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THE DETERMINATION OF THE ROLE OF BUS TRANSIT IN THE UNIVERSITY ENVIRONMENT: A CASE STUDY OF MICHIGAN STATE UNIVERSITY

By

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A THESIS

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ABSTRACT

THE DETERMINATION OF THE ROLE OF BUS TRANSIT IN THE UNIVERSITY ENVIRONMENT: A CASE STUDY OF MICHIGAN STATE UNIVERSITY

By

Frank W. Davis, Jr.

The purpose of this thesis was to examine in detail a major university transit system to isolate factors affecting the propensity of students to ride the bus, to ascertain those cost or operating characteristics which limit the university's ability to provide the desired level of bus service, and to determine the effect of the attitudes of riders, administrators, and operating personnel on bus system operation. Michigan State University, a large geographical scale university with over 40,000 full time students, 23 buses, and on-campus travel distances of up to two miles was chosen as the study area. Conclusions were drawn from in-depth interviews, questionnaire surveys of 453 on-campus students (80 per cent return), detailed demographic data on 6,836 riders (89.5 per cent of fall and winter term riders), and detailed financial and operating reports. All data were collected during the 1969-70 school year.

A least squares multiple regression analysis of sixteen independent variables was used to examine significant factors affecting propensity to ride. The 7 factors finally isolated as being statistically significant at the 95 per cent level explained 24 per cent of the variance in

ridership. Other analyses included the effect of weather and of prior transit experience on bus ridership. Campus travel patterns and methods used to meet bus schedules were examined. Finally, students were asked to rank various service variables in order of importance.

An examination of cost characteristics which limit the university's ability to provide the desired level of service revealed that although operating profits during fall and winter terms ran as high as 27 per cent of total revenue, during summer term revenue did not even cover variable cost. In fact virtually all the operating problems of the system stem from the extreme seasonality of demand. For example, labor (58.3 per cent of total operating costs) frequently had to work double shifts during winter quarter but were not needed at all to drive buses for 30 weeks of the year.

An investigation was made of the attitudes among riders, administrators, and operating personnel which affected the development of operating objectives. The students appeared to desire a high frequency bus service which would allow residents living in remote areas to commute to the heart of campus. If the service were available, they would use it; otherwise they would change class schedules and living areas to make walking feasible. Like the students, the operating personnel feel unable to change the bus system. They take pride in operation and maintenance of the fleet but are discouraged from "catering" to any individual's needs. The goals of the administration for the bus system mainly seem to involve minimizing problems and conflicts rather than attempting to positively utilize the system as an integral part of the university's function. This attitude appeared to stem from the original mandate given

to the bus system when it began operating in 1964. Conceived by an ad hoc committee appointed to recommend a solution to the university's parking and traffic problem, the bus system was originally visualized as a means of easing these conditions so that student cars could be prohibited from parking or driving on campus. This mandate has never been reevaluated to attempt to attune the bus system more closely to student travel needs nor to integrate it into the design of the campus or the scheduling of classroom facilities.

The final chapter offers recommendations to help attune the bus system to the needs of the riders and the university. These recommendations would also be useful for a university or other major activity center considering the implementation of a bus transit system.

ACKNOWLEDGMENTS

Many people have made the completion of this work possible. I would like to take this opportunity to thank those who have contributed so greatly to this effort.

First, I would like to thank my major professor, Dr. Frank H. Mossman, who directed both my program and my dissertation. It was Dr. Mossman who had the gift of discernment to know when frustration, financial pressure, or the pressure of the work load was increasing too rapidly and who was always there with counsel and a solution. It was Dr. Mossman who offered support and encouragement during the death of my sister and her family and during the period when my entire family was hospitalized with hepatitis. He truly did far more than was his duty.

Next, I would like to thank my committee members, Dr. John L. Hazard and Dr. Leo G. Erickson who offered very constructive suggestions and were generous with their time and patience, especially during the planning and research period.

Also, this project would not have been possible without the complete cooperation of the Michigan State University Administration. Particularly I wish to thank Roger Wilkinson, Vice President for Business and Finance, who provided funds for the gathering of data and the necesary computer time; Stephen H. Terry, Assistant Vice President for Finance who offered considerable help in gathering financial data; John

Lewis, Administrative Assistant to the Director of the Physical Plant; and Henry W. Jolman, General Foreman of Automotive Services, who supplied all cost and operating data requested. These men should be commended for their openness and desire to improve the bus system.

It would not have been possible to collect and process the large volume of data involved in this project during the spring quarter had it not been for five MBA students at Michigan State University who helped greatly. These students, Knowlton Atterbeary, Cemal Ekin, Mete Oktav, Frederick Otto, and Richard Seif helped in the compilation and administration of the survey, the writing of computer programs, the development of the origin-destination map, and the compiling of many of the tables and figures.

I would also like to thank Mrs. Janice Hemsley and Mrs. Marian Harper who spent many hours typing the manuscript and patiently made last minute corrections.

Finally, I would like to thank my family. My wife Marley, who became experienced by completing a Master's thesis, was a great help by proofreading manuscripts, processing surveys, making suggestions in composition, and giving general encouragement when it was vitally needed. Our four-year-old son Nephi helped by giving up his desire to go fishing and helping me deliver, collect, and count surveys and by writing his own parallel thesis "just like Daddy's" at the same time. Our one-year-old son Michael was very willing to help whenever he was able. His major contribution was in helping take surveys to the postoffice. It was truly a family project.

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CHAPTER I

INTRODUCTION

Statement of purpose

This dissertation examines the Michigan State University Bus System to determine:

1. what factors significantly affect the demand for bus service in the university environment
2. whether there are significant costs or operating factors which prohibit MSU from providing its residents with the level of service they desire
3. whether there are policy and goal conflicts or even conflicting goals which prevent the university from being more effective in meeting campus travel demands
4. what steps can be undertaken to make the system more responsive to both administrative and student goals.

This study should make two major contributions to the literature on bus transportation systems. First, it is one of the few comprehensive studies of the way riders and management respond to a major activity center transit system.[1] Second, it is one of the first comprehensive studies of a medium-scale transit system which faces none of the

[1] A more detailed discussion of a major activity center transit system and the way in which it contrasts to other forms of transit systems is contained in the Research Background section of this chapter.

handicaps[2] to which transit system failures are usually attributed. A study of this system, therefore, will identify factors other than those such as congestion, automobile competition, and taxes which contribute to bus system failures.

Background to the study

Michigan State University, the nation's oldest land-grant college, has nearly doubled its enrollment in nine years, from 21,157[3] in the fall of 1960 to 40,820[4] in the fall of 1969. This increase in enrollment has been paralleled by a vast building program to provide not only classroom and research space but also on-campus housing facilities for a majority of the students.[5]

This increase in enrollment and university physical plant necessitated the development of a complex traffic network. Prior to 1957 virtually all movement on campus was easily accomplished by automobile or on foot. Almost all academic buildings were located around Circle Drive[6] and could be reached easily in a ten-minute walk.

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[2] For a list of these handicaps, see below, p. 10.

[3] Office of the Registrar, Michigan State University, Annual Report (Lansing, Mich., 1969).

[4] Office of the Registrar, Michigan State University, Enrollment Report (Lansing, Mich. Fall quarter, 1969).

[5] Census records maintained by the married housing office and residence halls office indicated that for the 1967-68 academic year, for example, the university provided on-campus living facilities for 18,000 dormitory students and another 2,200 students in married housing units. On-campus housing was thus provided for over 53 per cent of the 38,758 students registered for that year. There has, however, been virtually no new residential construction since that time.

[6] All street names are shown on the campus map found in Appendix D.

The longest walk from a residence hall to an academic area was less than fifteen minutes. During 1957 and 1958, however, over 1300 apartments were built in the Spartan Village area, necessitating a 30-minute walk to the classroom areas for the residents. Consequently, a large percentage of the Spartan Village residents began to drive to classes, greatly increasing the number of automobiles on campus during the class day.[7]

Campus travel was further increased during the 1960-63 period by the construction of over 5300 on-campus residence hall units and the beginning of the science and business academic complexes south of the Red Cedar River. This new construction increased the traffic flow in two ways. First, it increased the number of parking spaces taken up by on-campus residents who needed to garage their cars while they resided in the dorms. Second, the geographic expansion of the academic area made it increasingly difficult for both faculty and students to travel between classes during the day unless they used their automobiles. The remotely located living-learning complexes being built at this time (early 1960's) contributed to the problem. These complexes, consisting of classroom and faculty office space as well as dormitory and cafeteria facilities were originally conceived to allow students to live and to study in completely self-contained areas without the need for

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[7]According to the Office of Public Safety 6,477 student vehicles were registered on campus from July 1, 1957, to October 30, 1957. By 1964 registrations for the same period had increased to 9,746. It is difficult to determine the increase in faculty and staff registration since it was not mandatory that they register in 1957 when only 552 cars were registered. Mandatory registration in 1964 found 6,960 faculty and staff automobiles registered from July 1, 1964 to October 30, 1964. The July 1 to October 30 figures were chosen since other time periods would include many duplicate registrations due to car trades, new term enrollments, withdrawals, etc. All cars, however, had to be registered at the beginning of fall term.

travel. The actual effect, however, was that the total academic area was increased greatly because many students found it necessary to travel one to two miles between complexes to complete their class schedules.

Recognizing the need for a campus transit system Lansing Suburban Lines, the local city bus system, contacted the university in 1960 requesting permission to operate on MSU streets. This request was denied since the university administration felt that the service was not necessary. By the next year, however, the traffic situation had become sufficiently difficult that the university instructed Richard O. Bernitt, Director of Public Safety, to request Lansing Suburban Lines to initiate service between Spartan Village and the academic area of campus. Agreement was reached and service begun in September 1961 with service every 40 minutes from 7:40 A.M. to 6:50 P.M. The bus line charged ten cents a ride and its service was apparently well received.

In spite of the new bus service the on-campus traffic and parking problem continued to grow, forcing the administration to restrict student parking on the campus north of the river and to exclude student traffic on Circle Drive from 6:00 A.M. to 6:00 P.M. In spite of these restrictive steps, the police force issued approximately 1,500 traffic and parking tickets per month.[8] In a feature article in the campus newspaper the public safety officers were quoted as stating that it was

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[8]"Traffic and Parking Real Headaches," State News, October 5, 1962, p. 1, 3.

futile to issue the large number of tickets.[9] The police stated that this only served to alienate the campus community which they were trying to serve. The students were developing a very negative attitude toward the officers for giving the tickets and the faculty felt that the officers were not effective in controlling the traffic situation. In an attempt to control parking a system of fines based on the number of tickets received previously was set up, with the fine for the sixth ticket set at $25.00.

Consequently, a special ad hoc Faculty-Student Motor Vehicle Committee was called during the winter term 1963 to help arrive at a workable solution. This committee made two recommendations. First, the university had to develop an "efficient and sufficient bus system servicing all parts of the campus and with service under the control of the University. The committee considers this recommendation an absolute essential."[10] As committee chairman John Lockwood stated in a newspaper article

> Until we devise an improved transportation system, we cannot legitimately prohibit students from driving. This was the cornerstone of the recommendation approved by the Trustees last summer.[11]

Although the committee did not specifically state that the bus system should be owned by the college, it did feel that the university should

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[9] Ibid.

[10] This statement was made in a letter from Chairman John L. Lockwood to the ad hoc Faculty-Student Motor Vehicle Committee prior to their February 7, 1963 meeting.

[11] "Fall Traffic Plans Drafted," State News, November 14, 1963, p. 10.

have direct control over it.[12]

The second recommendation of the Motor Vehicle Committee was that all parking for students be limited to peripheral parking lots and that no driving be allowed anywhere on campus except by the most direct route from the peripheral parking lot to an off-campus street. The major emphasis in the committee's report concerned the control of traffic and parking. The proposed bus system appeared to be primarily a means of silencing opposition to the parking and traffic controls. This is indicated by the statement of John D. Lockwood, chairman of the Faculty-Student Motor Vehicle Committee: "Until we devise an improved transportation system, we cannot legitimately prohibit students from driving."[13]

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[12]The final report of the ad hoc Faculty-Student Motor Vehicle Committee was in the form of a letter from its Chairman Dr. John L. Lockwood to Mr. Starr H. Keesler, Assistant Secretary to the University President. (See Appendix A for a copy of this letter.) Recommendation number seven stated that "Satisfactory bus service on the campus requires that the university control number of buses, schedules, and routes." It has been very difficult to determine why the committee felt so strongly about this point since the Lansing Suburban Lines' service was initially well received. Since the minutes of the committee have now been destroyed there is no record to indicate the reason for the deterioration of relations between MSU and Lansing Suburban Lines. Chairman Lockwood and Mr. Richard Bernitt, Director of Public Safety, stated from memory that even though the campus operation was profitable for it, the Lansing Suburban Lines would remove buses without notice to service downtown Lansing routes. They also indicated that service on the campus routes was very erratic and that when meetings were scheduled by the University administration to discuss the problems the bus lines representatives often would not appear. Mr. Bernitt indicated that students became so disenchanted that many of them began to tender large bills each time they would board the bus. In any case this committee felt that the University must have better control of the bus system if it were "to dispel any argument that student(s) will need their personal vehicles in the future."

[13]"Fall Traffic Plans Drafted," State News, November 14, 1963, p. 10.

Appendix A is a copy of the final letter report made by the committee. Of the twelve points made in this report three dealt with the development of a campus bus system. These three points identified problems encountered by the Lansing Suburban Lines and had little concern about the service level that should be provided on campus.

In accordance with this report the University asked the Lansing Suburban Lines to submit a proposal for providing a total campus service on a franchise basis. When the company replied that it was willing to continue the existing service but was unwilling to expand the service as requested, MSU cancelled the existing franchise and began its own service fall quarter, 1964. It ordered eight new buses and purchased four used ones to begin its own inhouse capacity and hired Mr. Henry Jolman, manager of the Grand Rapids Transit System since 1936, to manage the operation.

Currently the Michigan State University Bus System owns and operates twenty-three 51-passenger GMC buses. In 1969-70 it leased three additional buses during the fall term and an additional two buses during the winter term. It operates five different routes connecting each of the residential areas with the academic campus area. New buses currently on order will bring the 1970-71 fleet to twenty-six buses of 51-passenger size. During the 1968-69 school year 24,728 passes were sold at $14 per quarter and 5,600,000 rides were provided.

Research background

In examining the literature on this project three relevant areas were explored:

1. the classification and purpose of various urban transit systems
2. the major factors contributing to bus system failures
3. consumer demand and preference studies.

Classification systems.--Bus transit systems have been divided into three areas: neighborhood area travel, major activity centers, and extended area travel.[14] Neighborhood area travel occurs where housing units are owned by divers groups or individuals: most travel is generated here by shopping trips, primary school trips, or individual visits. Suggested public transit systems for neighborhood area travel include taxi-like operations such as demand bus and dial-a-bus which schedule their routes on the basis of telephone calls from people wanting to catch the transit service.[15]

In major activity centers (MAC), ownership or coordination is in the hands of one group and travel demand is generated by functional interaction among the various locations within the MAC. Examples of

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[14]Robert A. Burco and David A. Curry, Future Urban Transportation Systems: Impacts on Urban Life and Form, Vol. II: Study in New Systems of Urban Transportation (Menlo Park, Calif.: Stanford Research Institute, 1968), p. 35, also Eugene T. Canty, Transportation and Urban Scale (Warren, Mich.: General Motors Research Laboratories, 1969), pp. 1-11.

[15]Canty, Transportation and Urban Scale, p. 6. Mr. Canty refers the reader to the following texts for additional detail. Nigel H. M. Wilson, CARS: Computer Aided Routing System (Cambridge, Mass.: Massachusetts Institute of Technology, 1967); E. T. Canty et al., New Systems Implementation Study (Warren, Mich.: General Motors Research Laboratories, 1968) particularly "Case Study G" in Volume III; and J. Anders et al., Study of Evolutionary Urban Transportation (Westinghouse Air Brake Co, 1968) Vol. III, Appendix IV.

MAC are airports, shopping centers, universities, research centers, government complexes, military bases, etc. Very little research[16] has been done in the area of MAC travel, perhaps because until recent years there have been very few major activity centers with public transit systems other than central business districts (CBD) or military bases. Although the CBD have been quite large, they have not pioneered the development of special transit systems since they tend to view circulation within the CBD as a logical extension of the role of the urban transit system in bringing people into the CBD. Military bases, on the other hand, have been so large that they have tended to be viewed as extended area travel which is discussed below. One of the greatest needs for MAC transit is exhibited by universities where the number of people is very high and the degree of interaction (movement between buildings within the units) is also very high. It was predictable that the large state universities would be among the first to recognize the need to install MAC transit systems.[17] The

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[16] Two excellent studies have been done. These include Louis E. Keefer, Urban Travel Patterns for Airports, Shopping Centers and Industrial Plants (Milford, Conn.: Louis E. Keefer, Transportation Planning Consultant, 1966) and Urban Design and Development Corporation, A Study of Internal Circulation Systems for the Post Oak Urban Center, Houston, Texas (Washington, D.C.: Urban Design and Development Corporation, 1970). The first work was sponsored by the Highway Research Board and the National Academy of Sciences. The second study was sponsored by The City of Houston, Texas, and the Urban Mass Transportation Administration of the U.S. Department of Transportation.

[17] At the present time universities are rapidly starting their own bus services. The list includes in addition to Michigan State University, Indiana University, Kent State University, University of Michigan, University of Tennessee, University of Wisconsin, and many others. Various management approaches are taken. For example, the Kent State University bus system is entirely student run and managed under the direction of a faculty member. It is supported by a student-imposed tax of $4.00 for each student each term. Individual bus rides

university is somewhat different from other MAC in that it has a captive group and is not so dependent upon convenience of movement within the university to attract its clientele as would be a shopping center or a CBD. Likewise the university is not so concerned about the efficiency of movement as would be a research complex or a government office center since the university does not pay salaries to the students nor does it expect any direct university-oriented output.

The third area is the study of extended area travel (urban transit) which connects neighborhoods and major activity centers. Travel demand is generated by work trips, trips to secondary schools and colleges, major purchasing trips, etc. There is extensive literature[18] on the needs for urban transit systems and the implementation of new systems such as the San Francisco BART system.

Factors contributing to bus system failures.--Owen[19] states that the major factors leading to urban transit system failures and

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are then free to all students. The University of Tennessee, on the other hand, contracts with the City of Knoxville for bus service. The City of Knoxville in turn has a management contract with a professional management team which manages the bus system for the entire metropolitan area for a percentage of the revenue. The students are able to ride free of charge on campus area but are charged fifteen cents to go to the remote married housing locations.

[18]Wolfgang S. Homburger, ed., Urban Mass Transit Planning (Berkeley: Institute of Transportation and Traffic Engineering, University of California, 1967) is a good example of some of the work that has been done in this area. This book presents a theoretical approach for doing urban transit research, a summary of results from various mass transit demonstration studies and case studies of mass transit planning in San Francisco (BART), Cleveland, Washington, D.C., and the Minneapolis-Saint Paul area.

[19]Wilfred Owen, The Metropolitan Transportation Problem (Washington, D.C.: The Brookings Institute, 1966), pp. 66-87.

service declines are basically as follows:

a) competition from the private automobile which is highly subsidized by public investment in the nation's highway infrastructure[20]

b) peak-hour-only usage of the urban transit system. Owen suggests that 30 per cent of all bus traffic in the downtown Philadelphia area moves during the 5:00 to 6:00 P.M. rush hour[21]

c) increased congestion on city streets substantially restricts turnaround time for the buses. Traffic delays in the Boston area in 1962 were estimated to have occupied 18 per cent of the bus operating time.[22]

d) the high level of state and local taxes charged as franchise taxes for the privilege of using urban streets. These taxes averaged 9.1 per cent of operating revenues for 100 of the major privately operated transit companies. Many paid as high as 20 per cent of gross revenue for taxes.[23]

e) obsolete transit vehicles, inadequate headways, inconvenient schedules, and overcrowding.[24]

But such is not the case at Michigan State University. This system

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[20] Ibid., pp. 70-79.

[21] Ibid., pp. 79-86. The 30 per cent value becomes even more significant when it is realized that the morning rush hour also has a very high peak. Very little of the bus traffic then would flow during periods other than the 6:00 to 8:00 A.M. rush hour and the 4:00 to 6:00 P.M. rush hour. See Chart 13, p. 80 of his book.

[22] Ibid., pp. 74, 87.

[23] Ibid., p. 87.

[24] Ibid., p. 137.

operates in an environment where

a) there is little competition from private automobiles since students' cars are regulated off of the campus during the day.[25]

b) the typical morning-evening peak hour pattern does not exist since students attend classes throughout the day and use the bus system to travel between classes.

c) congestion is vigorously regulated by prohibiting student drivers on campus during the daylight hours

d) the bus system is not required to pay any taxes, nor is it required to yield a profit on its operation

e) all buses are of the newest variety, vehicles have a headway of one and one-half minutes on some routes and never over fifteen minutes on the less-traveled routes.

Consequently it would appear that Michigan State University should provide an ideal environment for the operation of a profitable bus transit system. This study then has the distinction of examining a bus transit system which is operating under apparently ideal conditions.

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[25]This statement should be clarified. The faculty and staff are allowed to drive and park on campus but the students, except for a few special cases, are not allowed to do so. This study has concentrated on the examination of student travel patterns since there is very little ridership of the bus by the faculty and staff. Also the faculty and staff are relatively small in number when compared with the total student body. A final factor which makes the travel patterns of the faculty and staff relatively insignificant in comparison with the student body is that the students tend to travel around campus much more during the day than do the faculty and staff members.

Consumer demand and preference studies.--The typical consumer demand or preference study has traditionally been based upon the modal split concept since it has been the goal of the urban transit system to determine why riders have deserted the transit systems in favor of the automobile. The first step in this modal split analysis has been to identify current bus users. The Memphis study[26] provides an excellent example of the market identification step, indicating, for example, that the major Memphis bus service users were commuters, domestics, low income groups and families without cars.

The second step of the modal split studies determines which service characteristics are most important to the user and how well each mode satisfies the needs indicated. One of the more complete studies of this type was conducted by a faculty group at the University of Maryland's College of Business.[27]

Although this type of study has been important in determining why people choose one mode over another it was not especially relevant for the MSU study since the automobile is not a real competitor on the MSU campus. Consequently, it was deemed to be more important to try to determine actual travel needs rather than to compare modes.

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[26] Memphis Transit Authority, Mass Transportation Studies in Memphis (Memphis, Tenn.: Transit Authority, 1965), pp. 78-79. This study was sponsored by a mass transportation demonstration grant from the U.S. Housing and Home Finance Agency. It is identified as project number Tenn. MTD - 1.

[27] S. J. Hille, F. T. Paine, A. N. Nash, G. A. Brunner, "Consumer Transportation Attitudes in Baltimore and Philadelphia," Transportation Journal, VII (Summer, 1968), 30-47.

CHAPTER II

RESEARCH DESIGN AND DATA

Research design

The basic organization of this paper arises from the structure of the basic economic model, i.e., first looking at factors which affect the demand curve, second identifying the major components of the cost curve and third, examining the goals of the system in order to ascertain the appropriate relationship between the supply and demand curves. Hence, Chapter III concentrates on analyzing factors which affect the demand curve, i.e., identifying those market segments currently riding the bus system, isolating and measuring the effect of price, weather, and service levels on bus ridership, and then determining what services are actually desired by bus riders.

Chapter IV analyzes the financial structure of the MSU Bus System to identify factors which control the cost structure and operating constraints. It also investigates scheduling practices, labor issues, and load factor fluctuations to learn how resources can better be tailored to the demand for bus services.

Chapter V examines the goals of students, administration, and bus operating personnel to determine how they relate to the MSU Bus System. Special emphasis is given to the perspective of the college administration showing why various policies and goals have been developed for the bus system, and to evaluation of the role of bus operating personnel.

In Chapter VI a suggested set of goals is developed and methods are discussed to facilitate the implementation of these goals. It is this chapter that integrates the findings of Chapters III, IV, and V into the development of overall operating objectives and policies.

Data sources

One of the major reasons for selecting the MSU Bus System as the subject of this case study was the availability of numerous sources of data on the well-defined student body living on campus and using the bus system. This data was collected from seven different sources each of which will be discussed in turn.

