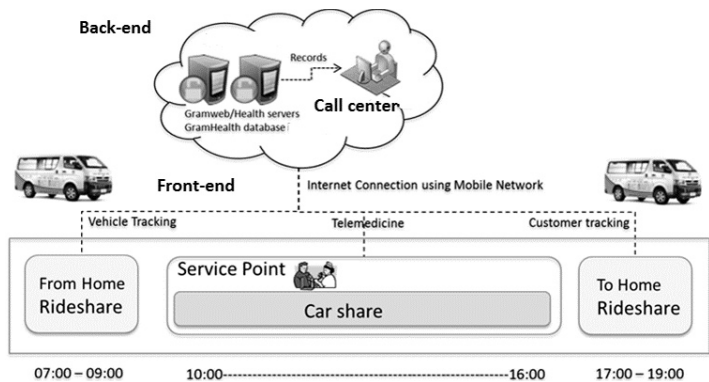


Figure 3 Community shared vehicle usage

The vehicle incurs varying operation costs in providing these multiple services. To make the concept a viable business, we schedule the vehicle to achieve maximum revenue while minimizing idle time. Users of the service can request the community shared mobility service system for either ride share or service delivery to their door steps/residential area. Users of the ride share service send their pick-up point, destination, intended arrival time and acceptable delay. The trip scheduler groups these users according to matching destinations and arrival times within respective time windows. Then the scheduler selects a vehicle based on seat capacity, vehicle availability and attainability of a quorum. The scheduler then calculates proximity of passengers to most optimum route and reassigns pick up point if necessary and sends cost of ride, estimated pick up time to the user. The same information of all passengers is sent to the drivers on board unit. The community shared mobility service operator collects information on users' location, specific type of service and their expected time of delivery. Once all requests of the day are received, a complete schedule is published by the system for reference by the community shared mobility service operator side as well as the driver on the on-board terminal, Figure

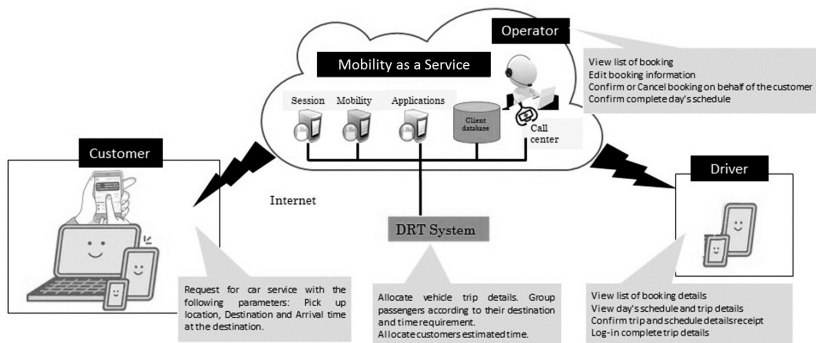


Figure 4 Community shared mobility service architecture

3.1.1. Vehicle Reservation

The Session Application Server keeps track of a customer's activity across sessions of interaction with the service system. A session can include customers account activation, customer reservation booking, customer service use and customer account registration. Customer account activation is a private contract where the customer registers personal details (age, address, contact details) and may choose a service plan such as medical care. Customer reservation booking is service dependent. For ride-share use case, the subscriber will use Mobile Phone SMS or APP and give Requested Drop-off Time (RDT), Requested Pick-up Time (RPT), pick-up location and Destination. The system will inform the customer to wait whilst it calculates the request. It checks on how many other clients have made a similar pre-request (live near, similar RPT, RDT and destination). If there is a sufficient demand, the vehicle seat allocation can be checked. The scheduler calculates the demand and once a minimum number of requests for the trip based on the trip details is reached, makes an offer to the subscriber. The offer will include pick up service point, RPT, and RDT at destination. The price is also included. The offer details may be different from the customer original requirements. If the customer books a seat, the scheduler allocates the seat in the vehicle and gives the customer a Booking ID (Figure 5).