Bus ridership profile.--In the fall of 1967 a new bus pass pricing policy was introduced. Prior to this time passes were sold for a flat fee of $12.00 per quarter. In 1967 it was decided that not only should the cost be increased to $14.00 per quarter, but also that there should be some means of reducing peak load demand during the winter quarter or at least of requiring the winter-term-only riders to pay the cost of the service they demanded. It was, therefore, decided that a winter-term-only rider should pay a $6.00 surcharge for the privilege of riding only during the cold weather period. As a means of policing the assessment of the surcharge, the purchaser of the winter pass was charged $14.00 if he turned in his fall term pass but $20.00 if he did not turn in the fall pass.

A preliminary examination of winter 1968, 1969, and 1970 sales revealed the sales patterns shown in Table 1.

TABLE 1

THREE-YEAR ANALYSIS OF BUS PASS SALES

Item	1967-68	1968-69	1969-70
Fall passes	8,438	8,318	8,956
Winter passes $14	6,830	6,697	7,149
Winter passes $20	2,822	3,035	2,822
Per cent riding both terms	71%	69%	72%
Per cent of fall passes returned	81%	80.5%	80%
Fall term registration	38,758	39,949	40,820
Winter term re-enrollment	34,365	35,804	36,442
Per cent of students re-enrolled	88.6%	89.7%	89.3%
Per cent of re-enrolling fall term riders buying winter pass	91.5%	90.0%	89.5%

On the basis of this preliminary analysis it was felt that a profile of students returning fall passes would provide virtually a complete picture of fall term riders since almost 90 per cent of these students also bought a winter term pass if they returned to school.[1]

[1]This statement is predicated on the assumption that bus riders dropped out of school at the same rate as non-riders. Although this assumption has not been substantiated statistically there is no a priori reason to disprove this assumption. The consequence of a Type I error

Also, since 72 per cent of the winter term riders also rode fall quarter it would also be strongly representative of winter term ridership.

The returned bus pass served as a very excellent source document since it had blanks on it for the student to enter his name, student number, and address. Since the bus pass is used for ownership verification when boarding the bus or in case of loss, virtually all of the students did fill in this information. Table 2 provides a profile of the sample obtained by using these returned bus passes.

TABLE 2

PROFILE OF BUS PASS SAMPLE

Total all passes turned in for winter pass	7,149
Passes destroyed by dormitory clerk	58
Passes without information filled in or mutilated beyond recognition	114
Key punch errors or non-matched student number or duplicate number	141
Total usable items	6,836
Percentage of fall riders who re-enrolled winter term	85.5%[a]
Percentage of winter term riders included in sample	68.5%[b]

[a] 6,836/8956 (89.3) = .855

[b] 6,836/9971 = .685

Student numbers were keypunched and verified from these bus tickets. Once the tickets were keypunched they were passed against

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is very low, however, since 80 per cent of the fall term bus riders were included in the sample. Consequently, if no bus riders dropped out at the end of fall quarter it would provide an 80 per cent sample. If all of the bus riders dropped out it would be a 100 per cent sample. If bus riders dropped out at the same rate it would provide a 90 per cent sample.

the registrar's student masterfile to select demographic information about the bus riders. Information on each student selected from the registrar's tape masterfile includes

a) sex and marital status

b) date of birth

c) class

d) college in which student was enrolled

e) cumulative grade point average at Michigan State University

f) credits taken winter quarter

g) home area by state or county in Michigan

h) campus residential area by dormitory number, married housing area, or off-campus zip code

i) cumulative credits taken at Michigan State University

The 6,836 items, representing those students who rode both fall and winter quarters, were selected onto a separate magnetic tape that was then used for tabulation purposes.

It should be pointed out here that none of this information was further verified as to its accuracy since it was assumed that people did not attempt to deceive the university. Although this assumption is not totally valid, the university feels sufficiently confident of its collection process to use this information to send mail, justify graduation, levy college tuition and fees, etc. The one item that did appear to be somewhat lacking was the birth day. Since the university does not make any policy decisions based on age, it does not make a strong effort to police this item. Consequently, thirty-six of the students did not include their birth day on the records. It is not known how many others may have made mistakes on this item but it is

probably very small since the student is asked to verify this item each time he registers.

University profile.--The university profile is compiled by the registrar each quarter. Basically, the process and information is similar to the ridership profile except that all university students are included. The data on the registrar's masterfile is collected at registration, from the student's application form and from grade reports. It is updated and corrected at least once a week. At the end of the second week of the quarter, the registrar's masterfile is classified into various combinations to develop the registrar's second week enrollment reports. The reports are not made until the end of the second week to allow late registration and "drops and adds" to be processed. Some of these reports are made public in many forms varying from Information Services' This is Michigan State University: 1970 Facts Book which is released to various news media, to the official quarterly enrollment report and the Annual Report both published by the Registrar's Office. Other reports are simply filed for the university's internal uses.

Survey of on-campus bus riders.--For the information that was not available from any other source, it was necessary to prepare a survey to collect the required data. The primary purposes of the survey were to determine the travel patterns of students throughout the week and to determine what services they actually desire. A copy of the survey is included in Appendix B. The survey sample list was selected by the computer from the registrar's masterfile by taking every

thirty-third individual[2] who lives on campus or in married housing units. The sample was restricted to on-campus students for three major reasons:

a) The bus ridership profile indicated that only 916 of the 6,836 winter term 1970 bus riders lived off-campus. Judging from the seasonal trends and the lack of off-campus bus service, it was felt that even fewer off-campus residents would be riding spring term. Consequently it was felt that the exclusion of this segment would not seriously alter the results.

b) The incidence of ridership among off-campus residents was so low as to make sampling very difficult. Of approximately 18,000 off-campus students only 916 students rode.

c) The campus mail system was available for both the distribution and collection of the surveys sent on campus. The cost of administering the survey would have been much higher if the sample included off-campus residents since postage would have been required in both directions.

The output from the computer sample selection program was in the form of "two-up" gummed labels which included the student's name,

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[2]The registrar's masterfile is arranged in student number sequence. The number a student receives is primarily determined by the time at which the student's application is accepted.

address, telephone number, and student number. One label was used as the mailing label and the second label was used for follow-up.

Before the survey was mailed each person was called and asked for a personal commitment of cooperation. Appendix C contains a copy of the telephone conversation. The surveys were received by the students within twenty-four hours of the telephone contact. If the survey had not been returned within seven days of the time it was mailed, a follow-up call was made to determine whether the student needed a second copy. Twenty additional copies were sent out.

The original sample consisted of 575 students. Seven of these students had either moved or refused to cooperate. Of the 568 surveys sent, 453 (80%) were returned. Eight of those returned were unusable because of incomplete answers.

It should be pointed out that on the day previously scheduled for release of the surveys, there were efforts made to start a nation-wide student strike to close down the nation's college campuses. Although the effort was not successful at Michigan State University, it did cause some confusion on the MSU campus for approximately one week. In spite of this, there was a high percentage of return on this survey, but it was felt that returns would have been even higher during more normal times since at least some of the non-respondents were participating in the strike. On the basis of the telephone calls made, surveyors felt that many of the non-respondents either were not attending classes or were not living at their mailing addresses.

In light of the strike it should be pointed out that the prime factor used in eliminating the eight unusable surveys was whether they gave a strike-oriented answer such as "did not attend any

classes--on strike." In general, however, most students gave answers for a normal week and many even included notes to this effect.

One of the major editing jobs required on the survey was to convert building names to machine readable numbers so that travel distance and bus times could be measured. The actual conversion scheme will be discussed in the next section.

Campus origin-destination map.--One of the major data processing problems was the development of some means of identifying and grouping the hundreds of buildings on campus. If each of the buildings had been identified individually, the origin-destination matrix would have been completely unmanageable since the matrix size is determined by the square of the number of individually identified locations. On a map (scale 1 inch = 200 feet) obtained from the campus Planning Office, the buildings were grouped according to the following guidelines:

a) All groups were to be mutually exclusive, i.e., each building would be included in only one group.

b) Collectively each group would include all major buildings to which students travel. Buildings such as the power plant, laundry, buildings and grounds offices, experimental farms, etc., however, were not included.

c) Buildings in each group were to be those considered by the students as being in the same general area. For example, the buildings that share an access street or path, lawn, a bus stop or some other distinguishing feature were grouped together. Since the grouping was made by people with three to five years experience traveling between

campus buildings, intuition was heavily relied upon when there were no clear-cut grouping features.

This method resulted in 23 groupings with the average distance between group center and each building only 290 feet. If the average walking speed of 325 feet/minute measured by the Campus Park and Planning Office is used, this means that a building in each group averages only 54 walking seconds from the group center. (Appendix D contains a map of the campus with the groups circled. Appendix E contains a list of the buildings in each group with the distance between the group center and the building. Walking time is also indicated. Appendix F lists each building in alphabetical order with its appropriate group number for reference purposes.) It should be pointed out that the married housing locations were grouped together even though their size might exceed the average distance of the other twenty groups since they were felt to reflect more closely neighborhood characteristics rather than major activity center travel patterns. This grouping, however, affected only Spartan Village since the other housing areas were within the average grouping size.

Once the building groups had been identified it was necessary to determine the walking distances between each group of buildings. Again, on the basis of five years of actually walking around campus the distance between points was determined and was measured with a straight edge. The chosen route was the shortest possible route that can effectively be walked in good weather. For example, walking was not restricted to sidewalks if a shortcut were available that did not go through a building. The Red Cedar River was crossed only at bridges.

Allowances were not made for paths becoming muddy during rainy or snowy weather. All distances were measured to the nearest fifty feet.

Bus times were determined by Henry Jolman, foreman of the bus system. He indicated the time required to go from Shaw Lot to each bus stop and from each stop to Shaw Lot. On the basis of this data, bus time was determined between each of the groups. To this time was added the average waiting time to make a transfer at Shaw Lot. In almost all cases the average waiting time was considered to be one-half of the headway time. The waiting time for the Spartan Village bus, however, was considered to be only four minutes since it was assumed that the individual would attempt to schedule his arrival time to coincide with the Spartan Village transfer. It was also assumed that the individual would walk to the nearest bus stop although no time was allowed for walking to the bus or for waiting for the bus. In cases where the bus routing made riding illogical, bus time was considered to be zero. This frequently occurred around Circle Drive where the one-way traffic pattern required that a person taking a bus from the library to the Women's Intramural Building, for instance, would have to ride to Shaw Lot, transfer buses, and then ride through University Village before the bus returned to the Women's Intramural Building bus stop. The logical alternative was to walk the 1250 feet between the buildings rather than to take the bus. (See Appendix G.)

The group numbers were manually substituted for the building specified on the survey. Since there were only 445 usable returns, it was felt that this method would be much more expedient than keypunching and programming for the many varied abbreviations used by respondents to designate buildings.

Frequency of bus service by each group area was determined from the campus bus schedule. These are listed in Appendix H.

Weather data.--All measures of weather were taken from the Local Climatological Data published monthly by the Environmental Data Service of the United States Department of Commerce. Data obtained included:

a) Average daily temperature in degrees Fahrenheit

b) Daily precipitation in inches of water between 7:00 A.M. and 7:00 P.M.

c) Average daily wind speed

d) Average daily sky cover from sunrise to sunset in tenths

e) Daily humidity readings at 1:00 P.M. Eastern Standard Time

These readings were taken by the weather bureau station at the Lansing Capital City Airport which is six and one-half miles from the MSU campus. Generally, the measures for the two locations are very similar; however, occasionally there are large deviations. Temperature measures are very similar between the two points. If weather data had been available for MSU during the investigation period it would have been used, but the service had not started collecting data at the MSU Horticulture Farm at that time.

Bus ticket sales.--Each quarter, bus tickets are sold at registration, the International Center Book Store, the Student Union, and at the desk in each of the dormitories. All records of sales and

transactions are maintained under the direction of the Comptroller's Office. These records provide complete information on ticket sales by quarter including the number of commuter or regular tickets sold and the number of fall tickets returned on the purchase of winter passes. A list of ticket sales by quarter is included in Appendix I.

Bus system operating reports.--There are basically three sets of reports maintained by the operating section of the bus system. The first report is compiled from data supplied by the driver. On each run the driver uses a hand counter to determine how many people board the bus on that run. If any people were left behind he indicates so by circling the run count on his daily log. These counts are made daily and are used to determine whether additional buses should be added to handle any students who may be left behind. One deceiving fact about these counts is the fact that a person who transfers buses is counted twice, first when he boards the bus at his origin and again when he transfers to his destination bus. Also, since people may board the bus for short trips, the total bus capacity may be exceeded several times without leaving any student behind if there is a rapid turnover among the bus riders.

The second report is maintained by the garage. Each time a bus enters the garage for fueling, repair, cleaning, or other service, direct charges are maintained by bus number. At the end of each month these costs are totaled and costs per mile are calculated. In addition, charter revenue reports are maintained on an individual bus basis. These reports reflect not only direct charter and labor costs but also revenue

derived from the charter operation and contribution to overhead. The garage also maintains a report of overtime hours worked by drivers.

The third group of reports, the funds flow ledger, is generated quarterly by the Bookkeeping and Accounts Payable Office. This office accumulates all receipts deposited and all vouchers paid to determine cash flow profit for the quarter. Several entries in the cash flow ledger should be pointed out. First, no provision is made for overhead charges for the bus system office space under the east wing of the stadium or for the water used in washing the buses. Second, since the purchase of buses was financed through an inhouse loan, no interest charges are recorded. Third, only part of the fringe benefits paid to the drivers are credited to the bus account. The rest of the charges, medical insurance, social security, and retirement, are paid by and credited to the University General Fund. Last, the $45,000 per year contribution to an equipment reserve account which was started in 1967 seems to distort the actual operating picture of the MSU Bus System. In the reports used for this paper the funds flow ledger has been adjusted to provide a better indication of actual bus system operation. These adjustments include:

a) The allocation of overhead at $3,000 per year. This figure was based on $1,200 for utilities and $1,800 for office space which the university allocates at $3.00 per square foot.

b) The calculation of interest payments on the net investment level at 7 per cent per year.

c) The removal of the equipment reserve transfer. This equipment reserve account has the effect of burdening the existing

system with the responsibility of paying for the current rolling stock as well as for future purchases.

d) No adjustment was made to reflect the fringe benefits not paid by the bus system nor was an attempt made to analyze the cost of transferring bus drivers to the physical plant payroll during the summer.

These adjustments have been made to Tables 28 and Table 32 in Chapter IV. The amount of each quarterly adjustment is given in Appendix N.

CHAPTER III

ANALYSIS OF FACTORS AFFECTING THE DEMAND FOR CAMPUS BUS SERVICE

This chapter identifies factors affecting the demand for bus service on the MSU campus. The data used for the analysis in this section comes primarily from two sources. First, the data obtained from the surveys were used to correlate bus ridership[1]--the purchase of a quarterly bus pass--with various service and travel demands such as frequency of service and total weekly travel distance. Second, the demographic data obtained from the registrar's masterfile was used to compare market segments to determine the propensity of each group to purchase quarterly bus passes. Whenever possible the results from one data source were used to verify the results from the other data source.

Major ridership determinants

A least squares regression analysis on sixteen independent variables (see Appendix J for detailed description of program and run)

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[1]The term "bus ridership" is defined as the propensity to buy a quarterly bus pass since non-pass holders are not legally allowed to ride the bus. It will be conceded that a large number of bus ticket holders do share their passes with non-passholder friends but for the purposes of this paper ridership differences within either the pass holder group or the non-pass holder group will not be considered.

finally isolated seven factors which were statistically significant at the 95 per cent level or greater. These seven variables explained 24 per cent of the variance in ridership. Each of these seven factors will be discussed in the following paragraphs.

Total weekly travel distance.--This variable, a measure of the total distance traveled each week in attending classes, meeting work schedules, and traveling to regular social engagements, was the most important single factor affecting bus ridership. This variable explained 6.34 per cent of the total variance in bus ridership and was statistically significant at the 99.95 per cent level. The "b" value obtained from this relationship indicates that an additional 7.4 per cent of the students ride when their weekly travel distance increases 10,000 feet per week.

Frequency of bus service to the student's living area.--This variable, measured in minutes between regularly scheduled bus service during the day, was the second most important variable affecting ridership. This variable explained 5.6 per cent of the total ridership variance and was also significant at the 99.95 per cent level. The "b" value indicates that an additional 29.88 per cent of the on-campus students living in any one given area will purchase bus passes if the frequency of service is increased from eight minutes to four minute intervals. This "b" value is in very close agreement with the values shown in Figure 1 and Figure 2 which were derived from the bus ridership profile. These freehand curves indicate that the propensity to use the bus varies by over 25 per cent between the two service frequency areas.

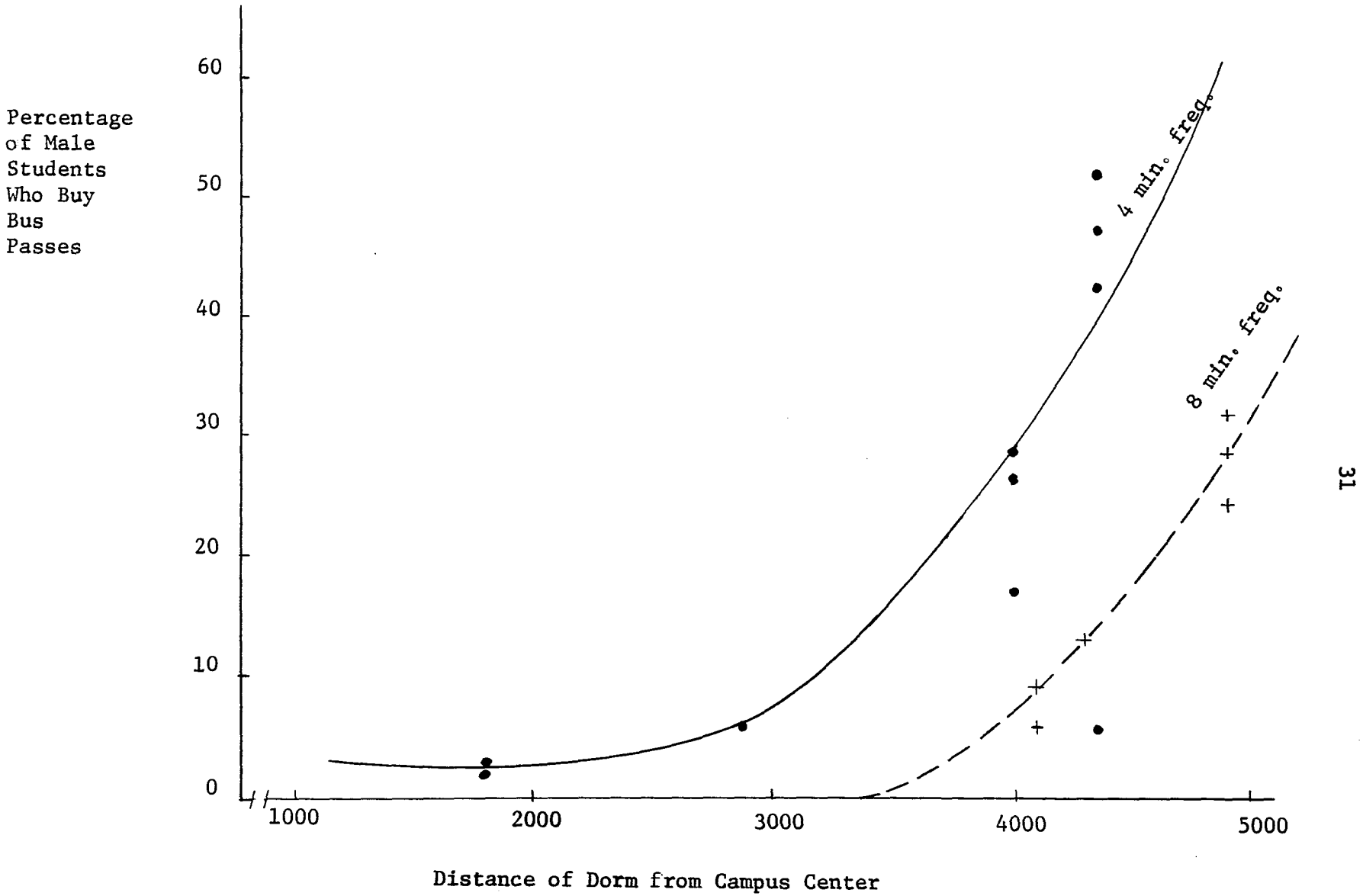


Fig. 1.--Bus ridership vs. distance of dorm from campus center for four and eight minute headways--male students only.

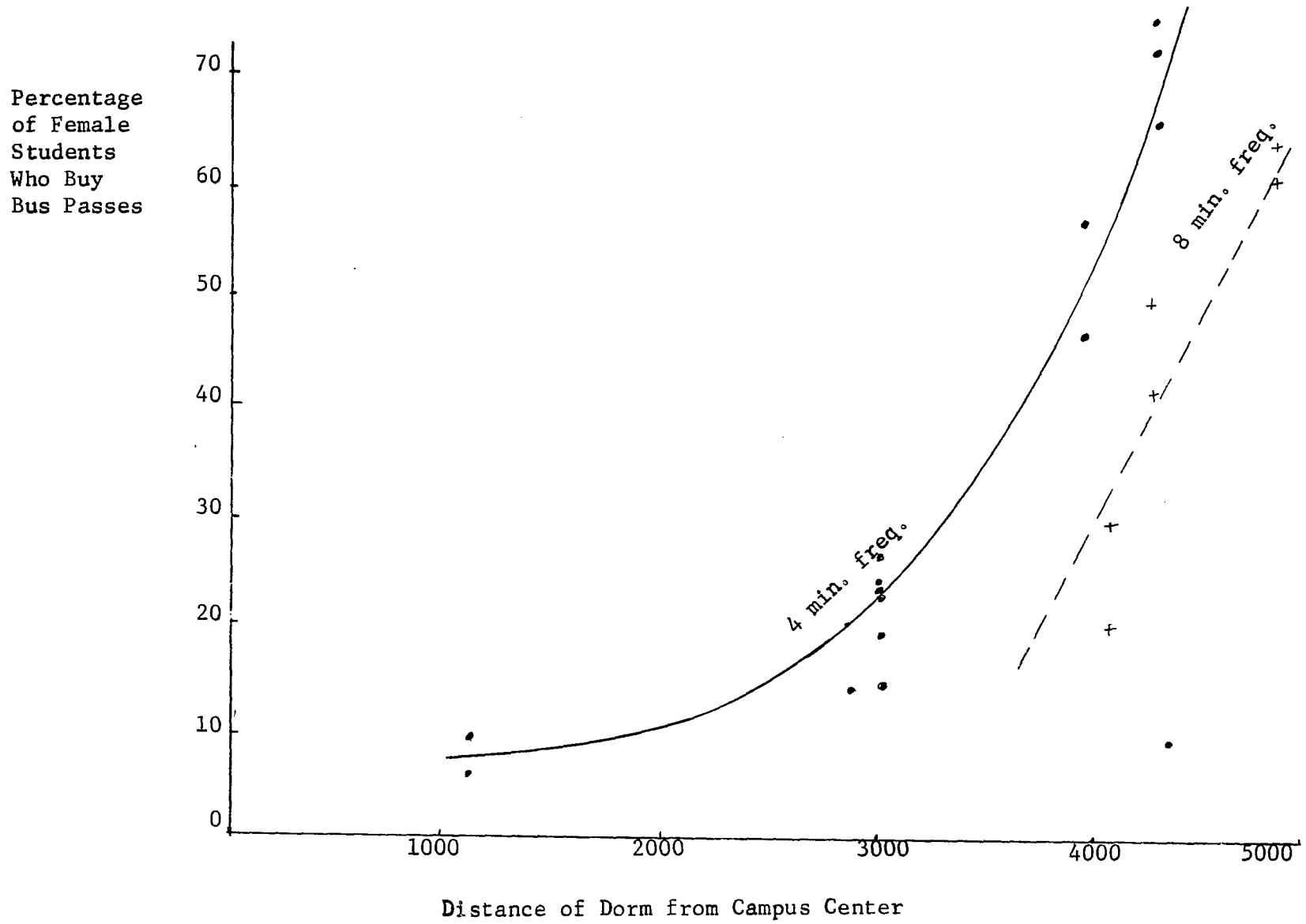


Fig. 2.--Bus ridership vs. distance of dorm from campus center for four and eight minute headways--female students only.

Table 3 indicates that 86.6 per cent of all bus riders live on campus. Since the student body is almost equally divided among on- and off-campus residents this value would be expected to be nearer to 50 per cent if the bus riders were looking only for a shuttle service within the academic area. This difference between on- and off-campus students in propensity to ride would imply that ridership is determined primarily by the service to the residence areas and not by the service within the academic area.

Distance between the individual's living area and the center of campus.--This variable, a measure of the shortest walking distance between the student's residence hall or married housing area and the center of campus--Farm Lane and Auditorium Road--explained 3.72 per cent of the total variance in quarterly pass purchases. This relationship was deemed especially important since ridership increased exponentially with this distance. This exponential (x^2) relationship was significant at the 99.95 per cent level although the linear relationship was only significant at the 56 per cent level.

TABLE 3

RESIDENCE, SEX, AND MARITAL STATUS OF BUS RIDERS

Group	Total	Residence Halls	Married Housing	Off Campus
Single males	31.7%	27.40%	.05%	4.2%
Single females	58.3%	52.00%	.05%	6.3%
Married males	6.8%	.05%	5.90%	.9%
Married females	3.2%	.05%	1.00%	2.0%
Total	100.0%	79.50%	7.00%	13.4%

Note: This table was constructed from a sample of 6,836 students. This sample contained 90 per cent of all fall term 1969 riders who re-enrolled winter term, 1970.

According to the "b" value 21.3 per cent more of the student body will buy passes if they live 5,000 feet from the campus center than if they live only 3,000 feet from the center of campus. Likewise, 53.2 per cent more of the student body will ride if they live 7,000 feet from the center of campus rather than only 3,000 feet. Figures 1 and 2, which were derived from the bus ridership profile, substantiate this relationship between distance from campus center and the percentage of the student body which buys a bus pass. Although the range of values for this regression equation is from 1,150 feet to 10,500 feet, the preponderance of observations was in the 3,000 to 5,000 feet range.

As could be expected there was a correlation between the distance from the dormitory area to the center of campus and the total distance traveled each week by the student. In this case the simple correlation value was 0.36. It is important to note, however, that once the individual effect of each of these variables had been considered there was very little residual or interaction effect remaining. This point is examined in detail in Appendix J.

Sex.--This variable explained 1.2 per cent of the total variance in bus ridership and was statistically significant at the 98.9 per cent level. Since sex was entered as a dummy variable, the regression coefficient can be read directly as indicating that females have a 9.75 per cent higher propensity to buy a bus pass than males under similar conditions. The same result is derived from the bus ridership profile by comparing Figure 1 and Figure 2. This comparison indicates that at every level of distance and frequency, a higher percentage of females purchase passes. Figure 3 indicated that this

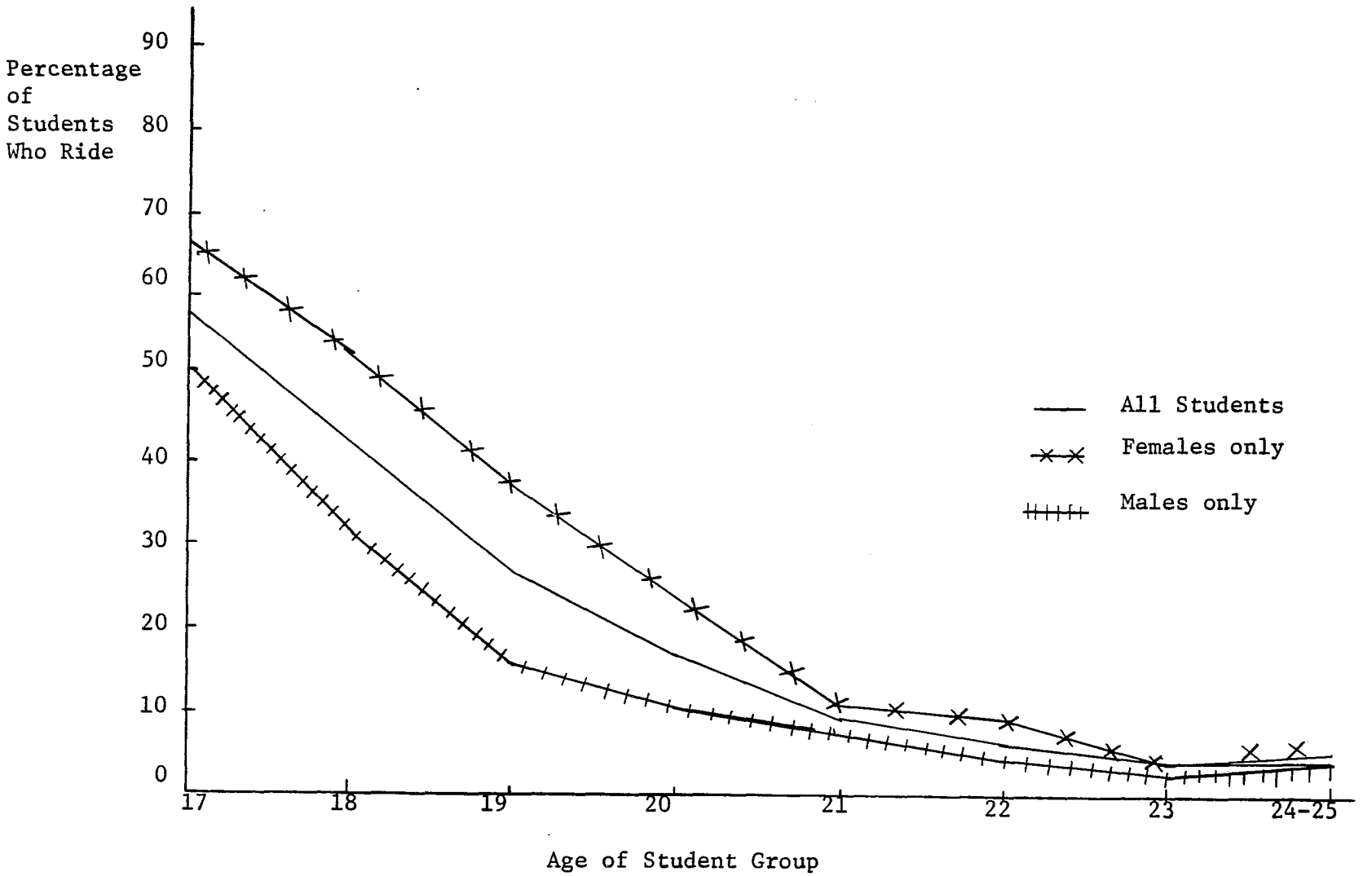
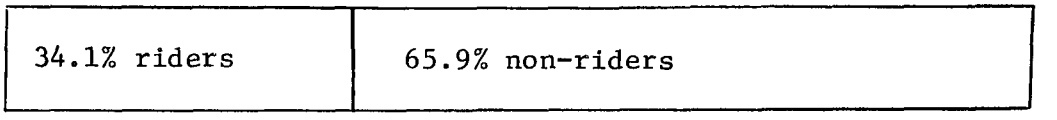


Fig. 3.--Ridership of MSU Bus System by age

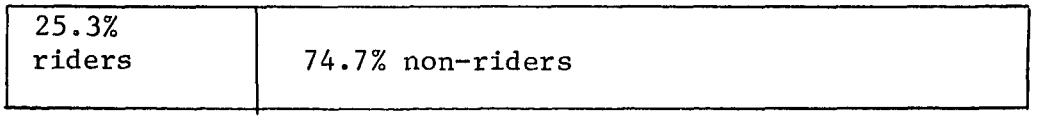
relationship holds true for all students under twenty-one years of age but that there is less difference in riding habits as students age. Figure 4 taken directly from the bus ridership profile indicated that 47.5 per cent of the single females rode the bus during fall and winter quarters of the 1969-70 school year versus only 24.3 per cent of the single males. Table 3 shows that 58.3 per cent of the bus riders are single females compared to only 31.7 per cent single males.

A possible reason for this difference in ridership between sexes is that the girls often buy a pass as a security measure since they dislike traveling alone especially at night. This reason was frequently suggested in the open-ended survey questions. A second reason might be that miniskirts are very cold in the late fall and winter.

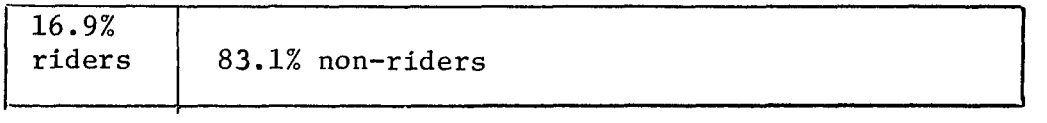
Class.--This variable explained 1.2 per cent of the total variance in the purchase of bus passes and was statistically significant at the 98.8 per cent level. The "b" value obtained from this relationship indicates that the propensity to purchase bus passes decreased by 3.2 per cent for each year in class standing. Figure 3 indicates an even greater decrease with approximately 42 per cent of the freshman class (seventeen-and eighteen-year olds) and only 10 per cent of the senior class (twenty-one-year-olds) riding. This difference between the regression equation and the bus ridership profile data can be explained in two ways. First, there appears to be a significant degree of concavity in Figure 3 so that the linear constraint imposed on the regression coefficient over a range of one through nine might deemphasize the rapid decrease during the first four years. For example, the correlation coefficient over the range of classes one through nine



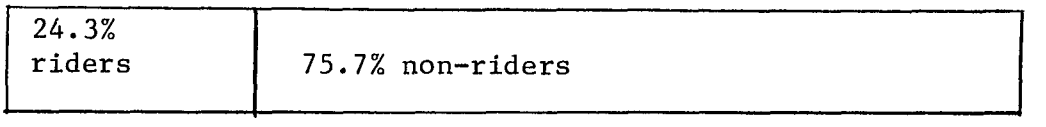
Base--All students living on-campus



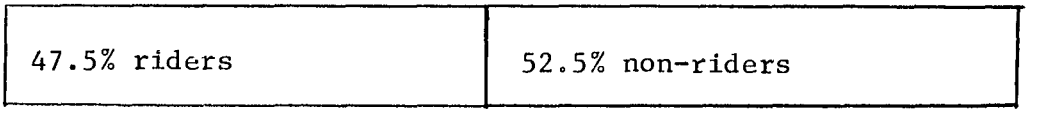
Base--All married males living on-campus



Base--All married females living on-campus



Base--All single males living on-campus



Base--All single females living on-campus

Fig. 4--Propensity of MSU students to use campus bus system.

would indicate a decrease of approximately 25.5 per cent which closely approximates the total change suggested in the chart by age relationship.

The second factor affecting this difference is the fact that the bus ridership profile from which Figure 3 was constructed was taken from fall and winter term data instead of spring term data which was used for the multiple regression calculation. As will be shown in Chapter 4, incoming students tend to have a very high propensity to buy a bus pass; however, during spring term a high percentage of them stop riding and never seem to begin riding again.

The multiple regression program identified two highly significant variables which yielded results very different than would have been expected a priori. These were the number of trips made each week and the percentage of night travel.

Number of trips made each week:--As could be expected, this variable had a relatively high positive correlation with the total weekly travel distance. The value of this simple correlation was 0.68. This means that a person who travels a very great distance during the week had to make a large number of trips each week. It was somewhat surprising however, to find that this variable had a strong negative correlation with bus ridership once the total distance effect had been removed in the multiple regression program. In fact, this variable explained 3.9 per cent of the total variance in bus ridership and was significant at the 99.95 per cent level.

Two factors would explain this negative relationship. First, the bus system is apparently viewed by riders as being a commuter service from the remote living areas to the center of campus. It is not needed

as a shuttle service within the academic community. Consequently, a person who makes many trips within the academic area often will not purchase a bus pass.[2]

The second factor that would cause this result is the tendency of those who make a large number of trips to make an effort to live in closer dorms so they will not be dependent upon the bus. In fact this point was brought out in the open-ended part of the survey. But either one of these reasons would indicate that the bus is primarily a commuter service to and from the residential complexes and is not used as shuttle service within the academic area.

Percentage of night travel.--This variable was also very important since it explained 2.2 per cent of the total bus ridership variance and was statistically significant at the 99.9 per cent level. It was surprising, however, that the "b" value coefficient was negative. Perhaps the best interpretation for this negative relationship was given by a student in one of the open-ended survey questions who stated that she bought a pass primarily because she did not like to walk back to her dorm alone at night. However, she

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[2]In order that the reader does not confuse the definition of "a trip" as used by this study it will be emphasized here. A trip is considered to be a normal expected movement from one group of buildings on the map in Appendix D to another for social, academic, or work purposes. Trips made within one of these groups of buildings were not considered to be trips in this sense since it would not be feasible to take a bus for the short distance. Also trips with either an origin or destination that was not included in the twenty-three groups indicated on the map were ignored since the campus bus system does not provide service to off-campus areas or to some of the remote agricultural research areas. Unexpected spur of the moment trips were not considered since a student would not purchase a bus pass at the beginning of the quarter to facilitate unexpected travel trips. The more accurate the understanding of this definition the more significant is the result of this negative relationship.

continued by stating that when she needed the buses most--at night--they ran only every twenty minutes instead of the normal frequency. She also stated that she had been frightened when the buses ran on different routes at night than the normal ones she had expected.[3]

Later in this chapter it will be shown that most students do not go to meet a particular scheduled bus but simply go to the stop when they are ready to leave. If they do not change their behavior they will have a long wait when the frequency changes to the night schedule. Perhaps this is an important factor in influencing night travelers to make other arrangements, which it is possible for them to do since all students are free to drive and park on campus between 6 P.M. and 6 A.M.

Effect of weather on bus ridership

Seasonality.--An analysis of bus pass sales by quarter shows a strong fluctuation between quarters in ridership. This can be expected since the weather during late fall quarter and winter quarter can be severe while spring and summer are comparatively mild in central Michigan.

Figure 5 shows the strong seasonal nature of the ticket sales. Index numbers are calculated and presented in Table 4.

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[3]At night the frequency between buses is decreased to one bus every twenty minutes. The longer time span allows some of the buses to cover two routes. For example, when the headway of the Spartan Village bus is increased from fifteen to twenty minutes at night, it makes a five minute run to the commuter lot rather than waiting at Shaw Lot interchange for the extra five minutes. It is assumed that the respondent boarded a Spartan Village bus to go to the Brody dormitory area and was frightened when the driver started toward the commuter lot which is located in one of the more secluded areas of campus. Since frequently there are only one or two passengers on this run late at night, it is easy to understand her concern.

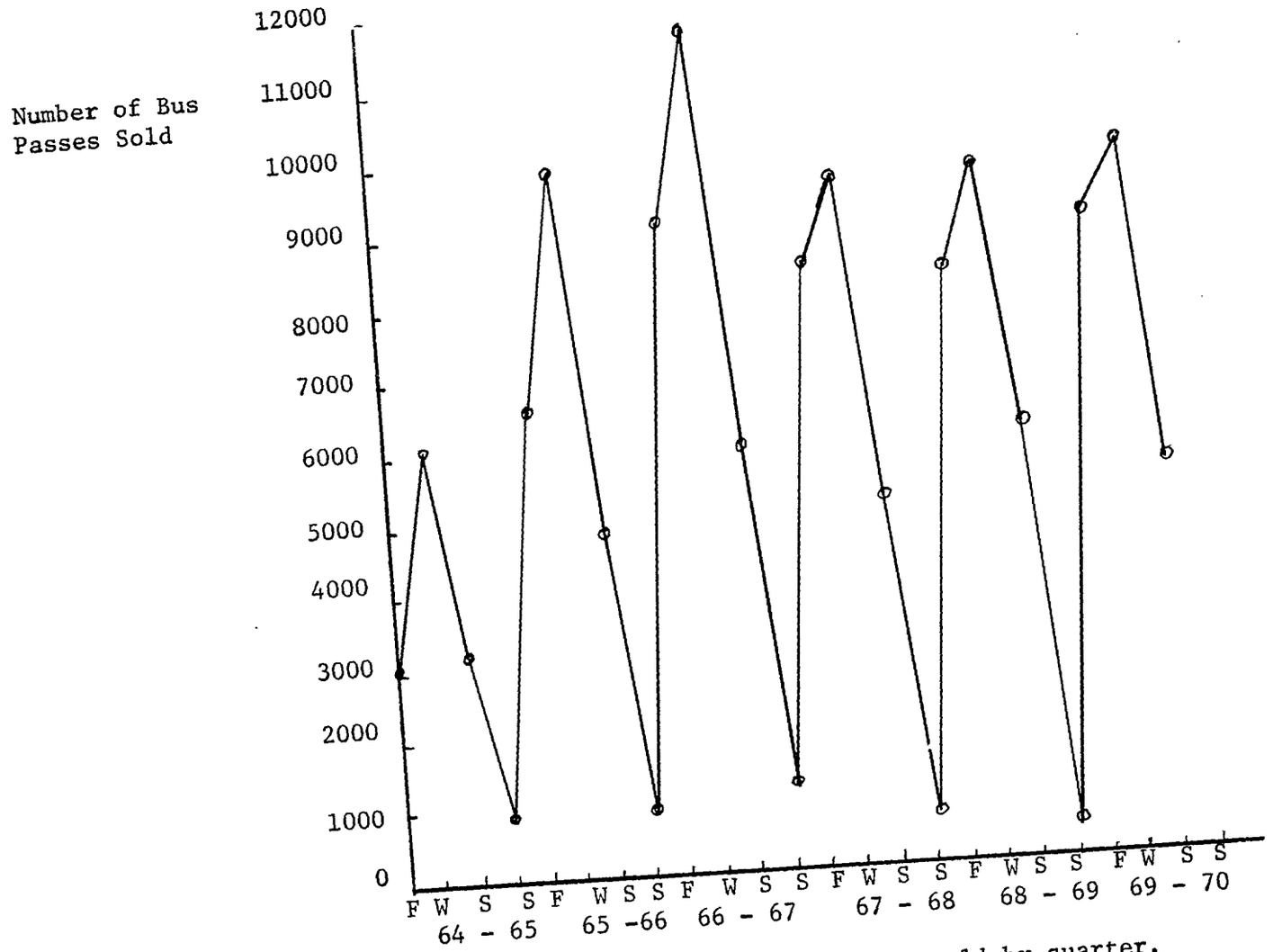

Fig. 5.--Number of bus passes sold by quarter.

TABLE 4

INDEX OF BUS PASS SALES BY QUARTER

Year	Fall	Winter	Spring	Summer
1964-65	94.1	182.5	95.7	27.7
1965-66	118.5	177.8	86.5	17.1
1966-67	129.8	167.2	85.2	17.7
1967-68	140.7	160.1	86.2	13.0
1968-69	134.6	157.4	98.9	9.2
Total	617.7	845.0	452.5	84.7
Mean	123.5	169.0	90.5	16.9

Note: Index for year is 400. Average quarter index is 100.

From the data in Figure 5 and Table 4 it is virtually certain that the reason for this strong seasonal influence is the weather.

Daily variation.--In considering the effect of weather on bus ridership, it is also necessary to consider the effect of weather on daily ridership within the season. This is a different problem than the seasonal analysis above since a different decision is involved. The seasonal analysis determines the sensitivity of bus pass purchases to expected weather conditions over the next ten weeks. The daily ridership analysis assumes that the pass has already been purchased but questions whether weather has an effect on daily ridership.

To determine this daily ridership effect, data was collected from the bus driver's daily ridership reports for fall quarter, 1969 and compared to measurements of weather as discussed in Chapter 2. First, the ridership data was adjusted to eliminate the effect of the

day of the week since Monday and Wednesday are traditionally heavy ridership days and Thursday and Friday are very light days. Also unusual days were eliminated, i.e., Thanksgiving, the four days when the bus drivers called in "sick," and the "Moratorium Day." This adjusted data was entered into a least square multiple regression program described in detail in Appendix K.

There was no significance whatsoever in the output of this analysis. The total regression on six measurements of weather explained only 15 per cent of the total variance in adjusted daily ridership and then only with a 51 per cent confidence level. No single variable was significant at an 80 per cent confidence level or greater except average wind speed which was significant at the 89.9 per cent level and explained 7.1 per cent of the total adjusted daily ridership variance. When the same test was run using daily faculty and staff ridership there was even less significance shown. Appendix K discusses the output in detail.

In general, then, students show a strong propensity to buy a bus pass when they expect the weather to be bad, but once they have made their decision to ride they become regular riders and are not significantly influenced by the weather.

Effect of price on bus ridership

It is difficult to measure the effect of the price variable since so many assumptions must be made. In this section, however, the price change made in 1967 will be examined to approximate its effect on ridership. This analysis assumes that there are no shifts in demand but only movements along the demand curve.

Before examining the price data, however, there are several theoretical points which should be discussed and the assumptions indicated. These factors are graphically presented in Figure 6. The first point involves the effect of a change in price. In Figure 6, β represents the effect of a price decrease. Here the demand is actually very inelastic for a short period of time. The demand curve will theoretically shift upward (β approaches 0) with the passage of time. Blurton substantiates this point in his Peoria-Decatur study in which he indicates that with his introduction of the special scheduled-seat premium service, it took from five to twelve months for equilibrium to be reached.[4]

The data in this study indicates that MSU students responded almost immediately to the fall 1967 price rise. It could be hypothesized, however, that the response to a price decrease would have been substantially slower if initiated during a period when riding and living habits had already been established, that is, a quarter other than fall quarter.

The second theoretical point concerns the α kink in the demand curve. According to several studies, price increases are very elastic until all individuals with alternative travel modes are priced out

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[4] In the Peoria study the growth rate was generally stable at approximately 0.7 passengers per route per week for fourteen months. In the Decatur study ridership grew to 69 per cent of seat capacity in one month, then was sharply reduced to a very low growth rate before finally stagnating in approximately 7 months. It should be pointed out, however, that this project had the strong backing of the local employers who gave extensive introductory and follow-up publicity in their house organs. They also offered free service for the first week to encourage acceptance. Under more normal conditions the acceptance of a new service or the adjustment to a price decrease would probably extend over a longer period of time. Mass Transportation Demonstration Projects: Ill. MTD. 3,4, Michael A. S. Blurton, Project Director (Urbana: University of Illinois Press, 1968), p. 85.

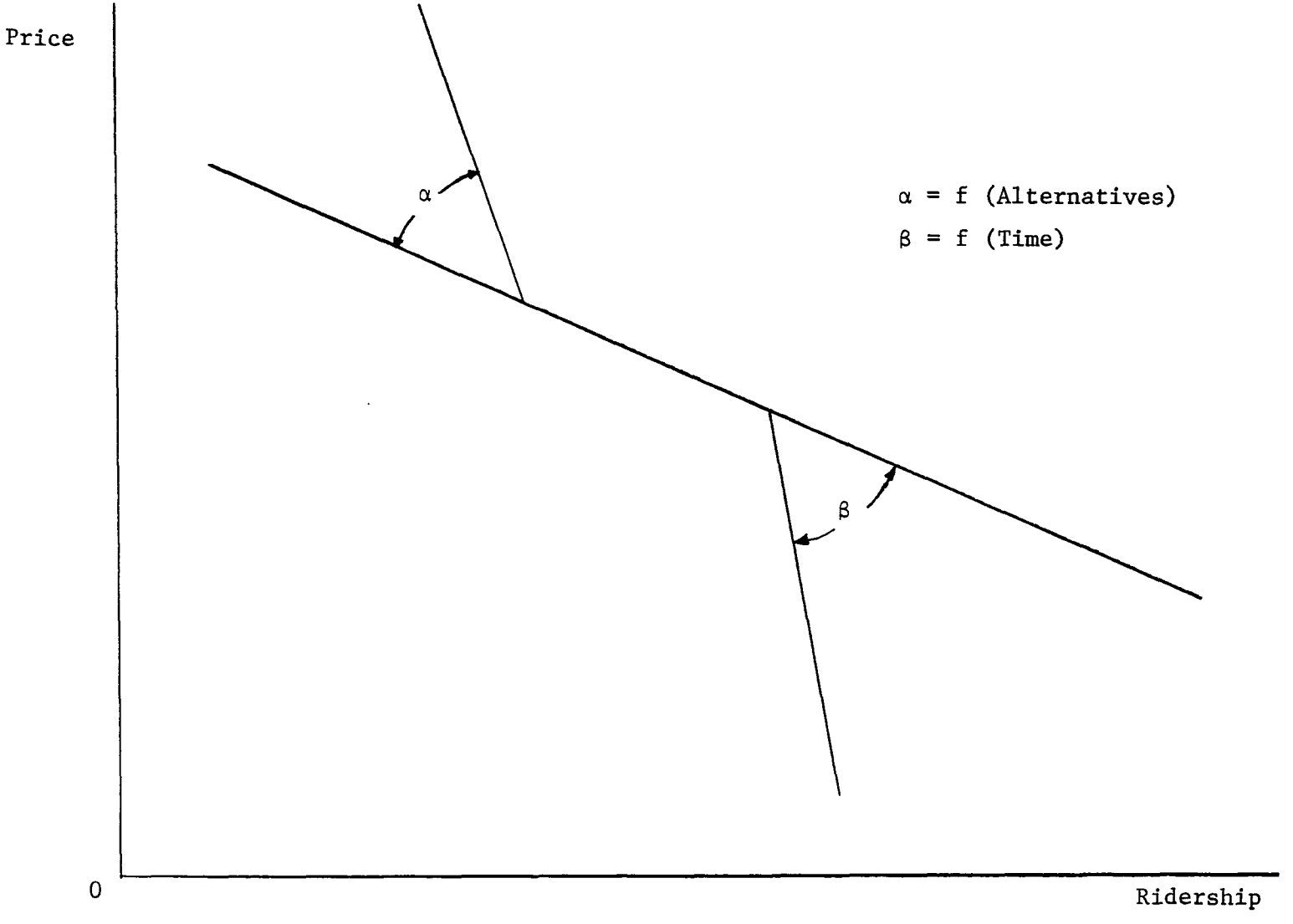

Fig. 6.--Theoretical demand curve for campus bus transportation.

of the market and only those with no alternatives are left. People in this group would include the physically handicapped, those with no access to automobiles, or those who are legally prohibited from driving. The demand curve for this group then becomes very inelastic and fare increases become effective means for increasing revenue. The angle α, then, is equal to a function of alternative travel modes available to the rider.