For car-share use case, the customer gives the date and duration. MSP calculates the car availability and makes an offer. The offer will include the date, service point (pick up and drop off) and price. In developing countries the car-share will come with a driver. The MaaS car share cars may be non-dedicated and owned by private individuals fitted a vehicle tracker. The community shared mobility service may offer both a ride share option (cheaper cost) and car share option (more expensive) for individuals who

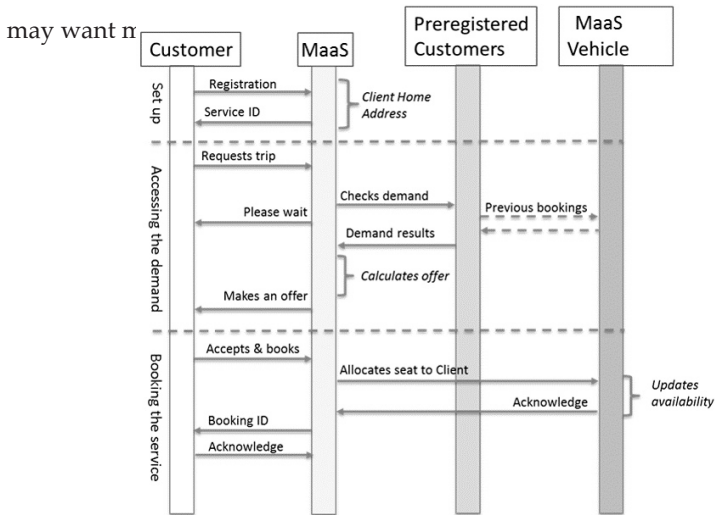


Figure 5 Ride reservation process

For wellbeing use case such as requesting for a Health appointment, the customer gives a target time (Estimate Time and date). The scheduler will inform the subscriber to wait whilst it calculates the request. It then checks on how many other similar request (live near her and same target time) have been made. If there is sufficient demand, a service point event with tent and healthcare lady can be established and the scheduler makes an offer to the customer. The vehicle will be booked for the Service Point event. The customer offer will include nearest Service Point Location and date. The price will also be included. The offer details may be different from the customers exact requirements. If the villager books an appointment, scheduler allocates the appointment with the Portable Health Clinic and sends the customer a Booking ID.

In all use cases, once the service has gained a critical mass, the MSP can learn the customer behavior promote services advertising rideshare slots,

cars have offers, and check-up reminders. The MSP may search the Electronic Health Records and automatically schedule screening campaigns, diabetes or hypertension in areas of high incidence. From the villager point of view this promotion will seem personalized and at the same time a service campaign will fit the community needs. For all use cases, a no-show /late cancellation policy should be enforced.

3.1.2. Vehicle Dispatching and Routing

Our approach considers a finite fixed number of vehicles. We deploy two vehicles in urban area and once vehicle each in two rural areas. Due to the limitation in number of vehicles considered, vehicle dispatching is not paramount to our solution. Vehicle routing for Scheduled community shared mobility service considers selected stop points (nodes) and routing traverse through these nodes as requested. The vehicle routing approach considers shortest route to travel to next node, not as selected but as requested. That is, if there is no pick-up or drop-off request at a specific node, the shortest route to get to the next node is selected, which could be with or without passing the unrequested node. The travel time from node to node listed in upper triangular matrix will inform the routing calculation.

For Real time community shared mobility service, routing is considered from one node to the next. Since the nodes do not have to be selected from preregistered stop points, routing is made by best search of route to next new node. Since no existing information is available for unlisted stop points, real time community shared mobility service relies on Global Positioning System (GPS), a space-based navigation system that provides location and time information for the routing calculation.

4. Experiment, Results and Evaluation

To validate algorithm for time scheduling and cost sharing with limited vehicle schedule and quorum discussed in chapter 4, we considered conditions set by our designed Community mobility service model discussed in chapter 3. Passenger requests were generated for short trips within vehicle working hours. If the choice of a random number did not give a departure or arrival time within 6 a.m. to 8 p.m. another random number was generated so that finally the service request was between 6 a.m. to 8 p.m. This was primarily based on the assumption that once the requests for using the bus service are validated, the community shared mobility service system would respond with the estimated pick-up/drop-off times or an error message. The simulation model was run until the last customer was dropped off. Results were generated for investigating the performance of the systems under a variety of conditions outlined in Table 1. The requests represented in the simulation involved both advance requests and ad-hoc requests, where passengers would request a fixed route trip in advance or request to be picked up as soon as possible.