It is doubtful that α is very large on the MSU campus since physically handicapped students are able to obtain special parking and driving permits which allow them unlimited access to all parts of campus. Students who are not handicapped always have the option of walking or of rearranging their travel and class schedules so that less long distance travel is required. Since they can walk from any residence area to the academic area in twenty-six minutes and most walks are considerably shorter, they can reasonably consider this alternative. There would, however, be some discomfort in walking during the winter quarter because of the severity of the weather.

Although data were not available to conclusively test the nature of α and β these relationships should be kept in mind during the following analysis which includes the effect of the 1967 price increase on the absolute change in ridership and elasticity of demand, on the growth rate of the system, and on the seasonal nature of bus ridership.

Effect of price on absolute change in bus ridership and arc elasticity of demand.--Table 5 indicates that the 1967 price increase of $2.00 yielded a decrease of 4,042 in the number of passes sold

TABLE 5

EFFECT OF 1967 PRICE INCREASE ON BUS RIDERSHIP
(A COMPARISON OF 1966-67 and 1967-68 ACADEMIC YEARS)

	Year	Fall	Winter	Spring	Summer
1966-67 price		$12	$12	$12	$12
1967-68 price		$14	$14[a]	$14	$14
Percentage of price change[b]		15.4	15.4[c]	15.4	15.4
Decrease in ridership	4,042	657	2,119	805	461
Base ridership[d]	26,136	8,811	10,711	5,596	1,017
Percentage of change in ridership	-15.5%	-7.5%	-19.8%	-14.4%	-45.3%
Arc elasticity of demand	1.01[e]	.49	1.29[e]	.94	2.94

[a]The price was $14.00 if the fall term pass were turned in. If the winter term only pass was purchased, the price was $20.00.

[b]Average price is used as base price [$2/($12 + $14)/2] = .154.

[c]This calculation does not consider the effect of the $20.00 pass since data were not available.

[d]Base ridership equals average ridership for 1966-67 year and 1967-68 year.

[e]These values are distorted by virtue of the implementation of the dual pricing system winter quarter.

for the 1967-68 school year as compared to sales for the 1966-67 school year. Figure 7 likewise indicates that the absolute level of sales dropped substantially and abruptly when the 1967 price increase was effected.

The calculation of arc elasticity for this price change suggests two factors that should be examined. First, the demand curve is substantially different for each of the four quarters; second, it appears that the bus system is currently operating very near unitary elasticity. Fall quarter demand in general seems to be very inelastic; this is probably due to the pre-enrollment promotion of the bus system and the general impression of vastness which the campus presents to the new enrollee.

Although the dual price increases obscure the exact elasticity of the winter quarter demand, it seems to be nearly unitary as does that of spring quarter. It is felt that the demand is more elastic in the winter and spring quarters due to several factors: by this time of year the students have better learned their way around campus, they are beginning to schedule classes to be more convenient to their living area, they have established a routine travel pattern among a limited number of buildings, and/or they begin to choose dormitory rooms on the basis of travel patterns. For example, several students indicated when surveyed that they frequently postpone a class to a quarter when it is scheduled to be given nearer their rooming areas. The summer quarter appears to be highly elastic as would be predictable due to the warmer weather and a general relaxation of parking regulations on campus.

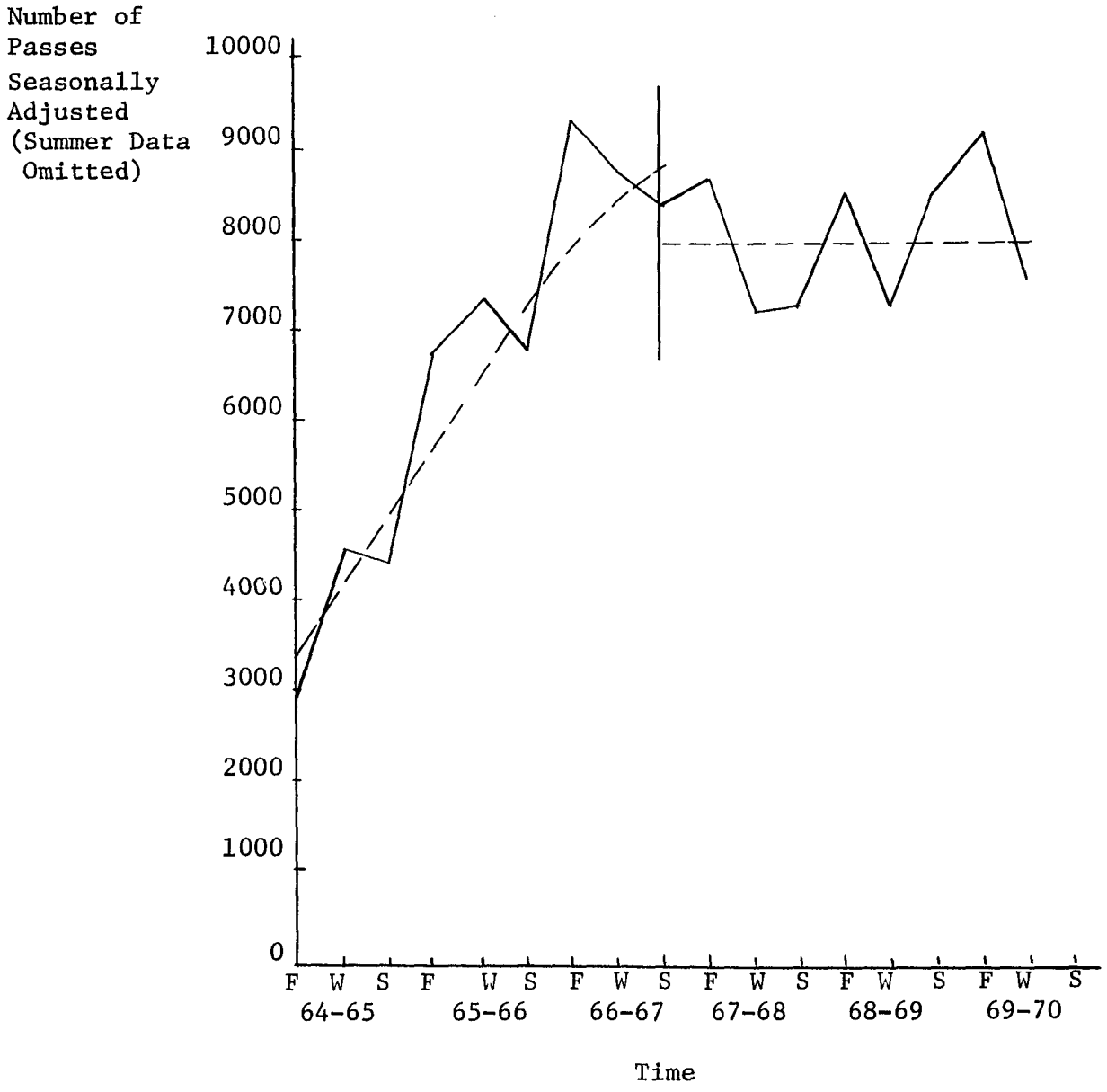

Fig. 7.--Bus pass sales trend

One difficulty with this analysis is that it assumes that the demand curve did not shift between the 1966-67 and 1967-68 school years. A second difficulty of this measure is the assumption of a linear demand curve, which is necessary to make any observation about future price increases. A third difficulty centers around the α concept presented in Figure 6. It could be argued, for example, that the 1967 price rise was effective in eliminating those students who had other alternatives and that the remaining riders did not cease buying bus passes when the price was increased. It is difficult for the writer to see any factors which would support these two arguments.[5] It seems reasonable, in fact, that the assumption of at least near linearity is valid since the location and size limits of the campus buildings prohibit any mass movements or schedule rearrangements which would change the demand patterns of the group as a whole.

Effect of price increase on system growth rate.--Perhaps the most significant effect of the price increase was to end the bus system's growth trend. Figure 7 indicates that the growth rate was very high during the fall 1964 through spring 1967 period but that growth was virtually eliminated as soon as the $2.00 per quarter price increase was implemented and has virtually leveled off since that time. It must be conceded that this growth rate was also affected by a "leveling out" of university enrollment and the completion of the dormitory and married housing building program (see Appendix R).

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[5] See above, p. 46.

Appendix S, therefore, makes an examination of bus pass sales as a percentage of the on-campus residency census. This analysis indicates that the propensity of the on-campus student to ride also was sharply reduced after the price increase. Figure S-1 indicates that this was true for each quarter.

Effect of price increase on the seasonality of ridership.--One of the major reasons given by the administration for the implementation of the $20.00-winter-term-only bus pass was that it would help eliminate the winter quarter seasonal peaks. If one examines the seasonal peaks for only one period before and after the $20.00-winter-only ticket was implemented, then there is a definite decrease in winter-term ridership over fall-term ridership. For example, in winter quarter, 1967, 29 per cent more riders rode than during fall quarter, 1966. After the $20.00 bus pass was implemented, however, this increase was only 14 per cent. This action then appeared to have accomplished its objective. If, however, an examination of the trend of these seasonal cycles is made, it appears that the preceding three years had also seen an equalizing of the winter term peak without the price increase. Figure 8 indicates that 94 per cent more students rode during winter term 1965 than during fall term, 1964, 50 per cent more during winter term 1965 than during fall 1965, and only 29 per cent more during winter term 1967 than during fall 1966. It is apparent, then, that the winter term peak was gradually being equalized even without the price increase. It is questionable how effective the price increase is in leveling seasonal demand.

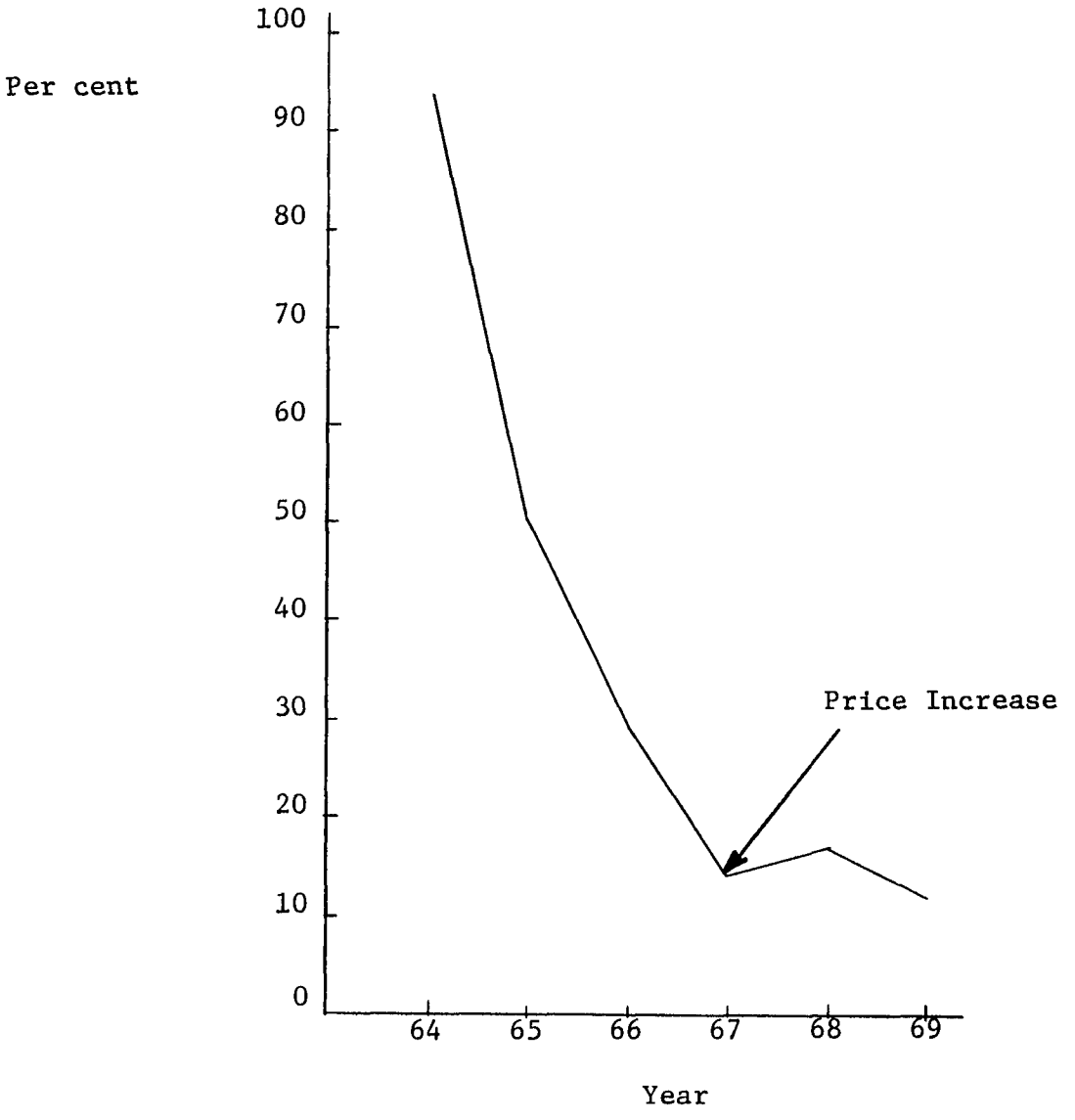

Fig. 8.--Percentage increase in winter passes over fall passes 1964-69

One feasible explanation for this apparent leveling of demand is that riding the bus has now become somewhat of a habit. This is supported by Table 1 which indicates that 91.5 per cent of fall-term bus riders who re-enrolled winter term purchased a bus pass winter term. Prior to 1967, however, there was a very rapid ridership growth rate when many people began the bus riding habit during winter quarter. Each of these years, however, the ridership growth rate began to decrease so the winter term seasonal peak became relatively smaller. By 1967 the winter term peak was probably limited to a relatively small group with a very inelastic demand. Consequently the $20.00 winter-term-only pass was an effective means of extracting additional revenue even though it did not alter the winter term peak ridership significantly.[6]

Additional factors affecting bus ridership

One of the factors tested in this study was the effect of environmental conditioning prior to MSU attendance on the propensity to buy bus passes.

One question concerns the effect of urban or rural orientation on the individual. It was felt that those who were reared primarily in an urban area might have a greater acceptance of the bus system due to their greater childhood exposure to bus transit systems. Table 6 indicates that this is true to a slight degree since a larger percentage of riders came from city and suburban areas than rural

[6]The students appeared to be very aware of this effect of the winter-term-only pricing method. In the open-ended part of the survey the student showed strong resentment to the "gouging" of students during winter quarter when they need the bus most.

areas; however, this could be accepted at only a 67 per cent confidence level.

TABLE 6

EFFECT OF HOME AREA ON BUS RIDERSHIP
(Percentages)

	City	Suburb	Town	Rural	Sample
Riders	16.4	52.3	16.4	15.0	128
Non-riders	12.3	47.6	21.1	19.0	317

Note: Chi-square = 3.43942

Level of significance at 3 degrees of freedom = 0.3287

A second question concerns a possible learning curve effect from ridership patterns which might have been established during high school. Table 7 indicates that a slightly higher percentage of riders came from the group who rode the yellow school bus during high school; however, the statistical significance of this conclusion was very low with only a 14 per cent level of confidence that there was a causal effect between the travel mode during high school and MSU ridership.

A third question in this group considered the possibility that the students had developed a dislike for using the bus during high school and that this attitude had negatively affected their use of the MSU system. The response to this question appeared to bear out just the opposite conclusion. Table 8 indicates that of the approximately 60 per cent of the respondents who answered this question,

those who rode the MSU bus service tended to rate their high school systems lower than the non-riders. It is somewhat difficult to understand why this relationship existed unless those who rated their high school systems lower also had their expectations of the MSU system lowered by past experience and consequently they did not become disillusioned and discontinue ridership after their first two quarters at MSU as many of the other students did.

TABLE 7

TRAVELING MODE DURING HIGH SCHOOL
(Percentages)

	Walk	Bike	City Bus	Yellow Bus	Car	Sample
Riders	30.7	0.8	9.4	37.0	22.0	127.0
Non-riders	32.1	1.5	10.7	32.4	23.3	317.0

Note: Chi-square = 1.31984

Level of significance at 4 degrees of freedom = 0.8580

A fourth question concerning the environmental preconditioning of the students hypothesized that the more frequently the student had used a public transit system prior to entering MSU, the greater his propensity to purchase a bus pass. Table 9 does appear to indicate a slight relationship since a somewhat higher percentage of those who had never used a transit system before were non-riders at MSU. Also the monthly and weekly prior users had a slight tendency to ride more while at MSU. The confidence level for this relationship was 81 per cent.

TABLE 8

OPINION RATING OF HIGH SCHOOL BUS SYSTEM

	Bad	Fair	Average	Good	Excellent
Riders	10.8	29.7	28.4	25.7	5.4
Non-riders	4.2	19.0	33.9	35.4	7.4

Note:

Of the 127 riders and 306 non-riders who responded to this survey 41.7 per cent of the riders and 38.2 per cent of the non-riders indicated that they had either not used a bus system during high school or else they had no opinion about the bus system that they had used. Consequently, Table 8 is based on responses from 58.3 per cent of the riders and 61.8 per cent of the non-riders.

Chi-square = 8.88

Level of significance at 4 degrees of freedom = 0.0678

TABLE 9

FREQUENCY OF BUS SERVICE USE DURING HIGH SCHOOL
(Percentages)

	Never Used	Once A Year	Once A Month	Once A Week	Once A Day	More Frequently	Sample Size
Riders	33.1	26.0	22.0	11.9	4.0	3.1	127
Non-riders	39.5	25.0	17.1	6.6	8.0	3.8	316

Note: Chi-square = 7.44183

Level of significance at 5 degrees of freedom = 0.1898

Desired travel patterns

It is the purpose of this section to determine student travel preferences to help predict their responses to new services.

First, an attempt was made to determine when students desired to arrive and leave their classroom areas. Survey questions 20 and 21 were used to ascertain an answer to these questions.

Figure 9 indicates that 73 per cent of the students prefer to arrive at class approximately five minutes or more before the class starts. It is difficult to explain the discontinuity between six minutes and five minutes except that people tend to think in blocks of five minutes and responded to this question by approximating five minutes as a familiar value. It is probable, however, that the students would also plan their arrival time on the same basis.

Figure 10 indicates that the desire to depart after class is dismissed is almost instantaneous. Almost two-thirds of the students desire to depart within two minutes of the time class is dismissed. Figures 12 and 13 in Chapter IV also support the contention that arrival and destination times are similar for most students and produce very high peak loads during the class breaks but that ridership during class time is very low.

It would not be important when students arrived or left for class if they did not use the bus for their arrival and departure. Therefore it was necessary to determine where students go during their class breaks so that load factors could be projected. Table 10 indicates that 70.6 per cent of the riders prefer to return to their living area--which is usually a bus trip. Only 12.7 per cent wished

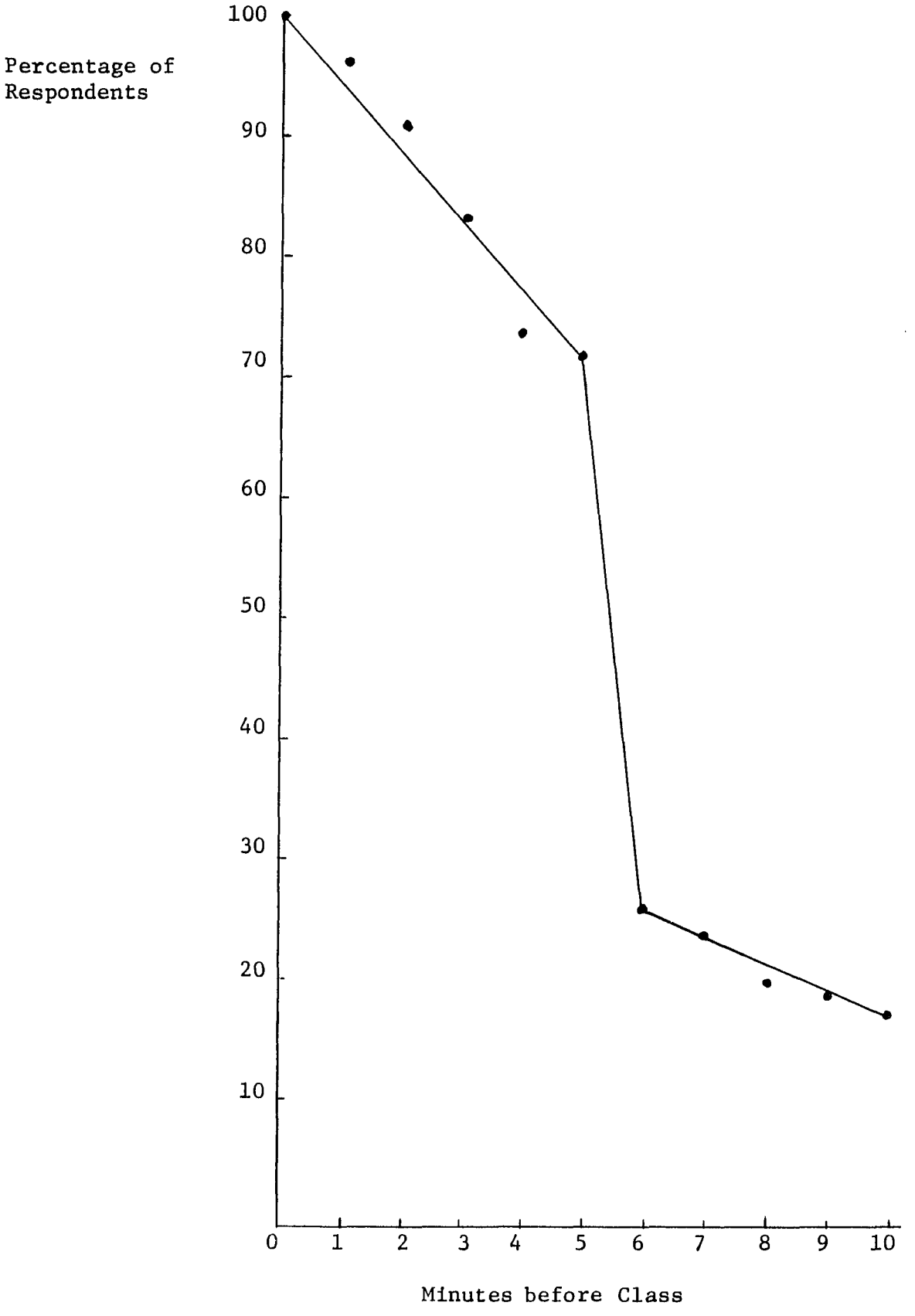

Fig. 9.--Cumulative percentage of students reporting themselves to be in class area vs. minutes before class