Table 1 Experiment configuration

Item	Configuration
Service area	50km radius
Fleet size	2 vehicles
Vehicle capacity	10 seats each
Vehicle average speed	30kmph
Vehicle operating hours	06:00 to 20:00
Stop points	10-20
Stop time	20 -30 seconds
Time window	5, 10,15, 20 (fixed and variable)
Number of requests per day	20-100
Demand pattern	Low, average, high
Operations	Scheduled, on demand, idle

4.1. Time Performance

The levels of service in terms of travel time and waiting time were esti-

mated. The travel time ratio, defined as the ratio of the actual journey time to the travel time if the most direct route was travelled was used to investigate the performance for users of the system (Figure 6). The percentage of persons experiencing longer travel times decreases as the number of customers increases.

Passengers are assumed to be sensitive to the time between when the service was requested and the time the vehicle arrived to pick them up. We present the average waiting time versus number of passengers who made requests for using the transit service. Time windows were set at maximum of 20 minutes, with requests being in a minimum 10 minutes. Figure 7 shows that all records had service time deviations below time window. Average waiting time was calculated as 2 minutes. While ensuring pick-up and drop-off times are within passenger set travel times, our solution reduces waiting time due to its increased time constraints.

4.2. Cost Performance

4.2.1. Passenger trips per revenue hour

The effect of the total number of passenger in a trip on the costs for a fixed number of operating vehicles at 10 passengers maximum seat capacity and considering same distance and travel time was investigated. For each run, a distribution of costs was estimated. Figure 8 presents decreasing estimated costs per passenger as the total number of customers increased. At the higher demand levels the costs appear to be reasonable approaching that of traditional public transport services.

4.2.2. Operating cost per revenue hour

The effect of our cost sharing approach in cost per revenue hour was

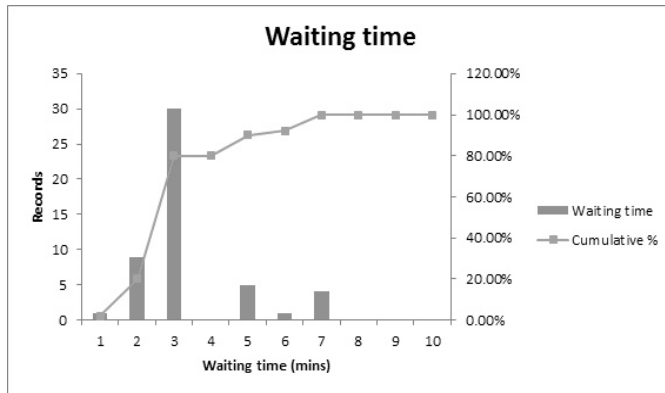


Figure 6 Waiting time distribution of simulation data

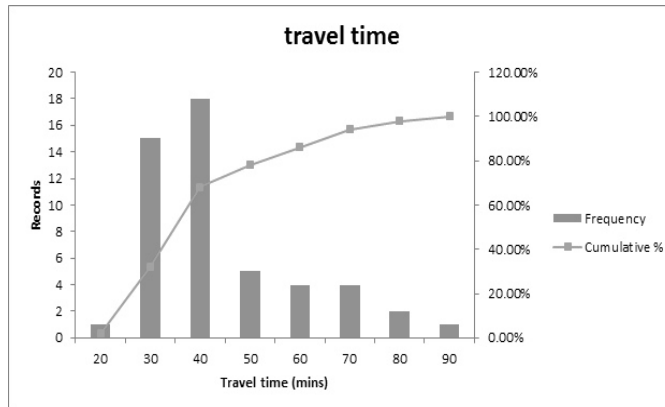


Figure 7 Travel time distribution of simulated data

plotted as in Figure 9. The person correlation of cost and travel time was .922 based on 100 records. This indicates a positive linear relationship between cost and travel time. Similarly, a correlation between cost and distance showed a positive correlation. It shows that, our model, while being based on number of passengers per trip, it also relates to traditional costing models that relate to time and distance. Hence, the model exhibits a cost sharing model that appeals to both passengers and vehicle entrepreneurs.