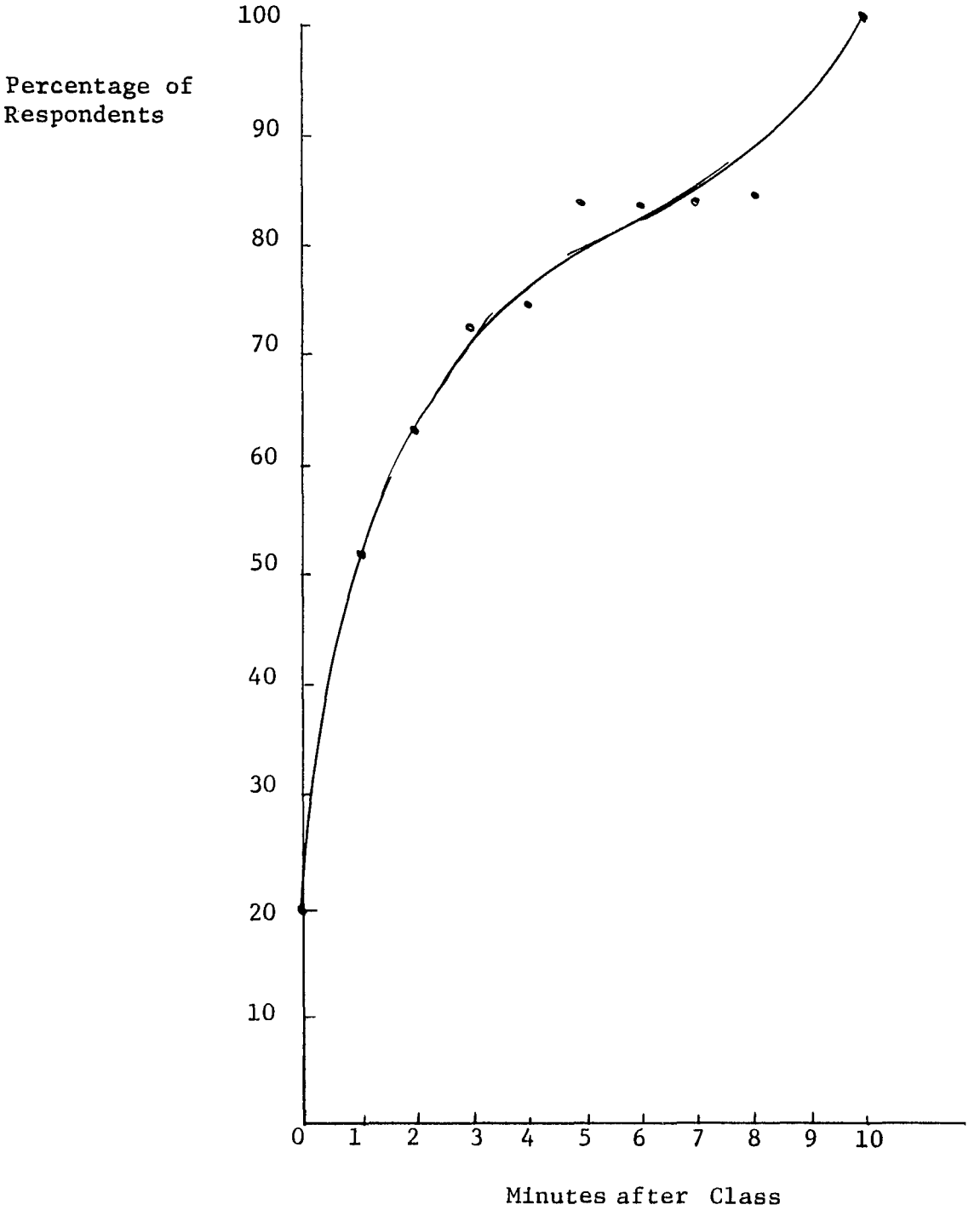

Fig. 10--Cumulative percentage of students leaving class area vs. minutes after class

to remain in the classroom area or in the department library. Since the desire to return to the living area between classes was not related to the purchase of a bus pass, this indicates that any changes in bus ridership--increases or decreases--will not change the bus load factor patterns throughout the day.

TABLE 10

DESTINATION PREFERENCE FOR BETWEEN-CLASS BREAKS OF ONE HOUR
(Percentages)

	Return to Living Area	Remain in Class Area	Go to Dept. Library	Go to Main Library	Other[a]	Sample Size
Riders	70.6	6.4	6.3	3.2	13.5	126
Non-riders	66.0	8.3	8.0	5.4	12.2	312
All Respondents	67.4	7.8	7.5	4.8	12.5	438

[a]Including the Union Building and International Center

Note: Chi-square = 2.45814

Level of significance at 5 degrees of freedom = 0.7828

It is important to realize that graduate students do tend to return home less and to go to department libraries or to their offices more than undergraduates. See Table 11. This would tend to reduce the class break load factors near the graduate facilities.

TABLE 11

DESTINATION PREFERENCE FOR BETWEEN-CLASS BREAKS OF ONE HOUR BY CLASS LEVEL
(Percentages)

Class Level	Return to Living Area	Remain in Class Area	Go to Department Library	Go to Main Library	Other[a]	Sample Size
Freshman	80.0	7.2	3.3	3.7	5.8	152
Sophomore	72.5	10.9	4.5	3.1	9.0	110
Junior	72.0	4.7	5.9	4.6	12.8	85
Senior	53.0	9.7	14.6	0.8	21.9	41
Graduate	18.4	6.1	24.4	18.5	32.6	49

[a]Including the Union Building and International Center

Note: Chi-square = 101.15

Level of significance at 16 degrees of freedom is less than 0.001

An additional factor affecting the bus load factor pattern is the locational scheduling preferences for classes. If a student makes an effort to schedule all of his classes in the same building then he will probably make use of the bus only twice a day. Such was not the case as shown in Table 12, since almost 75 per cent of the respondents indicated that they preferred to schedule classes in different buildings which necessitated additional travel effort. Since this was true for both riders and non-riders it would not affect the propensity to buy bus passes, only the number of rides per pass. This is especially interesting in light of the fact that most of the recently constructed MSU residence halls have included living-learning facilities in which classroom and office space, as well as the normal living and eating facilities, are grouped together in a single building. According to this survey only 16.5 per cent of the students prefer having all classes in the same living-learning complex.

This question makes the assumption that the students will schedule classes in harmony with their stated locational preferences. Such is not always the case since they are limited to selecting classes when and where they are offered. It is probably safe to assume, however, that if the student has a choice of two locations in which the class is offered he will choose the one which allows him to travel preceding and following class.

Table 13 indicates that even though there is a significant relationship between class and location preference with upper classmen and graduate students preferring less diversity in their class location choices, there are still 44.9 per cent of the graduate students who prefer to travel between classes.

TABLE 12

LOCATION PREFERENCE FOR CLASSES OF RIDERS AND NON-RIDERS
(Percentages)

	Sample Size	All Classes in Living Complex	All Classes in Same Building	One or Two Classes in Different Buildings	Each Class in Different Building
Riders	125	19.2	8.8	45.6	26.4
Non-riders	310	15.5	8.7	47.1	28.7
All Respondents	435	16.6	8.7	46.7	28.0

Note: Chi-square = 3.41901

Level of significance at 3 degrees of freedom = 0.3374

TABLE 13

LOCATION PREFERENCE FOR CLASSES BY CLASS STANDINGS
(Percentages)

	Sample Size	All Classes in Living Complex	All Classes in Same Building	One or Two Classes in Different Buildings	Each Class in Different Buildings
Freshman	151	20.5	2.0	47.0	30.5
Sophomore	108	17.6	3.7	42.6	36.1
Junior	85	11.8	1.1	56.5	30.6
Senior	41	17.1	17.1	46.3	19.5
Graduate	49	8.2	46.9	38.8	6.1
All Respondents	434	16.4	8.7	46.7	28.2

Note: Chi-square = 121.49

Level of significance at 12 degrees of freedom is less than 0.001

Individual relationship with the bus system

It is the purpose of this section to examine which factors the student feels are most important about the bus system and the way in which he coordinates his relationship with it.

During the pre-test phase of the survey, one statement was repeatedly made on the open-ended part of the questionnaire. Often students would single out particular bus drivers they knew by name and would indicate that these were the only drivers who provided the service they desired of the bus system. A further investigation indicated that the administration felt that these same drivers were frequently to blame for delays in meeting their schedules and that they were packing too many people into the buses. Consequently, question 36 was added to the survey (Appendix D). Table 14 provides the percentage tabulation from this question to indicate the type of service the students prefer.

TABLE 14

SERVICE PREFERENCE OF RIDERS AND NON-RIDERS
(Percentages)

	Strict Punctuality	Serve Everyone	Limit Crowding	Sample Size
Riders	16.9	68.5	14.6	124
Non-riders	33.1	55.5	11.4	308
All Respondents	28.5	59.3	12.2	432

Note: Chi-square = 11.37881

Level of significance at 2 degrees of freedom = 0.0034

As this table clearly indicates the respondents feel that strict punctuality and overcrowding are not so annoying as having the bus pull out as the student is leaving the building to catch it. This is in perfect agreement with the observed behavior of the student-preferred drivers. These drivers regularly made it a habit before pulling out to look in the doorways of each dormitory to make sure that there were no more students on the way. Also, if there were more students who could be loaded onto the bus these drivers were very vocal in joking about the crowding and in trying to increase the crowding so that everyone could be loaded. This behavior was not only observed by the writer but was also verbalized by both the drivers and the riders.

It is interesting to note that non-riders felt that punctuality was more important than those who were actually riding. This is predictable since it is normal to think of the goal of any transportation system to be punctual; however, exposure to the system appears to modify this notion.

It is interesting to note in Table 15 that punctuality was more important where the headway between the buses was slightly greater, but that the concern about crowding was virtually unchanged from 10 per cent. In the essence then the most important service criterion appears to be to serve everyone even if the bus is slightly delayed or overcrowded.

Although this study did not delve into the importance of keeping the same driver on a route, informal comments and observations tend to indicate that this does improve the attitude of the student toward the bus service. Five girls, for example, who were leading a

boycott against the bus system to try to improve service to the South Complex mentioned that one of the preferred drivers recognized them and said "Good Morning." This made a strong positive impression. Although this response was not measured it did tend to agree with Blurton's Peoria-Decatur study which indicates that their special service became in effect a large carpool and that it was "their bus." In the Peoria study the only significant complaint registered concerned the changing of drivers. It was interesting to note that 52 per cent of the survey respondents made this complaint while the next highest complaint had a frequency of only 7 per cent.[7]

TABLE 15

SERVICE PREFERENCE BY THE FREQUENCIES OF BUS SERVICE FROM LIVING AREAS (Percentages)

Frequencies	Strict Punctuality	Serve Everyone	Limit Crowding	Sample Size
15 minutes	35.6	53.6	10.8	28
7.5 - 8 minutes	30.6	57.5	11.9	160
4 minutes	25.9	61.3	12.8	243

Note: Chi-square = 1.8614

Level of significance at 4 degrees of freedom = 0.7616

[7] Mass Transportation Demonstration Projects: Ill. MTD. 3,4, p. 93.

Most people feel very apprehensive about missing the bus and arriving late at their destination. This feeling was first brought out when asking bus pass holders living in Spartan Village why they would drive their cars some days and ride the bus others. A typical response was that if they left their apartment less than five minutes before the bus was due, they would drive rather than run the risk of missing the bus. This feeling appears to be widespread among all students. Tables 16 and 17 indicate that almost 68 per cent of the students were apprehensive about missing the bus and that neither sex, marital status, or bus ridership, made any significant difference in this apprehensive feeling.

TABLE 16

ATTITUDE TOWARD MISSING THE BUS

	Apprehensive	Not Apprehensive	Sample Size
Riders	68.0	32.0	124
Non-riders	71.0	29.0	293

Note: Chi-square = 0.09668

Level of significance at 1 degree of freedom = 0.7558

There are probably two major factors which contribute to this apprehensiveness. First, people have difficulty memorizing a bus schedule since they tend to think in time blocks of five, ten, or fifteen minutes. In fact, transportation schedules are probably the only thing that they have to schedule that does not begin on the

hour or quarter hour as most meetings and appointments do. Consequently, the memorizing of a timetable is probably foreign to a person's thought pattern.

Secondly, most people do not have their watches synchronized by a common source. In fact, substantial variance between watches is not unusual, and people may simply lack confidence in the complete coordination of their timepieces with those of the bus drivers.

TABLE 17

ATTITUDE TOWARD MISSING THE BUS
BY SEX AND MARITAL STATUS

Sex and Marital Status	Apprehensive	Not Apprehensive	Sample Size
Single Males	66.1	33.9	186
Married Males	75.7	24.3	33
Females[a]	72.7	27.3	198

[a]Married and single females have been grouped together.

Note: Chi-square = 2.56051

Level of significance at 3 degrees of freedom = 0.4645

In light of these facts, it was not surprising that 62 per cent of all people felt that they should allow at least a five minute wait (see Figure 11) at the bus stop if they were going to try to meet a certain schedule. It is significant, however, that a five minute wait substantially removes the advantage of the bus system. First, it nearly doubles the length of time required to make all but

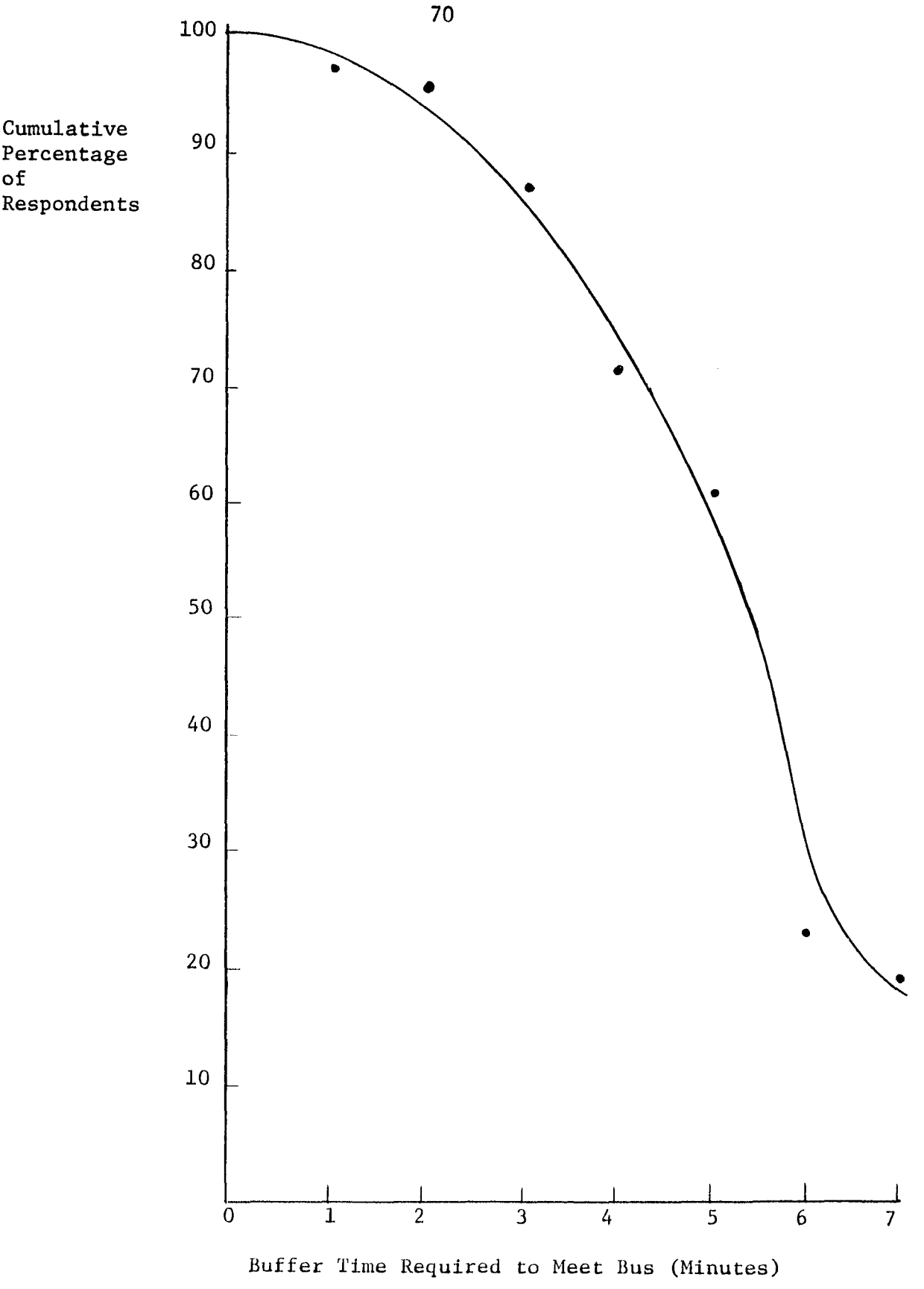

Fig. 11.--Cumulative waiting time to meet MSU Bus System

the longest trips on campus. Secondly, the five minute wait will seem especially long to the student in a hurry or to the apprehensive coed waiting for a bus at an isolated bus stop on a cold night.

It was not surprising then to find that 82 per cent of the bus riders abandoned the effort required to try to meet a given bus schedule but simply left when they were ready and took the first bus which came along. In Table 18 this behavior is labeled as "random" scheduling as opposed to the more orthodox behavior model of the individual "scheduling" of departure time.

TABLE 18

STUDENT SCHEDULING BEHAVIOR PATTERNS

	Scheduled	Random	Sample Size
Riders	18.0	82.0	126
Non-riders	31.8	68.2	226

Note:

Non-riders indicated how they thought they would schedule.

Chi-square = 14.59209

Level of significance at 2 degrees of freedom = 0.0007

Table 19 points out that the bus scheduling behavior is strongly dependent upon the headway between bus runs. It appears that the percentage of individuals going to meet a particular schedule increases very rapidly if the headway increases from eight to fifteen minutes. This is reasonable since a rational model would suggest tha

a person should shift his behavior to meeting a given timetable when the expected waiting time for random scheduling exceeds the time normally allowed in meeting a particular bus schedule.

TABLE 19

STUDENT SCHEDULING BEHAVIOR PATTERN
BY FREQUENCY OF BUS SERVICE FROM LIVING AREA

Frequencies	Scheduled	Random	Sample Size
15 minutes	76.1	23.9	21
7.5 - 8 minutes	31.5	68.5	130
4 minutes	24.5	75.5	200

Note:

Chi-square - 24.328

Level of significance at 2 degrees of freedom is less than 0.001

In this case the largest percentage of respondents felt that it was necessary to allow five minutes to meet a bus schedule. If the expected waiting time on a random basis were one-half of the headway, then ten minutes would be the point where most individuals felt it prudent to begin to meet a schedule.

Bus ridership information

This section examines the process of communication about the MSU Bus System to determine whether any particular groups are particularly effective in influencing people to ride the bus. This section will attempt to identify those opinion leaders and to determine their recommendations and whether these recommendations are followed. Survey

questions 29 through 32 were used to gather this information.

According to Table 20, 63.5 per cent of the riders and 52.5 per cent of the non-riders asked other people about the bus system before they decided to ride or not to ride. Table 21 indicates that the girls had a higher propensity to solicit information than the males by approximately 10 per cent.

TABLE 20

PERCENTAGES OF PEOPLE WHO ASKED FOR INFORMATION ABOUT MSU BUS SYSTEM

	Asked for Information	Did Not Ask for Information	Sample Size
Riders	63.5	36.5	118
Non-riders	52.5	47.5	314

Note:

Chi-square = 3.77776

Level of significance at 1 degree of freedom = 0.0519

It is interesting to learn that each group has a different opinion leader. For example, Table 22 indicates that married males consult primarily with their spouses. This tends to support the frequently voiced reason given by many of the married students for riding the bus--the need to leave the family car for the spouse. It should also be noted that a very low percentage of all students consulted their parents but rather a roommate or close acquaintance. Of course it is not known whether the student first developed a desire to ride and then asked his parents who supplied the funds and might exercise veto power.

TABLE 21

PERCENTAGES OF PEOPLE WHO REQUESTED INFORMATION ABOUT MSU BUS SYSTEM BY SEX AND MARITAL STATUS

Sex and Marital Status	Asked	Did Not Ask	Sample Size
Single Males	49.2	50.8	191
Married Males	56.4	43.6	39
Females[a]	61.7	38.3	205

[a]Married and single females have been grouped together.

Note:

Chi-square = 11.26815

Level of significance at 3 degrees of freedom = 0.0104

TABLE 22

MSU BUS SYSTEM OPINION LEADERS BY SEX AND MARITAL STATUS (Percentage)

Sex and Marital Status	Parents	Spouse	Room-mate	Close Friend	Acquaint-ance	Other	Sample Size
Single Males	5.1	0.0	28.6	45.9	12.2	8.2	98
Married Males	4.2	45.8	4.2	12.5	25.0	8.3	24
Females[a]	9.6	1.7	38.8	25.9	11.2	12.9	116

[a]Married and single females have been grouped together

Table 23 indicates that most opinion leaders recommend that others follow the choice the opinion leader himself has made. Here 80 per cent of the favorable recommendations came from riders and almost 80 per cent of the unfavorable recommendations came from non-riders. It is also obvious that people followed the recommendations given to them. For example, in Table 24, 86.8 per cent of those students stating that they received a favorable recommendation also purchased a bus pass. On the other hand, 76.4 per cent of those receiving an unfavorable recommendation did not purchase a bus pass.

TABLE 23

RIDERSHIP OF OPINION LEADERS
BY RECOMMENDATION
(Percentage)

	Opinion Leader Rides	Opinion Leader Does Not Ride	Sample Size
Favorable Recommendation	80.2	19.8	131
Unfavorable Recommendation	21.5	78.5	181

Note:

Chi-square (with Yates correction) = 102.68486

Level of significance at 1 degree of freedom = .0001

It was likewise interesting to note that the opinion leaders feel that single males should not ride but the same opinion leaders were divided on whether or not the girls and married men should ride. See Table 25.

TABLE 24

PERCENTAGES OF RIDERS AND NON-RIDERS
FOLLOWING BUS RIDERSHIP RECOMMENDATION

	Purchased Bus Pass	Did Not Purchase Bus Pass
Favorable Recommendation	86.8	23.6
Unfavorable Recommendation	13.2	76.4
Sample Size	91	233

Note:

Chi-square = 105.212

Level of significance at 1 degree of freedom is less than 0.0001

TABLE 25

TYPE OF RECOMMENDATION RECEIVED
BY SEX AND MARITAL STATUS

	Single Male	Married Male	Females[a]
Favorable Recommendation	33.3	48.1	47.1
Unfavorable Recommendation	66.7	51.9	52.9
Sample Size	138.0	27.0	159.0

[a]Married and single females have been grouped together.

Note:

Chi-square = 8.24991

Level of significance at 3 degrees of freedom = 0.0411

In summary, then, it appears that potential riders do seek out the opinions of others who generally recommend that the solicitor of information do the same thing that the advisor does. Consequently it is felt that student attitudes are fairly important in determining acceptance of the bus system.

Ranking and rating of bus service variables

Ranking.--The last step in analyzing demand for the bus system service was to determine which service variables the students felt were most important and how well the MSU Bus Service was meeting these needs.

On the survey, respondents were asked to rank eight variables according to their importance. Table 26 is a tabulation of these results.

The following points should be emphasized. First, service variables were deemed to be the most important offered by the bus system. The most important service variable was frequency of service. This agrees with the results of the bus ridership profile which indicates that the students desire and respond to a high frequency service that they can interface with on a random basis. The second most important variable was dependability. Although the question did not distinguish between exact timetable dependability and interval dependability, the writer feels that the consensus favored interval dependability. One of the major objections often voiced in the open-ended section of the survey and during the preliminary investigation was the tendency of buses to bunch up. Consequently interval integrity is a critical factor if the random scheduling approach to meeting the

TABLE 26

RANKING OF SERVICE VARIABLES
BY RIDER AND NON-RIDER

Variable	Median	Median Rank	Mode	Mode Rank
Riders				
Headway	1.927	1	1	1
Dependability	2.822	2	2	2
Coordination	3.423	3	2	3
Cost	3.984	4	3	4
Directness	4.361	5	5	5
Driver's Attitude	5.236	6	6	6
Crowding	6.008	7	7	7
Cleanliness	7.187	8	8	8
Non-Riders				
Headway	2.630	1	2	3
Cost	3.045	2	1	1
Dependability	3.553	3	1	2
Coordination	3.562	4	3	4
Directness	4.657	5	4.5	5
Driver's Attitude	5.858	6	7	7
Crowding	5.916	7	6	6
Cleanliness	7.035	8	8	8

Note: Spearman Rank Correlation Coefficients (r_s).

$r_{riders} = 1.0$

$r_{non\text{-}riders} = .905$

$r_{riders - nonriders} = .928$ for median

$r_{riders - nonriders} = .815$ for mode

bus is going to be effective. Otherwise, the deviation between expected waiting time and actual waiting time can become unacceptably large. The third factor, coordination between the bus schedule and class schedules, probably reflects the lack of coordination between night school and the night bus service and/or the coordination problem to the Spartan Village and South Complex.

The second point which should be emphasized is that so-called comfort features are not deemed to be especially important. Cleanliness was ranked as the least important variable. It is not known if cleanliness is really considered unimportant or if the buses are so well kept that cleanliness is not now considered to be a problem but might become so if the buses were not cleaned so effectively.[8] Perhaps most surprising was the low ranking of the need to eliminate crowding since the bus system is usually very crowded during fall and winter quarters. The low ranking of crowding and cleanliness is emphasized by the high relative ranking of the driver's attitude which would be expected to rank very low in a high frequency, low convenience type of service which the students appear to desire.

The third point that should be emphasized is the consistency in the rankings both within the rider and non-rider groups and between these groups. For the riders, the modal and median rankings were

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[8]From July 1, 1969, to April 30, 1970, the MSU Bus System spent approximately $29,000 on cleaning labor alone. This does not include water or power cost since they are not allocated to each department of the university. The cleaning expenditure represents over 43 per cent of the total operating expense of the bus system which includes repair labor, parts cost, fuel cost, tire costs, and other miscellaneous labor. This information is compiled monthly by the garage on its "Campus Bus System Maintenance Report."

identical. Also the wide range of the median scores, 1.937 to 7.187, indicates that the deviation in individual rankings was very small.[9] The only factor which was not consistently ranked was cost. (The cost difference will be discussed in the following paragraph under the fourth point.) The slight difference in the importance of headway and dependability between riders and non-riders was quite predictable in light of the random scheduling preferences of the riders over the non-riders. This distinction was discussed in detail in a preceding section of this chapter.

The fourth point requiring close scrutiny is cost. Among the non-riders cost was mentioned as being the most important variable more times than any other variable. It was also listed as the most important variable more often than it was given any other ranking. Consequently it is suggested that the major factor which prevents non-riders from using the bus system is its cost.

Even with the variation between the cost, frequency and dependability factors, there was still a very high correlation[10] between the

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[9]The spread of the median scores is an indicator of the consistency of the rankings among individuals. For example, if all individuals ranked headway as being most important or "1" and cleanliness as least important or "8" then the median values of the ranking would be "1" and "8" respectively. If on the other hand one-half of the individuals listed headway as most important or "1" and the other half felt it was least important or "8" then the median value would be "4." Furthermore, if they gave the opposite ranking to cleanliness then it would likewise have a value of "4."

[10]Correlation was calculated using the Spearman Rank correlation coefficient. This coefficient is defined as:

$$r_s = 1 - \frac{6 \sum_{i=1}^{N} d_i^2}{N^3 - N}$$

where N = total number of x-y rank pairs
d_i = the difference between the two ranks, that is

mode and median ranks in each group and between the riding and non-riding groups. The correlation for riders was equal to 1.0. For non-riders the correlation between the two rankings was .905. This high correlation between the median and the mode indicates, as did the spread between the median values, that there is very close agreement among all respondents in the way that they rank the eight variables.

Ratings.--In conjunction with the ranking questions the students were asked to rate the current MSU Bus System on a seven-point scale with a "1" being the best rating, "4" an average rating, and a "7" the lowest possible rating. Table 27 presents a tabulation of the results. It is interesting to note that cleanliness is rated very high. Most other factors are rated around average except for cost and crowding. Overall the system is considered to be average.

A very important observation can be made about the cost of the MSU bus pass. Cost was given an aggregate rating of 5.8 which indicates that it was felt to be excessive by virtually all respondents. This means that even those people who ranked cost low in importance felt that the bus pass cost was unreasonably high. Since cost was listed as the most important factor for non-riders this is a variable that should be of concern. Crowding, on the other hand, was felt to be great but was not deemed to be an important variable.

Since cleanliness scored so high and yet was ranked so low in importance, there is some justification for reducing the amount of cleaning that is done if a reduction in pass cost could be realized.

$x_i - y_i$. Sidney Siegel. Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill, 1956), pp. 202-213, describes this measure in detail.

TABLE 27

RATING OF MSU BUS SYSTEM

Factors	Rating[a]	Percentage[b]
Cleanliness	2.79	70.1
Attitude	3.19	63.5
Coordination	3.59	56.8
Dependability	3.84	52.7
Headway	3.87	52.3
Directness	3.91	51.5
Crowding	5.02	33.0
Cost	5.80	20.0
Overall	4.00	50.0

[a]Based on 1 being most favorable and 7 being least favorable rating.

[b]Rating converted to percentage basis with 100% being most favorable and 0% being least favorable rating.

CHAPTER IV

COST AND OPERATING CHARACTERISTICS OF THE MSU BUS SYSTEM

It is the purpose of this chapter to examine the current cost structure and operating characteristics of the MSU Bus System. This is necessary not only to determine a base from which to make decisions but also to identify those factors which most strongly affect cost or operating limitations.

Current profit levels

It was necessary first to construct a workable income statement since the existing funds flow ledger did not consider factors such as the allocation of overhead and the assessment of interest charges. In addition, the purchase reserve account was eliminated since it does not truly reflect a period expense as does depreciation or direct wages but is merely an arbitrary fund for the future purchase of new buses. Income statements were constructed for a period of five years from 1964-65 when the system was initiated through 1968-69. As can be seen in Table 28 the net profit from the bus operation has yielded a return of 8 per cent or better on gross revenue.[1] Profit as a

[1]This profit level does not include the cost of steps needed to overcome the labor problems which are covered in the latter part of this chapter. Also the direct labor cost did not include the university's contribution to the worker's social security benefits or hospitalization fund since these benefits are paid from the general university fund and are not assigned to the bus system as a cost.

TABLE 28

COMPARATIVE FINANCIAL STATEMENT OF MSU BUS SYSTEM

1964 - 1969

	1964-65	1965-66	1966-67	1967-68	1968-69
Receipts:					
Tickets	170,080.55	284,728.45	353,402.85	380,179.05	379,587.18
Charter	14,123.80	25,777.17	54,031.72	45,344.32	72,125.12
Shuttle	1,060.24	2,888.13	6,016.08	5,790.47	5,990.25
Rental		300.00		122.50	599.77
Misc. Damage		53.00	310.08		
Bus Shield Sales		10.35			
Total Receipts	185,264.59	313,757.10	413,760.73	431,436.34	458,302.32
Disbursements:					
Operating Expense	36,433.49	62,480.36	91,905.81	89,658.15	96,519.74
Overhead	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00
Labor	79,866.76	138,823.51	215,201.06	221,627.54	244,958.97
Depreciation	25,504.62	38,773.11	51,315.75	57,042.96	57,916.68
Interest	18,593.50	21,345.28	24,143.16	21,972.45	17,918.70
Total	163,398.37	264,422.26	385,565.78	393,301.10	420,314.09
Net Profit	21,866.22	49,334.84	28,194.95	38,135.24	37,988.23
Investment (prev)	52,179.99	265,621.47	304,932.63	344,902.26	313,892 14
Purchase	238,946.10	78,084.27	91,285.38	26,032.84	
Depreciation	25,504.62	38,773.11	51,315.75	57,042.96	57,910.68
Investment (net)	265,621.47	304,932.63	344,902.26	313,892.14	255,981.46
Previous Retained Earnings		21,866.22	71,201.06	99,396.01	137,531.25
Profit	21,866.22	49,334.84	28,194.95	38,135.24	37,988.23
New Retained Earnings Level	21,866.22	71,201.06	99,396.01	137,531.25	175,519.48
Profit - per cent of Revenue	11.8	15.7	6.8	8.8	8.3
Profit - per cent of Investment	8.2	16.2	8.2	12.1	14.8
Charter Contribution @ 56.5%	7,979.95	14,564.10	30,527.92	25,619.54	40,750.69
Charter as per cent of Profit	36.5	29.5	108.3	67.2	107.3
Total Charter Contribution for 64-69		119,442.20			
Total Charter Contribution as per cent of Total Profit		68.0			

percentage of investment is even higher; it was 14.8 per cent in 1968-69 and appears to be increasing each year as would be expected since the investment level is being lowered by depreciation. (Although the 1969-70 funds flow report was not complete at the time of publication, there were indications that profits might be lower for the current period.)

Source of revenue

Most of the revenue of the MSU Bus System is derived from the sale of quarterly passes with the rest coming primarily from charter operations. As shown in Table 29, charter revenue was 15.8 per cent of total receipts during the 1968-69 fiscal year but during the 1969-70 year several major charter groups were lost so the percentage will probably be substantially less for the current fiscal year. The shuttle service business is largely determined by the number of home football games and the attendance at these games since this service is offered only to people attending the football games and has not been extended to include basketball games.

Effect of charter revenue on profits

Prior to MSU's entry into the bus operation in 1964, the university operated two buses with which they offered charter service to the various academic departments on campus. This operation had not been profitable on a fully allocated cost basis. This picture has changed, however, now that the university has a regularly scheduled fleet of buses and it is explained primarily by the way in which costs are allocated. If the bus system had buses exclusively for charter operations then the entire overhead allocation must be assigned to

TABLE 29

PERCENTAGE BREAKDOWN OF FINANCIAL STATEMENT 1964-1969

	1964-65	1965-66	1966-67	1967-68	1968-69
	Receipts				
Tickets	91.8	90.75	85.4	88.1	82.7
Charter	7.6	8.20	13.1	10.5	15.8
Shuttle	.6	.92	1.5	1.4	1.4
Rental		.13			.1
Total Receipts	100.0	100.00	100.0	100.0	100.0
	Disbursements				
Disbursements	1964-65	1965-66	1966-67	1967-68	1968-69
Operating Expense	22.3	23.6	23.8	22.8	23.0
Overhead	1.8	1.1	.8	.8	.7
Labor	48.9	52.5	55.8	56.4	58.3
Depreciation	15.6	14.7	13.3	14.5	13.8
Interest	11.4	8.1	6.3	5.6	4.3
Total Disbursements	100.0	100.0	100.0	100.0	100.0

the charter operation and the present level of charter operation would not be profitable. The same would be true if additional buses had to be purchased to handle the charter overload. But such is not the case at MSU. MSU has substantial unused capacity which is not currently being scheduled. As shown in Table 31, annual hourly utilization is less than 30 per cent. Table 30 indicates that maximum utilization is during the five morning hours of winter term when 83.7 per cent of the buses are used.[2] At no other time does bus utilization exceed 75 per cent. Consequently, it is a distortion of the fact to charge depreciation to the charter operation to determine its profitability when the buses are actually purchased and used primarily for the scheduled operation. This problem is not unusual, however, for a transportation system.

To overcome the problem of allocating overhead, the concept of "contribution to overhead" is used as a measure of the benefit derived from a particular part of the business. "Contribution to overhead" is defined as the difference between revenue and variable cost. In evaluating the total operation, profit is the residual of "contribution to overhead" after all fixed charges have been accounted for. In evaluating a marginal transportation activity it is considered that the fixed charges are incurred whether the service is supplied or not; consequently, the "contribution to overhead" becomes the equivalent of profit due to the performance of the marginal activity. This is true since the overall system's profit would be reduced by the amount of the contribution of the marginal service if it were not performed.

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[2] It is not expected that 100 per cent utilization will ever be reached since good management practice will always dictate that several buses be kept in reserve in case of mechanical failure. Also buses should periodically be withdrawn from use to perform routine maintenance.

TABLE 30

UTILIZATION OF MSU BUS SYSTEM BY TERMS
1969-1970[a]

	Weekly Capacity (bus hours)	Daily Utilization (bus hours)	Service Days Per Week	Total Utilization (bus hours)	Per cent of Utilization
FALL - 25 buses (23 owned + 2 leased)					
A.M. (5 hrs.)	625	92	5	460	73.5
P.M. (6 hrs.)	750	103	5	515	68.6
Night (5 hrs.)	625	25	5	125	17.3
Weekends (16 hrs.)	800	64	2	128	16.0
Total	2,800			1,228	42.3
WINTER - 28 buses (23 owned + 5 leased)					
A.M. (5 hrs.)	700	117	5	585	83.7
P.M. (6 hrs.)	840	123	5	615	73.1
Night (5 hrs.)	700	26	5	130	18.6
Weekends (16 hrs.)	896	64	2	128	14.3
Total	3,136			1,458	46.5
SPRING - 23 buses (all owned)					
A.M. (5 hrs.)	575	67	5	335	58.3
P.M. (6 hrs.)	690	76	5	380	55.0
Night (5 hrs.)	575	23.5	5	117.5	20.4
Weekends (16 hrs.)	736	64	2	128	17.4
Total	2,576			960.5	37.2
SUMMER - 23 buses (all owned)					
A.M. (5 hrs.)	575	15	5	75	13.0
P.M. (6 hrs.)	690	18	5	90	13.0
Night (5 hrs.)	575	0	5	0	0
Weekends (16 hrs.)	736	0	2	0	0
Total	2,576			165	6.4

[a]See appendix M for bus utilization detail.

TABLE 31

YEARLY UTILIZATION OF MSU BUS SYSTEM[a]

Terms	Weeks Per Term	Weekly Use	Total Utilization	Weekly Capacity	Total Capacity
Fall	11	1,228	13,508	2,800	30,800
Winter	11	1,458	16,038	3,136	34,496
Spring	11	960.5	10,566	2,576	28,336
Summer	11	165	1,815	2,576	28,336
Break Time	8	0	0	2,576	20,608
Total			41,927		142,576
Annual Hourly Utilization					29.4%

[a]See Appendix M for bus utilization detail.

In this section the marginal charter operation was examined to see how large a contribution it made to overhead (or profit). Since the report maintained by the bus system dispatcher was on a calendar year basis rather than a fiscal year basis it was necessary to convert contributions to a fiscal year base. This was approximated by calculating an average percentage contribution figure for a three-year period.[3] For the three-year period gross charter revenues exceed the variable cost of operating the bus system by 56.5 per cent. The figures given near the bottom of Table 28 indicate the calculated charter contribution by years. The next row of values in Table 28 indicate that the charter contribution made up the major portion of the entire bus system profit. In fact over the entire five-year period the charter contribution amounted to 68 per cent of the gross system profits. Although it may not be completely correct to call the charter contribution "profit" since overhead is not allocated to the charter operation, it is true that profits would have been substantially reduced for the year if the charter service had not been offered.

It should be pointed out that an analysis was not made of the shuttle service operation since it made up such a small portion of gross revenue; however, it would be logical to assume that the same principle applies and that a major portion of the revenue generated from this service can be considered as contribution to overhead.

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[3]The average percentage of charter revenue that exceeded variable cost for the calendar years 1966-68 was calculated as follows: average percentage contribution to overhead =

$$\sum_{i=1966}^{1968} (TR_i - VC_i) / \sum_{i=1966}^{1968} TR_i$$

where TR_i = total charter revenue in year i; VC_i = variable costs for year i

Seasonality of profits

One of the most obvious factors brought out in both the section on seasonal ticket sales (see Table 4 or Figure 5) and the section on seasonality of bus utilization (see Table 30) is that the bus system is highly susceptible to seasonal demand. The effect of this seasonality is amplified even more when profits are examined.

Table 32 presents an analysis of profit by quarter for five years. The unadjusted quarterly incomes are taken directly from the funds flow statement. The adjusted income figures have been modified to reflect the 7 per cent interest charge, the overhead allocation and the reabsorption of the post-1967 purchase reserve as shown in Appendix N. These figures indicate that fall and winter terms have been consistently profitable. In 1967-68, for example, these two quarters generated $79,346 profit on a gross revenue for the same period of $312,042.45. In 1968-69 comparable quarters yielded profits of $90,190 on revenues of $328,907.34. This represents a 25.4 per cent return on sales in 1967-68 and a 27.5 per cent return in 1968-69.

The situation is entirely different for spring and summer terms when the system does not even cover variable cost of operation. For example, if fixed cost of operation is defined as the sum of depreciation, interest, and overhead then the system would lose only $20,504 a quarter if it did not operate in 1967-68 and $19,707 a quarter in 1968-69. As Table 32 plainly demonstrates, summer losses and the spring quarter 1969 loss are definitely greater. Consequently total profits for the year 1967-68 could have been improved by $13,430 or 35.5 per cent if the buses had not been operated summer term.

TABLE 32

INCOME REPORT BY QUARTER (IN DOLLARS)

	1964-65	1965-66	1966-67	1967-68	1968-69
		UNADJUSTED			
Fall	10,409.54	25,124.69	29,650.13	23,780.00	24,131.54
Winter	32,872.75	58,357.35	46,936.09	38,052.28	46,518.41
Spring	177.43	4,145.04	(3,272.98)[a]	(16,034.00)	(32,148.12)
Summer		(13,946.96)	(24,521.09)	(27,690.59)	(24,588.95)
		ADJUSTED			
Fall	5,011.17	19,038.37	22,864.34	32,536.89	33,901.86
Winter	27,474.38	52,271.03	40,150.30	46,809.17	56,288.78
Spring	(5,220.94)	(1,941.28)	(10,058.77)	(7,277.11)	(22,377.80)
Summer		(20,033.28)	(31,306.88)	(33,933.70[b])	(29,818.63[b])

[a]Brackets indicate loss.

[b]Purchase reserve transfer was not made summer quarter.

Note:

Adjustment formula and quarterly adjustment values are given in Appendix N.

Likewise profits could have been increased $12,782 or 33.6 per cent for the 1968-69 academic year if the bus system had not been in operation spring and summer terms.

The above analysis, of course, makes three very strong assumptions which need to be examined in detail. The first assumption is that the labor force can easily be shifted to physical plant the way it has been in the past. This is questionable and will be discussed in detail in the labor section of this chapter. The second assumption is that the university would be unable to lease, rent, charter, or make other income-producing use of the buses during these periods.

The third assumption is that the university is only concerned about the bus system as a funds flow generator and does not view it as an integral part of the campus service facilities. This will be discussed extensively in Chapter 5.

Nature of bus system costs

Table 29 provides a percentage breakdown of bus system costs for the first five years of operation. Pertinent points that should be noticed are as follows. First, the operating expenses which include fuel, tires, maintenance, cleaning, etc., have been held virtually constant for the entire five-year period due primarily to good operations management, the university's purchase of new buses, and discontinuance of leasing used ones. This has substantially reduced the maintenance and repair required for the fleet, but this decrease has been offset by a substantial price increase for both parts and labor. For example, mechanical labor required for repair work was previously priced at $5.00 per hour and is now charged at $6.50 per hour due to increase

in wage rates. It is questionable how much longer operating expenses will be held in line since virtually all of the equipment is relatively new, so continued economies in this area can be expected to be limited while prices are continuing to increase.

The second and perhaps the most important point to be derived from Table 29 is that the cost of drivers to operate the buses has increased substantially from 48.9 per cent in 1964-65 to 58.3 per cent in 1968-69. It should be emphasized that this is not only the major cost of operating the bus system but that it is also the only cost that is increasing percentagewise.

The fixed overhead is dropping as could be expected with the increasing cost base. Interest charges are likewise decreasing as debt is retired through the use of depreciation. Depreciation fluctuates only as the cost base varies since there have been no new purchases within the last several years.

Labor considerations

When management attempts to use a fixed labor supply to meet a highly seasonal demand within reasonable cost limits, problems develop. As can be expected the MSU Bus System is no exception in spite of the fact that every effort is made to transfer bus drivers over to the MSU building and grounds facilities during the slack season. These labor problems can be grouped into three categories: excessive overtime, labor grievances, and safety violations.

The MSU Bus Service maintains a staff of thirty-two full time drivers. During the fall and winter term these thirty-two men cannot possibly do the driving required. During the spring and

summer quarters only a part of the drivers are needed. To overcome this problem two steps are taken. First every effort is made to hire off-duty firemen or other non-college students who can drive during the fall and winter term on a part-time basis. There are a limited number of part-time people available and it is difficult to schedule duty hours and run cuts for people who have other jobs. As a consequence excessive overtime is required during the fall and winter quarters. As indicated in Table 33 the drivers averaged 470 overtime hours and many worked over 600-750 hours overtime. An average of 470 hours of overtime may not be excessive when viewed in light of a normal 2000 hour work year. When it is realized, however, that during spring quarter, summer quarter, and during the eight weeks of between-quarter breaks, there is a large excess supply of drivers, then virtually all of this overtime must occur during the fall and winter quarters[4] and it is probably greater during winter quarter. Consequently, when this 470 hours of overtime is viewed in light of the 880 hours of normally scheduled work during this period then it is seen as excessive. It seems unlikely that one individual can be an effective driver when he works 745[5] overtime hours in addition to his regular work schedule of 880 regular hours.

It is easy to understand why the men are scheduled to work so many overtime hours. In addition to the fact that the men welcome

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[4] It is necessary that some overtime be incurred during spring and summer terms to allow for scheduling problems, run cuts, etc., but there should be very little since a driver can always be shifted back from physical plant for all or part of a day.

[5] One driver in Table 33 worked a total of 745.4 hours of overtime for the calendar year 1969.

TABLE 33

BUS SYSTEM CUMULATIVE OVERTIME HOURS
FOR 1969 CALENDAR YEAR

Employee[a]	Number of Overtime Hours	Employee	Number of Overtime Hours
A	667.6	R	561.3
B	568.5	S	441.6
C	687.4	T	384.7
D	111.5	U	589.4
E	131.3	V	128.2
F	409.9	W	685.1
G	594.9	X	622.3
H	684.7	Y	517.7
I	485.5	Z	286.1
J	745.4	AA	192.7
K	628.1	BB	668.0
L	502.3	CC	540.7
M	411.5	DD	512.1
N	587.9	EE	286.6
O	401.3	FF	295.2
P	525.1	GG	223.6
Q	340.1	HH	574.4
Total	15,992.7		
Average	470.4		

[a]All employees with less than 100 hours of overtime were excluded because, without exception, they either refused to work overtime, were part-time employees, or had terminated employment with MSU.

it as a means of increasing their earnings, the bus system views it as the lowest cost alternative to the hiring of additional employees who would be needed only eleven to twenty-two weeks each year.

The second problem, labor grievances, stems from the work assignments given to the bus drivers during spring and summer terms and during the school vacation periods when they are not driving their buses. Since the bus drivers receive the same pay as general labor, they are considered as such when they are transferred to physical plant. However, if a person is hired to drive a bus and considers himself to be a bus driver he is often not happy with "just any" job assignment. Consequently there is an extensive filing of grievances about job assignments. Although there were no figures available about the amount of time lost in negotiations, meetings, etc., many hours are involved. Likewise there may be a general decline in employee morale whenever such grievances are processed.

Although there were no data available and no estimates were made, there are serious questions about how effectively the bus drivers can be used by physical plant. These problems stem primarily from three general areas. First, the scheduling of work crews is very difficult if there is always the possibility that they may be recalled by the bus system for a charter operation or some other special run. Secondly, the drivers may not be particularly adaptable to the physical plant jobs either by skill, by aptitude, or by attitude. Last, it is questionable if physical plant actually needs the additional manpower during the spring and summer quarters and during breaks. Certainly there is maintenance that can be done better during the periods when the university is operating at reduced levels, but there are also

numerous physical plant personnel released from their regular university support functions at this time. This report, however, will not attempt to delve into these areas since it is the basis for a study in itself.

The third major area of labor difficulty stems from charter assignments. If a charter run is made on short notice, especially during fall or winter quarter, it is often necessary to ask a driver to make the overnight run after working a full all-day shift as well as possible overtime. It is easy to understand the burden placed on the dispatcher who is confronted by a very limited supply of drivers who are already working excessive overtime and also the charter demands from the more influential academic community. The dispatcher also knows that the charter business yields the major portion of the system's profit and he does not want to lose it. In spite of the reasons given, it may be in violation of ICC regulations and of common regard for safety to have drivers working excessive hours, especially on charter runs where highway speeds greatly increase the danger of fatalities.