Figure 8 Costs and average number of passengers in a trip

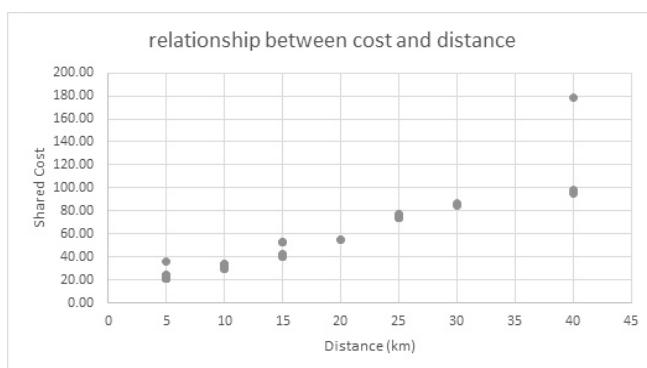


Figure 9 Costs in travel time

5. Community Shared Mobility Service Experiment in Dhaka

5.1. Overview of transport situation in Dhaka, Bangladesh

Dhaka is the capital city of Bangladesh with a population of 6.97 Million and area of 815.8 km². We set out to experiment our community shared

mobility service in a busy city environment with need for a low-cost structured transport solution. This project, aiming to explore how ICT can contribute in solving mobility needs in developing countries, was funded by Toyota Motor Corporation. Grameen Communications in Bangladesh provided the project support in conducting surveys and the experiment. A survey to find out transport requirements in different areas of the city was carried out so to establish service area of the community shared mobility service vehicle. Survey results indicated major problems in public transport in Dhaka to include; traffic jam, unavailability of seats, improper time management, over crowded, expensive fare, unsafe, unavailability of transport in some areas and uncomfortable vehicles (Figure 10). We asked respondents who have frequent transit needs to work/school of the availability of scheduled transport to get to their destinations. Majority of respondents did not have such services available. Of those who did have such a service, some did not utilize it with reasons including; having own private car, short travel distance and not wanting to share ride with other staff. We also found that 70% of the respondents are not satisfied with

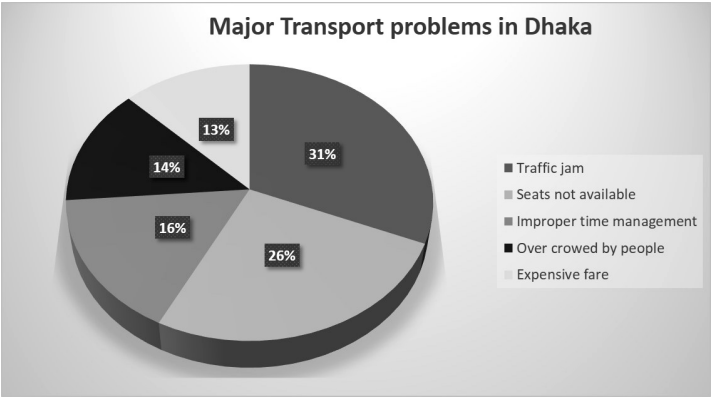


Figure 10 Survey of transport problems in Dhaka

public transport, with 84% of whom want safe, comfortable and quality transport alternative, Figure 11.

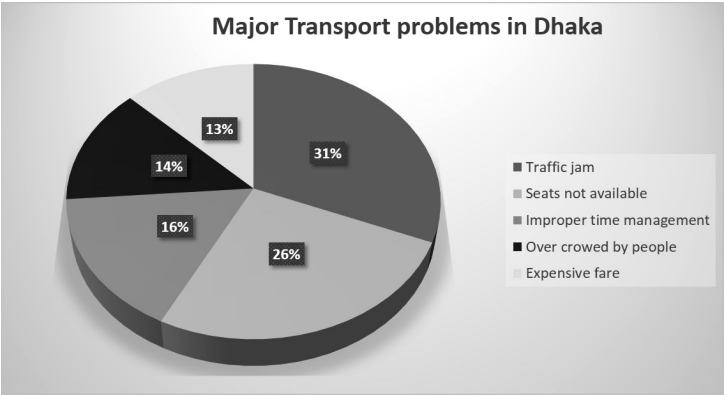


Figure 11 Satisfaction with current transport alternatives

Current cost and duration of road transport options in Dhaka taken at a constant distance were summarized in Table 2. Bus transport is most used due to the low cost. CNG, Compressed Natural Gas, is a motorized three-wheeler vehicle that used compressed natural gas as opposed to diesel to reduce operation costs. They operate at high cost, similar to taxi. Rickshaw is a light two-wheeled passenger vehicle drawn by one or more people.

Other options include: bicycle, motorcycle and train. There is no schedule for any of the public transport options. Passengers have to wait at designated bus stops until a vehicle plying the route they want to go arrives. Minimum waiting time was reported at 12 Minutes. Respondents were willing to pay only up to Tk.1630 per month, meaning that they would prefer a quality but low-cost transport alternative.

5.2. Experiment Profile

The experiment site was identified to cover areas of Uttara and Mirpur districts in Dhaka, from residential areas to the central business district. To conduct this experiment, 2 Toyota Hiace vans were leased, 2 Portable Health Clinic briefcases were sourced, 4 notebook PCs, 2 driver consoles, remote database, operator and doctor's call center was set up in the central office of Grameen Communications. The experiment provided fixed route office and college transport and fixed transport for PHC service delivery and accepted real time requests for flexible schedules when the car was inactive.

5.3. Evaluation of Community Shared Mobility Service experiment

We considered advanced requests for the pilot program. Estimated average waiting time was calculated as 3 minutes. At constant distance, the community shared mobility service system is compared to average cost and travel time of alternative transport options, see Table 2.

Table 2 Community shared mobility service compared to existing public transport in Dhaka

Transport medium	Travel time (mins)	Waiting time (mins)	Cost (taka)
Community shared mobility service	72	3	60
Bus	68	12-60	39
CNG auto-motor	48	-	225
Rickshaw	90	-	120
Others	97	-	110

Average waiting time for CNG, rickshaw and other modes of transport have not been identified. Waiting time for buses in Dhaka varies from

an average of 12 minutes during peak times to up to an hour in off peak times. This uncertainty makes it difficult for passengers to make accurate travel plan. Our approach offers to avail the vehicle for pick-up and drop-off at estimated times, with minimum waiting time.

A comparison of actual and simulated waiting time is shown in Figure 12. In both actual and simulated data, passengers generally had reduced waiting time, with few outliers having longer times. Nevertheless, both accounts showed times within set passenger time allowance. Average waiting time calculation showed actual data at 3 minutes as opposed to 2 minutes in simulated data, a minimal yet slightly significant relation.

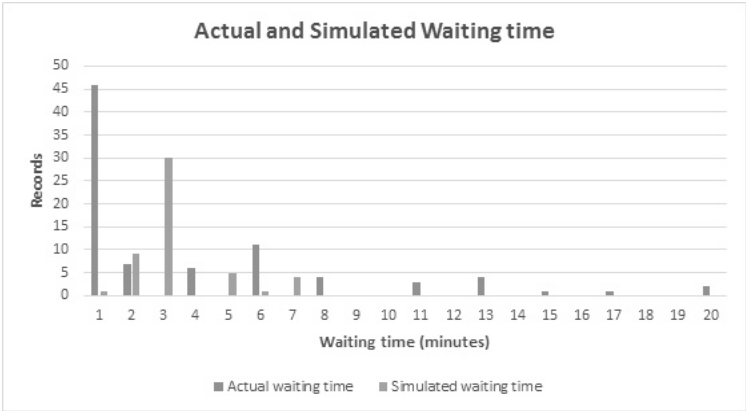


Figure 12 Actual waiting time compared to simulated waiting time

6. Conclusion

We identified a gap in quality and affordable transport alternative especially in developing countries. Access to social services like health, education and economic activities. The study addressed the formal transit needs and the service accessibility needs of the rural communities by introducing a Demand Responsive Mobility as a Service model. It comprises of a minibus and a mobile platform that carries ICT tools to access Healthcare,

Education, Learning and Purchasing Opportunities. The need for back-end Mas a Service support is apparent in providing scheduling support, doctor call center support, ICT support, database storage, backup and maintenance and performance analysis.

From the initial field study of Demand Responsive Transport, we understand that our community shared mobility service model needs to be subsidized at the initial phase. We established that operational cost can be reduced by proper time utilization and maximizing the income by providing more social services during the cars idle time. We introduced a community shared mobility service trip scheduling and cost sharing approach to make the solution more effective in time and cost. Main contributions of the study were: (i) a design of a multiservice demand responsive transport alternative with both fixed route (advanced requests) and flexible (real-time requests), (ii) Demand Responsive Transport, DRT, based trip scheduling addressing constraints of vehicle fixed schedule and quorum.

We conducted a simulation experiment to validate the algorithm and found that our proposed solution reduces waiting time due to its increased time constraints. An actual field experiment in Dhaka, Bangladesh confirms our hypothesis that a demand responsive transport based solution can minimize waiting time. Eventually, we sought to establish the community shared mobility services as a business model.

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