Daily demand peaks

Not only are there extensive fluctuations in seasonal demand but there are also extensive fluctuations in demand throughout the day. Students primarily use the bus system to go from their living areas to class and to return. Consequently, there are high peak usage periods just prior to the beginning of each class period on the inbound trips and just after class breaks on the outbound runs. At the other times during the day the buses frequently have very low load factors. Figures 12 and 13 are graphical presentations of the extent and predictability of the load peaks. Figure 12 indicates that there are peaks on both inbound and outbound routes. The Spartan Village route

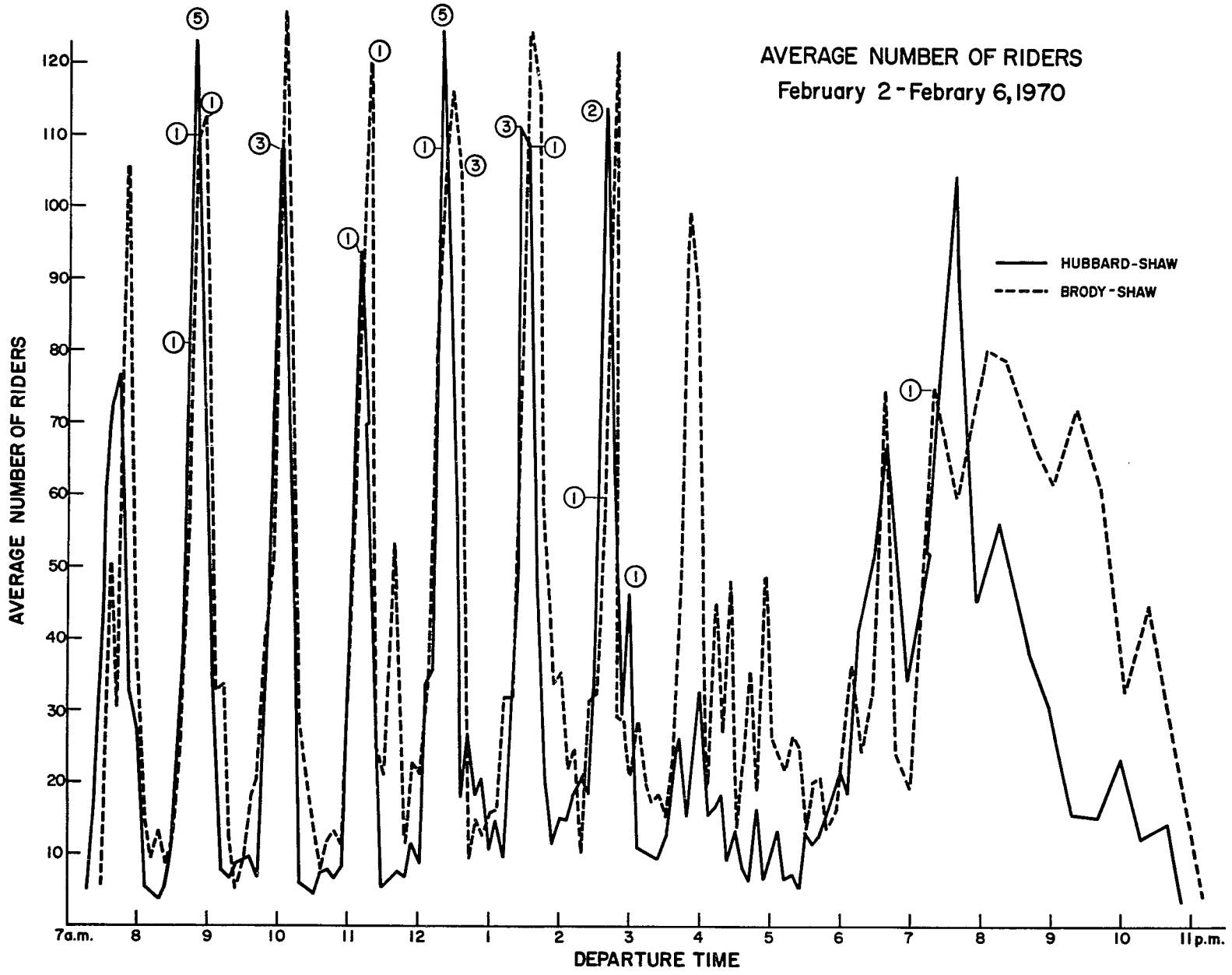

Fig. 12.--Daily ridership comparison for two inbound routes

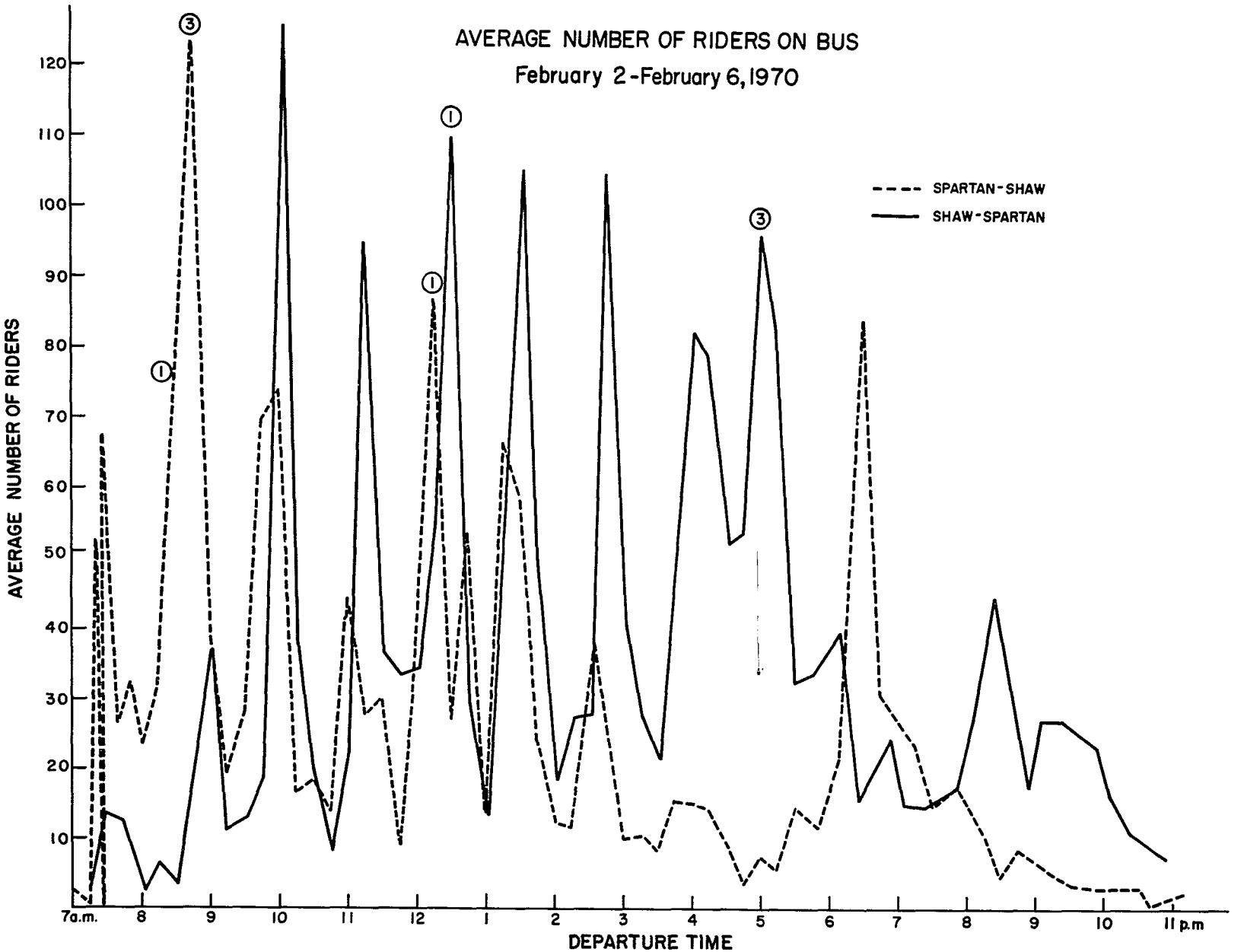

Fig. 13.--Daily ridership comparison for inbound and outbound routes

was selected since it provides a good mixture of both married students and residence hall students. Figure 13 provides a comparison of routes to two different sections of the campus along the most heavily traveled routes--to Brody and to the East Complex. It should be pointed out that these charts present the average ridership for the five-day week of February 2, 1970 to February 6, 1970 since this was felt to be representative of a typical winter quarter week. The figures in the circle represent the number of days in which that particular bus was unable to load every one that was waiting.

Operating reports

Perhaps one of the most interesting facts about the operation of the MSU Bus System was the complete lack of any goal-oriented reports which would measure its effectiveness and efficiency in meeting administrative goals. There are funds flow reports which indicate revenue and expense items for each three month period, but they are generally at least one quarter late in being compiled. The garage maintains extensive data on each bus and passenger counts on each bus run each day, but there was little evidence that this data was used for evaluating the efficiency or effectiveness of the system. In fact this lack of goal orientation was true not only in the reporting system but also among the many administrative levels responsible for the system both directly and indirectly. For these reasons an entire chapter has been devoted to an examination of the purpose of the bus system as viewed from each group concerned about it: the student rider, the operating personnel, and the college administrator.

CHAPTER V

EXAMINATION OF CURRENT GOALS AND OBJECTIVES

During the course of this study, in-depth interviews were held with the major groups involved with the MSU Bus System: those of the student body who ride the bus system, university administrators, and the operations personnel. It was obvious that each group in general as well as individuals within each group held vastly different opinions about the role, purpose and objectives of the bus system. This chapter attempts to identify the salient current attitudes of people in each of these three groups. It is hoped this will facilitate a determination of university-wide long-range goals since no organization can be effective without some unanimity in objectives among its people.

Objectives of the users of the bus system

The student is a consumer who does not feel that he is able to influence the bus system but feels that he must simply take advantage of the service offered.[1]

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[1] During spring quarter 1970 there were two groups who organized action against the MSU Bus System for the first time. The first group, led by members of the dormitory councils in the South Complex dorms, attempted to organize a boycott of bus pass sales to force the university to increase the frequency of service through the Case-Wilson area to one bus every four minutes as was then scheduled for the Brody and Fee complexes. (See Appendix P.) The boycott was largely ineffective. The second group, composed of black students from the university, formed as the results of disagreements over the enforcement of

As Chapter III indicates, students are willing to pay for a high frequency service, or at least a service which will minimize the uncertainty of trying to meet an uncertain and difficult-to-understand bus schedule. They are not particularly interested in a high-priced shuttle service within the academic community but are primarily interested in a means of commuting from remote living areas to the academic complex. The group is willing to pay a premium to ride during cold weather, and a portion is anxious to pay for protection or security in night travel.[2] The students are willing to pay for improved service but are not particularly concerned about aesthetic and comfort factors.

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pass procedures by a bus driver. As a consequence of the action of this group a code of conduct was drawn up for both drivers and riders. A copy of this code is given in Appendix O.

Perhaps one reason for the usual lack of student effort to modify bus system services is a complete lack of channels available for the processing of complaints or requests for new services. The telephone number listed in the campus directory under "bus system" is manned by the dispatcher during the day and by the garage mechanics during the night. Although the bus system manager is available from 7:30 A.M. until 3:00 P.M. he does not have the authority to make major policy decisions about changes in bus service. The mechanics who man the garage phone after the manager leaves have neither the authority nor the interest to do this. For example, when the representative of the dorm council called the garage at 7:00 P.M. to inform the appropriate channels of the proposed boycott she was answered by a mechanic and was infuriated when he did not show proper interest in her demands. As can be expected minor consumer requests for information or service changes frequently lead to an irate consumer "fed up" with the rigid unresponsive system and a bewildered mechanic unable to understand why anyone would feel that he was not performing his job adequately.

[2]In the open-ended part of the survey 42 (almost 10%) stated that to improve the bus service increased frequency of service during the evenings was necessary. They indicated that at night when they most need the security that the bus system could provide, it drastically reduced service and implemented new route patterns. One coed stated that she was extremely frightened one night when she was the

such as more cleanliness, softer seats, less crowding, etc., if it increases the cost or decreases the service levels.[3]

In general the students feel that they must take the bus system as they find it. It is part of the "establishment" (fifteen persons used this word in the open-ended part of the survey) and many students feel that since they are only here for four years they can always rearrange their class and work schedules or move to another residence area to find the best campus living and traveling combination. They have no strong sense of pride in the bus system nor do they feel that it is part of any concern about social problems or a potential experiment source for working on urban transportation problems.[4] It is only a service to be used if it meets their needs.

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only rider on the bus going to one of the residence complexes. Instead of making the normal turns on the route she expected, it headed off campus to the commuter lot which is added to the normal night-time loop.

Others stated that the twenty minute bus frequency can seem like a long wait on a cold winter night when the campus is largely quiet except for you when you are a lone girl waiting at a bus stop protected by one lonely street light and deserted academic buildings.

[3]This is consistent with the practice of eliminating one line of seats (three instead of four across) at Kent State University since this practice allows more comfort when load factors are low but greatly increases the maximum number of standing riders who can be loaded onto a bus during peak periods.

[4]The author should note that since he has been working on this bus project--from April 1970 to August 1970--no less than seven individuals contacted him about the advisability of using the campus bus system as a research subject for new ideas in urban planning, pollution control, and in ecological sciences. There definitely appears to be a renewed interest in bus transportation research. It should be mentioned, on the other hand, that twenty-three of the people (over 5 per cent) surveyed indicated that the bus system was a major source of pollution on the university campus and many of these felt that for this reason the bus system should be eliminated. These responses were on the open-ended part of the survey.

They feel that the cost of the service is very high and that if the administration were being "fair" the cost would not be so high; therefore, they have no compunction about sharing passes even though the pass states emphatically that it is non-negotiable and that it is not to be used by other riders. In the in-depth surveys not a single student denied having shared passes or having friends who shared passes. (It is virtually impossible for the bus drivers to control this type of sharing since the drivers do not have time for extensive checking of the student's identification and verifying it with his bus pass.[5])

In summary then, the student is a very cost-conscious customer who has a need and wants it filled at the lowest possible price, but does not feel that it is his role to have to force the system to be more receptive to his needs.

Objectives of the administration

The second group involved with the MSU Bus System is composed of the administrators directly responsible for its operation and for

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[5]As an interesting sidelight the passes returned winter quarter, 1970 had some very original names, addresses and student numbers. One student indicated that his name was "King Richard the Lion Hearted" and that his address was "Camelot Castle." In the space marked "student number" he stated "I am Number 1." Many passes had two or more names and student numbers on them. Virtually all of the unreadable ones had no name or address on them. In addition many appeared to have been bleached white when they were washed with the students' loads of wash. But still all of these tickets were accepted by the bus drivers as well as the desk clerks who accepted the fall term passes for the $6.00 discount on the winter pass.

In light of the difficulty incurred by the bus system in checking passes and the protest raised by a group of black students during spring quarter, 1970, the new bus passes printed for fall term, 1970 no longer have the non-negotiable clause printed on them and have become simply a bearer instrument. The results of this move are not yet known.

the formulation of operating goals. To understand the basis upon which these goals have been formulated it is first necessary to review the original mandate given to the bus system when it was introduced in 1964. As indicated in Chapter I the bus system was organized in response to the recommendation of a special ad hoc Faculty-Student Motor Vehicle Committee. This committee was not called to develop a bus system nor to develop a campus-wide transportation system but only to find some method of solving current parking and traffic problems. As would normally be expected, the committee made numerous recommendations for restricting the use of automobiles on campus and of determining who should be allowed driving privileges. The committee recommended the bus system only as a means to this end. See Appendix I for its list of recommendations. In view of the fact that these recommendations were never further developed, it is easy to understand why those responsible for implementing the bus system did not view it as a constructive, cohesive service which provided support and flexibility to other functions of the university but only as a service required to eliminate traffic problems.

When the bus manager was hired he was instructed to provide the service required but was strongly admonished not to do any "empire building." This attitude was reinforced by making the bus service merely an adjunct to the university motor pool operation and by giving the bus system manager the title "General Foreman--Automotive Services." Consequently, the bus system operation is viewed by the campus administration as part of the motor pool operation where the only major decision that needs to be made revolves around the purchase of vehicles.

The administrative goals for the bus system have never been explicitly formulated except for the very brief statement included in the committee's report. See Appendix A. The omission of formal bus system goals has clouded the positive aspects of the bus operation, particularly in three general areas:

1. constraints on the size and growth of the system
2. reduction of administrative problems
3. avoidance of conflicts with the private sector.

Constraints on the size and growth of the system.--Since the bus system is viewed only as a required support service, then only that service which is absolutely required should be provided. Just as any administration is anxious to reduce overhead expenses, so the university administrators are careful to maintain control over the bus system to prevent any "empire building" or unrequired growth.

One administrator stated that he wished that the bus service could be eliminated. His justification for this was that the cost of operation was rising so rapidly that he felt eventually the system would no longer be breaking even. In addition he felt that the service was not needed. He indicated that the physically handicapped did not need it since they had special driving and parking permits. He went on to say that most of the students do not need it since they can either live near the academic area or take classes in the living-learning complexes and besides he felt that it is not difficult to

walk anywhere on campus and the exercise would be beneficial.

There was a strong consensus among the administrators interviewed that they were not interested in ways to increase bus ridership but would appreciate learning of ways to decrease ridership. In fact, the $20.00 winter-term-only pass was implemented as a means of curtailing winter ridership peaks so that the number of buses would not have to be increased to handle the winter overload. One administrator stated his position very succinctly: "We are not in the bus business unless it is absolutely required to facilitate the educational and research process."

Reduction of administrative problems.--Another reason frequently given for constraining the size of the bus system is the desire to eliminate administrative difficulties. For example, the street design in the academic area is not conducive to good traffic flow. Several administrators feel that if the buses could be removed from Circle Drive, congestion would be reduced and "essential" traffic could flow more smoothly.

A second administrative problem is the frequently voiced objection to the noise and pollution created by the buses. In fact, twenty-three students (over 5 per cent) on this survey responded that noise and pollution were sufficient cause to eliminate the bus system. This number was especially high for an open-ended question.

A third area that presented administrative difficulties is the seasonal labor problem discussed in Chapter IV. It is reasoned that any expansion of the bus system would further increase the problems involved with drivers during the spring and summer. Likewise, a decrease in service would reduce these problems.

The fourth area of administrative concern is the increasing number of complaints from riders. Several of these problems were mentioned under the preceding section on student goals for the system. In general, however, they stem from the enforcement of the use of the bus pass and complaints about service, i.e., bunching of buses, inadequate headways, etc. During fall term 1969 there was also the problem of refunding part of the cost of tickets due to the days that the bus drivers were out on strike. Although all these issues are part of a normal customer service program, they are somewhat resented if they are visualized as part of an unnecessary service.

A final administrative consideration is the level of investment required for the purchase of rolling stock. It is easy for an administrator to view the bus system as an unnecessary user of funds which are obtained at the expense of the academic and research functions. Consequently there is still further reluctance to expand the bus system or to consider additional services.

Avoidance of conflicts with the private sector.--The third objective of the bus system policy is the minimization of conflicts with privately owned bus services. Even now there are private bus systems which would like to handle the university's charter runs, and the administration is particularly concerned about competition with private carriers. During

the 1969-70 school year, for example, the developers of one of the new apartment developments contacted the MSU Bus System to request service to the apartment complex since most of its residents are students. The university flatly rejected any interest whatsoever in providing the service since they were not given this authority in their original mandate. Since the university would not provide this service the developer has begun its own bus service with a school bus type of vehicle. During summer term 1970, the first quarter the system was in operation, nine round trips were scheduled each school day. See Appendix Q for a copy of the schedule. The charge for this service is twenty cents per ride.

This example is not presented, however, to prove that there is a demand but to show that the administration's concern about avoiding competition with the private section is much greater than it need be. In this case the administration was intent on avoiding competition with the Lansing Metro Lines[6] or private taxi fleets as well as holding down on the growth of the MSU system. The Lansing Metro Lines, however, has very definite flow routes that are primarily radial into the central business district of Lansing. The routes taken by students commuting from their residences to campus are usually perpendicular to those of the existing bus lines. Furthermore, the Lansing Metro Lines which has been servicing the Lansing metropolitan area is not anxious to expand service since they have been losing money on existing operations. In fact, the City of Lansing

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[6]The Lansing Suburban Lines became the Lansing Metro Lines after it was taken over by the City of Lansing during Spring 1970.

found it necessary to buy out the Lines in spring 1970 to prevent a complete collapse of the bus transit system.

Likewise the taxi is not a viable alternative for the off-campus student because of the high cost of commuting via this mode. Consequently, there is a complete lack of alternatives for commuting off-campus students. In effect, the private sector for transportation does not exist for the student.

Furthermore, the administration's fear that it will compete with the private sector is not a valid concern. There is, in fact, little chance that anyone will be willing to provide this service except perhaps as a necessary adjunct to another service as in the case of the apartment complex that felt it must provide transportation to attract students to its apartments. George Smerk sums up the probability of an entrepreneur coming forth to offer the service quite well.

> It is difficult, or impossible, to operate mass transportation as profit making, private enterprise in the United States today. In cities already enjoying transit service, its mere continuation, much less improvement, requires public action and public funds. In cities without transit, it is rare, indeed, today for an entrepreneur to come forward to offer service.[7]

The competition between the public and private sector does arise in another area but is viewed differently. The university has a very large investment in dormitories but has been having difficulty with low occupancy rates due to the large number of apartments built

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[7]George M. Smerk, Working Draft of Report on Department of Transportation Project Number IND-MTD-1, Chapter 2. (mimeographed.)

by the private sector. Although the reasons for the migration toward off-campus living will not be discussed in this paper it is important to point out that the administration is concerned that improved off-campus bus service might further lower the dormitory occupancy rate. On the other hand it might be argued that improved off-campus transportation enabling students to go to local shopping centers and stores would mitigate the off-campus advantage. This issue was not researched in this study but should be the subject of further consideration if the university wishes to protect its housing investment against competition from the private sector.

In summary then, the university administrators in charge of the campus bus system tend to view it as a service they are required to provide but see little value to any more than a minimal system. They have made little effort to incorporate transit system planning into the very sophisticated long-range university design. Although there have been several class projects investigating operational aspects of the bus system, this study is the first project looking at the role of the transit system in the university. As of the present time there has been virtually no effort made to encourage the involvement of the various academic departments in research projects using the campus bus system.

Objectives of the operating personnel

Operating personnel have very little to do with overall systems goals or policy making, but they strongly reflect to the customer their perception of the administration's goals. They receive a given

level of equipment and they are instructed as to what level of service should be provided.

One attitude was frequently voiced during interviews with the operations people. They stated that they were to provide a campus-wide level of service and that they were to be careful not to "cater" to individual student's needs. The writer personally felt that this was a reflection of the attitude of providing the service necessary so that driving and parking could be restricted but of not trying to expand the service. This feeling was manifested even more strongly in the attitude of supervisors toward drivers whom the students felt most effective. As mentioned in Chapter III, the students were impressed with two or three drivers whom they felt provided the best service; that is, they felt that these drivers did not leave behind those running to meet the bus nor would they leave if they could "pack on" a few more riders so that all of those waiting could board. The supervisors of operating personnel, however, felt that these same drivers were some of their less effective drivers since they were often slightly delayed by following this procedure.

Primarily the operating personnel feel that it is their responsibility to be professional and to provide a professional service: they are hired to do a job, including meeting published schedule committments and using clean buses that are in good repair. The drivers are to make sure that passes are checked, safety rules are observed, and that their uniforms are neat and clean. However, they feel that they are not hired to define system goals, and they know

they do not really have the authority to do this. Thus, complaints and requests for service changes outside the scope of their authority are very frustrating to operations personnel. Confused, they can only view these as a criticism of their "professionalism," yet somehow whether the driver was courteous, safety rules were obeyed, etc., does not seem to be at the root of the problem. Consequently, student requests for changes made directly to operations personnel are frequently misunderstood.

The final goal or responsibility as viewed by operating personnel is control over maintenance and repair costs of the bus fleet. This they have done very effectively and they have been able to maintain a very stable repair cost in spite of inflation. This point was discussed in detail in Chapter IV. As could be expected one of the prime reasons for purchasing new buses according to this group is to reduce maintenance costs.

Changes required before goals can be integrated

Any complaint that can be made against the MSU Bus System stems from the fact that there seem to be no overall goals for it which consider the needs of the university as a whole. But before the university needs can be considered and an overall set of goals can be determined, there are five obstacles that need to be overcome.

The first obstacle to be overcome is the lack of a feedback system to measure the effectiveness of the bus system in meeting consumer needs. In the private sector the firm generally views its goal as increasing profits and realizes that its profits are largely determined by its ability to tailor its services to its

customer's needs. Consequently, the private firm can closely check its daily revenue to see how well it is doing. However, the non-profit setting of the university plus the desire not to provide any more support service than necessary virtually eliminates any effective feedback system that would reflect the needs of the bus riders and potential riders.

The second obstacle which needs to be overcome is the low status of the bus service in the eyes of university personnel. If the bus service were a high-status service such as the computer center or the placement center, then there would be numerous committees appointed to continually evaluate the service and make necessary changes; or if the bus service required a very high capital outlay and experienced severe competitive pressures from the private sector as does the campus food service and residence halls, then extensive administrative effort would be exerted on market research to protect the market share. However, such is not the case and the bus system is left without any form of market research or an effective basis for the reevaluation of goals.

The third obstacle which needs to be overcome is the feeling that the bus system is of little importance and serves only a small part of the student body. It should be remembered, however, that the campus bus system has more contact with the students than either the computer center or the placement center. Bus riders use the bus system more frequently (approximately six rides per day) than they patronize the campus food service. Also the bus system is heavily used in those areas where it provides a needed service. For example, in the more remote dorms almost 75 per cent of all

dormitory residents purchase bus passes. These statements are not made to detract from other services but only to indicate the importance of the bus system in the lives of a large number of students.

The attitude that the bus system lacks importance is further amplified by the university's organizational structure. The bus system is administered by the Physical Plant group which is charged with the maintenance of non-student oriented services. Furthermore, the bus system is placed directly under the "General Foreman--Automotive Services" whose main responsibility is the maintenance of vehicles on campus. There is, in fact, no organizational structure to maintain communication between the student and his transportation. On the other hand, the student-oriented residence services are administered by an extensive system of area managers, hall managers, and resident assistants. The resident assistants, for instance, are never more than one floor away from the student's rooms. These resident assistants are given extensive orientation to answer virtually any question the students may have about university services. In case the resident assistant cannot provide an answer or solve a grievance, there is a well-defined line of authority which is very willing to handle suggestions and grievances, or to supply information. In addition there are dorm councils with elected members who provide information and suggestions to the dorm managers who are required to be at each meeting. In contrast, the writer discovered in interviews with resident assistants, dorm managers, dorm council members, and area managers that nothing about the bus system was known except that bus tickets could be purchased at the dorm desk, schedules could

be obtained from the drivers and the bus system's phone number was 353-5280. They knew of no grievance or suggestion channel other than to call the garage. This was amazing in light of the 35,000 to 40,000 rides per day provided by the bus service. But it is completely understandable if the service is considered to be only a required overhead function.

The fourth obstacle which needs to be overcome is the general feeling that the bus system makes no positive contribution to the university but is only a not-too-satisfactory solution to an annoying parking and traffic problem. This perspective needs to be changed. It should be remembered that the traffic and parking problems were caused by the increase in the size and design of the campus. Consequently, it is the bus system which makes the current campus design, size, and scheduling patterns possible. If the university chooses a particular design pattern, in this case a large geographical scale, then it must consider the movement patterns that will be created and plan accordingly. If it plans for automobile movement then it must provide adequate parking and street facilities. If on the other hand, a limit is placed on the street and parking facilities, then bus lanes and loading areas need to be integrated into the campus plans.[8]

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[8]It is frequently felt that the location and size of buildings are effective means of predicting traffic flows. On a university campus, however, traffic flows are also dependent upon how the buildings are used. Since building use is largely determined by class schedules, the scheduling of classes becomes a major determinant of campus traffic flows. For example, by shifting room assignments for several of the larger, more popular classes from one side of campus to the other the classroom scheduler can change travel patterns drastically.

Furthermore, the freedom of movement of students around the campus is important to the educational process of the university. Students need easy access to all the facilities and opportunities the large campus affords, and the bus system is in effect the circulatory system of the university. Students not only need to be able to somehow get from class to class but also to have the freedom of feeling that they are able to move within their environment. The trapped feeling expressed by so many of the students without cars might very well be the reflection of a lack of a recognition by the bus system of its true role as a giver of freedom of movement. It should also be pointed out that the main strength of the large university is the potential interaction among all students, departments, colleges, and faculty members as well as the widespread use of specialized facilities which can economically be offered only at a centralized location. The actual realization of these benefits, however, is largely dependent upon effective and convenient campus transportation.[9]

The fifth obstacle which needs to be overcome is the general feeling that the bus is not important enough to require administrative attention and should be managed at the operating level. This attitude manifests itself in two ways. First, operating personnel simply assume that the operating goals have not changed from the original 1964 mandate given in the report of the ad hoc Faculty-Student Motor

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[9]The students' strong desire to travel around the campus was revealed in Chapter III. For example, Table 10 indicates that approximately 80 per cent of all students prefer to travel between classes. Table 12 indicates that almost 75 per cent of all students prefer to have classes in various buildings and only 16.5 per cent desire to schedule all their classes in the living-learning complexes.

Vehicle Committee. Consequently, they feel that there will be no goal changes until a crisis obtains administrative attention. Such a crisis will probably be either a large operating deficit or strong consumer resentment as manifested by the two student groups this spring. Second, since the operating personnel do not have the authority, research facilities, prestige, or perspective to set university goals, they feel that they must concentrate on daily operating goals. These daily operating goals consist of meeting the published schedule, checking for bus passes, maintaining their personal appearance, maintaining bus cleanliness, etc., whether these goals are relevant to the riders or not.

However, the administration must realize that goal making is not a function that they can delegate to the operating personnel. The delegation of the goal making responsibility in this manner is the equivalent of abdication since the operating personnel do not have the resources to integrate bus system goals with university goals.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The observations made during the course of this study lead the writer to several conclusions:

1. The MSU Bus System is now providing a very valuable service to the on-campus students who live in the more remote dormitory complexes. This is indicated by the fact that approximately 50 per cent of the male students and 75 per cent of the female students in the remote dormitories purchased bus passes spring quarter, 1970. (See Figures 1 and 2.)
2. The MSU Bus System does not provide an effective service to the faculty and staff at the university even though they are allowed to ride at no charge. This is substantiated by the fact that fewer than 100 faculty and staff members ride the bus each day. (See Table K-3.)
3. There is a lack of any means for maintaining the sensitivity of the bus system to student travel needs. (See pages 116-117.) This is indicated by such factors as the dissonance between riders and managers as to desired driver behavior, the management's instructions not to "cater" to riders, the student boycott, the black student protest, and the complete

absence of channels of communication between the riders and the management of the bus system.

4. Two variables, total weekly travel distance and distance between the individual's living area and the center of campus, explained over 10 per cent of the total variance in ridership. (See pages 30-34.) This would tend to indicate that the major service the bus system has to offer is to provide transportation between a student's residence area and the academic complex. Although the data were limited to on-campus students, it is felt a priori that off-campus students would not have radically different travel needs from on-campus students merely because they live within different political boundaries and travel in a different direction. This extrapolation, however, needs to be researched.
5. Although the ad hoc Faculty-Student Motor Vehicle Committee recommended that bus service be made available to all students (see item 8, Appendix A), current university policy excludes approximately 47 per cent of all MSU students because they do not live in on-campus housing facilities. Although they are allowed to purchase bus passes, off-campus students do not have the same service available that on-campus students do.
6. The university has very low over all utilization of its rolling stock and its drivers. This is indicated by the low load factors between classes (see Figures 12 and 13) and during spring and summer quarters, by the low utilization of

equipment (Table 31 indicates an annual usage rate of 29.4 per cent with never more than 75 per cent of the buses scheduled for service except during the morning of winter quarter), and by the excessive overtime paid bus drivers during 22 weeks of the year and the intra-university transfers during 19 to 30 weeks of the year. (See Table 33 and pages 94-98.)

7. It is unlikely that the bus system can remain self-supporting under its present mode of operation. This is substantiated by the data in Chapters III and IV which indicated that a) student ridership is no longer increasing, b) revenue cannot be expected to increase through further price increases, c) operating costs can no longer be substantially decreased by the purchase of new equipment, d) labor costs now comprise 58.3 per cent of total operating costs and have increased from 48.9 per cent in 1964-65. These facts would lead the writer to conclude that the MSU Bus System is entering the spiral of increasing costs and decreasing revenue and service.
8. The university has established specific policies which prohibit any operating economies which might accrue from a larger operating base. These policies include prohibiting city transit and private bus systems from providing the service, and the policy of on-campus service only which precludes increasing utilization and load factors by servicing new off-campus markets.
9. The university is not integrating the bus system into the

design and planning of the university nor in the criteria for the scheduling of classroom space. (See pages 117 and 118.)

Recommendations for operating changes

The following operating recommendations are based on data obtained from this study.

First, the bus system is providing a good service to the majority of the on-campus students. There are, however, several areas on campus that would probably yield a substantial increase in ridership if the frequency of service were increased. These are the Brody complex which now has an 8-minute headway and the Case-Wilson complex with a 7 1/2-minute headway. By using the "b" value of 29.88 given in Chapter III (see above, p. 30), ridership can be projected to increase by approximately 760 people in the Brody complex and 1275 in the Case-Wilson complex if service were increased to 4-minute headways instead of the current 7 1/2- and 8-minute intervals. This would appear to justify the scheduling of additional buses to each of these areas. It is doubtful, however, that a reduced headway could be justified in the Spartan Village or University Village complexes since the student population in these two areas is relatively low and many of these are graduate students who have permits to drive and park on campus.

In the other residential areas where the headways have already been reduced to 4-minute intervals, it is doubtful that many more students could be induced to ride at the current fare levels. This is emphasized by the fact that over 70 per cent of the female students and 50 per cent of the male students in the more remote dorms are

already riding. Although the propensity to ride drops rapidly in the dorms which are closer to the campus center, it is questionable if the bus service can or should attempt to encourage these residents to use its service unless the cost of the service could be substantially reduced. Increased frequency in the Brody and Case-Wilson dormitory areas should, however, generate enough revenue to pay for the cost of the service, especially when it is considered that buses and drivers are already available.

The second recommendation suggests that the university should develop channels for improved contact with the university community which uses the bus. There are many ways in which the channels could be developed. The minimum responsibility of these channels should include the conducting of periodic research into student travel needs, the receiving and handling of all grievances, suggestions and requests for bus service, and educating the dorm managers, resident assistants and the student body in general about the services and policies of the campus bus system. The major purpose in developing a channel for improved contact with the riders is to increase the over all effectiveness of the service which is being supplied.

The third recommendation is that the university should take steps to obtain part time employees to work in the part time job of bus driver. It is extremely expensive to pay bus drivers overtime to work an average of 61 hours per week during fall and winter quarters and then let them stand idle or shift them to physical plant where the need for additional employees is open to question. Consequently, it is strongly recommended that the university begin to view and define

many of the current driving hours as a part time or temporary employment need so that students, off-duty firemen, or other seasonal or temporary employees could be engaged to handle those peak hour needs. This should do much to lower the cost of providing the current level of service.

The fourth recommendation is that the university take strong steps to integrate the bus system into the planning and design of the university campus and in the scheduling of academic classrooms. This would include the designating of bus lanes and all-weather loading areas near each of the major residence and academic areas rather than the current practice of locating bus stops on streets where they will not "interfere with traffic" but may be far from the student's origin/destination. It would also include the scheduling of classroom areas and starting times so that bus capacity and routes are coordinated to the riders' actual travel needs. This proposal should provide greater design flexibility and over all university effectiveness as well as opening up areas of increased efficiency as cost tradeoffs between campus design, classroom scheduling, student travel needs and available bus service are identified.

Policy considerations

This study has brought to light many areas which demand further research, but the direction for this research and a means for evaluating it can be determined only when the role and purpose of the bus system is clearly visualized. Since goals for the system at the present appear to be widely divergent, the rest of this chapter will present some of the goals various campus groups prescribe for the bus

service and will indicate the direction future research would take if that particular goal were ascribed to.

One group feels that the purpose of the bus system should be to provide a transportation alternative so that the regulation of traffic and parking on campus is feasible. This group would define the mission of the bus system as the minimization of cost and service as long as traffic and parking can be restricted to a reasonable level without undue complaint from the university community. If this policy were established, then future research should be directed to determining reasonable levels of congestion, cost of alternative parking facilities, and the acceptance of the bus system by each group on campus. This objective would support efforts to reduce the number of buses to the point that the campus community would begin to complain about having to walk and the low frequency of bus service.

The second group explains that the State of Michigan gives the university the authority to establish and operate an on-campus transportation system to serve the main purpose of the university as an institution. This position would grant the administration the responsibility of using the bus system to serve whatever travel needs they saw whether they be to facilitate remote parking, to relieve congestion, or to transport a team to an event at an out-of-state college. This group would further state that the university should maintain ownership and control over the bys system so that it can control the availability and response of the bus system to its needs. If this position is accepted, then effective management would be defined as the ability of the bus system to shift as much of the cost of the

operation of the bus system as possible onto the users of the system so that the buses could become self-supporting if at all possible. The backers of this policy would encourage research into means of maintaining the self-supporting nature of the bus system. For example, they might consider taxing each of the students each quarter so that the revenues and demand for bus service might be stabilized. This position might be called the institutionally-oriented approach.

The third position might be called the consumer-oriented approach. This group would indicate that the purpose of the bus system should be to serve the travel needs of the individual student and faculty members at the university. Effective management should be judged then on how effectively the bus system is tailored to the needs of the university population. These people would say further that the bus system should be used to furnish transportation whenever and wherever it is needed as long as the riders are willing to pay their share of the cost. All students, this group would reason, should be served whether they live on campus or in off-campus apartment buildings, sororities or fraternities. The prime objective, then, is to provide the bus system management with a strong consumer orientation that will aggressively promote and operate the system to provide service at the lowest possible cost. By providing many and varied services such as occasional runs to shopping centers, charter operation for professional sporting events, spring break excursions, etc., they would largely eliminate the need for the student having to own a car. Proponents of this goal-orientation would justify these trips as being within the operating authority of the campus bus system since the goal of the system would be to expand

the broad educational, recreational and vocational options available to the people the bus system was established to serve. By the efficient management of the bus system, the individual cost of this service can be decreased through increased utilization and load factors.

If this view is accepted, research would be directed toward consumer-oriented research to determine what type of regular and charter service would be desired by a reasonable number of students. For example, the bus system might consider initiating runs to off-campus shopping centers where commuting students could board. Definitely the bus service would consider the needs of the off-campus students. For example, research could be done into the possibility of having buses extend their routes to off-campus locations instead of the current practice of retracing their routes during class when the load factors are low. (See Figures 12 and 13.)

The fourth point of view might be called the economic efficiency approach. The proponents of this point of view would indicate that the bus system is actually a state-supported transportation. It should thus have as its objectives the efficiency and effectiveness of total government expenditures. Consequently, when not serving its prime role, the providing of transportation for the university community, the bus service should be made available to other government agencies or functions such as the state legislature, the 4-H Clubs, National Guard groups, or the State Police organization. This attitude stems primarily from the feeling that it is not logical to tie up public funds to duplicate transportation equipment when each agency or political unit has such seasonal demands and often, unused capacity. In

fact, some members of this group would go so far as to say that if there is still excess capacity available after serving the needs of the university and the state, then the buses should be used to serve the needs of various public groups such as the churches, the Boy Scouts, Boys Clubs, Community Action Centers, etc. The advocate of total economic efficiency would also state that if operating economies could be obtained from combining the Lansing Metro Lines, the MSU Bus System, and the State of Michigan motor pool, it would be wasteful to let political or agency jurisdiction prevent over all economic public benefit. They might also suggest that if these agencies could not cooperate then perhaps economic efficiency could be improved by turning ownership over to a private group which might be able to implement operating economies and allocation of service among the agencies.

As a brief sketch of these views indicates, the goals discerned by each group are not sharply delineated nor mutually exclusive. The final policy developed by MSU will undoubtedly take each of these positions into consideration. In fact, the resulting policy will probably not be based on such all-encompassing principles as stated in these points of view. However, the wide divergence of present goals does tend to indicate that the university will have some very basic questions to answer:

1. What is the purpose of the bus system?
2. Whom should the bus system serve?
3. Is it desirable that off-campus students be denied the service which is most desired by on-campus students,

i.e., transportation from living area to the academic complex?

4. Is it desirable for the university to continue to maintain an exclusive university bus system which has a low utilization of buses and drivers?
5. How much emphasis should be given to meeting the travel needs of the university population which are only obliquely related to the daily instructional process of the university?

When the university has defined its goals for the campus transit system, then the direction for further research will be established.

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APPENDICES

APPENDIX A

FINAL REPORT OF AD-HOC FACULTY-STUDENT MOTOR VEHICLE COMMITTEE

MICHIGAN STATE UNIVERSITY East Lansing 48823

Department of Botany and Plant Pathology

February 14, 1964

Mr. Starr H. Keesler
Assistant Secretary
317 Administration Building
Campus

Dear Mr. Keesler:

This is a summary of the recommendations of the Faculty-Student Motor Vehicle Committee which you requested concerning matters affecting future student driving and parking at Michigan State University. It reiterates the points I discussed with you personally a week ago.

1. The concept of dividing students into commuter and resident groups is sound. Residents and commuters should be prohibited from driving on the campus during business hours. Commuters only should have access to one or more perimeter parking lots.

2. The resident group should include all campus residents, including those of Spartan and University Villages, and most of East Lansing.

3. A commuter parking lot should be constructed on South Campus off Farm Lane, preferably just north of the Grand Truck tracks to avoid this hazard and the delays it might impose. If this is not possible, a location somewhere north of the C & O tracks is suggested.

4. Another commuter parking lot near the Kalamazoo Street entrance would facilitate entry to the campus from the west, and would reduce problems at the railroad tracks on Farm Lane. A third lot on the eastern perimeter of the campus would be desirable if space permits.

5. All existing student parking lots on South Campus, except storage lots for dormitory residents, should be removed from student use in the Fall, 1964.

6. It is immaterial to this committee whether the student lot serving the dormitory complex on East Campus is north or south of the Grand Trunk tracks. A location south of the tracks creats (sic) obvious safety problems, however.

7. Satisfactory bus service on the campus requires that the University control numbers of buses, schedules and routes.

8. Bus service should be made available to all of the resident group of students including those residing off campus in East Lansing. Service should be made available to and from commuter lots.

9. For reasons of efficiency, a card or pass system good for one quarter, is suggested for all students who wish to use the bus system. This could be obtained at registration for a given fee, which should be uniform for all students. Systems involving tokens, change-making, etc. should be avoided. No free bus rides, such as to and from commuter lots, should be provided.

10. Graduate assistants and full-time employees whose spouses are students have long been underprivileged and frequently hampered in their ability to carry out their responsibilities to the University. If student parking is prohibited in the present South Campus lots as recommended, we suggest that these two groups of University employees be granted faculty-staff parking privileges. If this is not possible, they should be permitted to park in those lots vacated by students, such as Lots E, S, D, and I; they should also be given permission to use North Campus Lot G.

11. Graduate assistants should be required to pay a faculty parking fee (if any is imposed) if they have faculty-staff parking privileges. If they have lesser privileges, they should pay the student registration fee.

12. The new Student Motor Vehicle regulation, whoever writes it, should be simple and with as few exceptions as possible. Use of colored maps to designate areas and lots authorized for use by holders of the different types of permits is suggested.

The Committee appreciates being asked to express its views on these questions, and wishes to indicate its willingness and desire to cooperate further, if you desire.

Very truly yours,

John L. Lockwood, Chairman
Faculty-Student Motor Vehicle Committee

JLL:sjd

APPENDIX B

SURVEY OF MICHIGAN STATE UNIVERSITY

BUS RIDERSHIP PATTERNS

After you have completed this survey, please fold, (with this page on the outside), staple, and return by campus mail to:

MSU CAMPUS BUS STUDY
c/o FRANK DAVIS, JR.
315 EPPLEY CENTER
CAMPUS

This survey is being conducted as part of a doctoral dissertation in transportation at Michigan State University. Its purpose is to examine the effectiveness and acceptance of university transit systems. The university administration has expressed a strong interest in this study and plans to give it careful consideration in making changes in the MSU bus system. At the end of the survey you will be asked to state your suggestions for improvements to the MSU system.

NOTE: Since the purpose of this survey is to improve the bus service for the entire student body--not just present bus riders--it is very important that you answer all questions even if you do not ride the bus. Your answers will lead to new service which will adapt the bus system to your needs.

1. What class are you in?

1. _____Freshman
2. _____Sophomore
3. _____Junior
4. _____Senior
5. _____Special Undergraduate
6. _____Masters
7. _____Doctoral
8. _____Other_____

2. What is your sex and marital status?

1. _____single male
2. _____single female
3. _____married male
4. _____married female

3. What college are you enrolled in?

1. _____Agriculture and Natural Resources
2. _____Arts and Letters
3. _____Business
4. _____Communications
5. _____Education
6. _____Engineering
7. _____Home Economics
8. _____Human Medicine
9. _____James Madison
10. _____Justin Morrill
11. _____Lyman Briggs
12. _____Natural Science
13. _____Social Science
14. _____Veterinary Medicine
15. _____No Preference
16. _____Other_____

4. How many terms have you been enrolled at MSU? _____terms

5. How many terms have you purchased a bus pass? _____terms

6. Which of the following terms did you purchase a bus pass?

1. _____Spring 1970
2. _____Winter 1970
3. _____Fall 1969
4. _____Summer 1969
5. _____Spring 1969
6. _____Winter 1969
7. _____Fall 1968
8. _____Summer 1968
9. _____Other_____

7. What is your age?

1. _____under 18
2. _____18
3. _____19
4. _____20
5. _____21
6. _____22
7. _____23-25
8. _____26-35
9. _____over 35

8. Were you raised in primarily a:

1. central city area? _____
2. suburban area? _____
3. Town? _____
4. rural area? _____

9. Which of the following transportation vehicles do you own or have frequent use of on campus? (Please check even if they are not licensed to drive on campus)

1. _____automobile
2. _____motorcycle or motor bike
3. _____bicycle
4. _____other (please specify) _____

10. What mode of travel did you regularly use in going to high school?

1. _____walk
2. _____bike
3. _____city bus
4. _____yellow school bus
5. _____car
6. _____other_____

11. How frequently did you make use of a local bus system prior to entering MSU? (include all trips for which you paid a fare but not free trips such as those provided by the yellow school bus.)

1. _____never
2. _____one trip per year
3. _____one trip per month
4. _____one trip per week
5. _____one trip per day
6. _____more frequently

12. How would you rate the bus service that you used prior to entering MSU?

1. _____never used
2. _____bad
3. _____fair
4. _____average
5. _____good
6. _____excellent
7. _____no opinion

13. Where do you now live while attending MSU?

1. _____campus residence hall (name of hall _____)
2. _____married student housing (name_____)
3. _____East Lansing excluding campus
4. _____Lansing
5. _____other off campus area (name of town_____)

14. How many hours are you taking this quarter?_____

15. How many of these hours are taken in your residence hall complex?

_____

16. How many hours a week are you working (outside of normal classwork) this quarter?_____

If you are employed on campus which building do you work in?

_____

17. In order to determine the effectiveness of the MSU bus schedule it is necessary to learn of your regular campus travel patterns whether or not you ride the bus. The easiest method of remembering your travel patterns is to first list your Spring classes in Column 1 below.

	class	class location	depart from	trips/week	time available (minutes)
1.					
2.					
3.					
4.					
5.					
6.					
7.					

(For additional space see next page)

17. Continued

	class	class location	depart from	trips/week	time available
8.					
9.					
10.					

After you have listed your classes in column 1 indicate the building in which the class is held in column 2. If the class meets in two different locations treat each location as a different class. In column 3 indicate the location from which you normally depart to attend the class listed in column 1. In column 4 indicate the number of times you make that trip each week. If you have a previous class or work assignment which limits the time you have available to make the trip please indicate the time available in column 5. If any of these classes are attended at night please circle the class in column 1.

18. If you are working on campus or in East Lansing please list your work trip patterns using the format provied in question 17. If any of these trips are made at night please circle column 1 to indicate which ones.

	Job	work location	depart from	trips/week	time available (minutes)
1.					
2.					
3.					
4.					
5.					

19. If you have any other weekly trips (not listed in question 17 or 18) which you regularly make please list them here according to the same format given in question 17 or 18. (Example trips may include study trips, dates, social trips, student government trips, etc.) Do not include local trips within your own living area.

	Purpose	Location	depart from	trips/week	time available
1.					
2.					

(For additional space see next page)

19. Continued

	Purpose	Location	depart from	trips/week	time available
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

20. How many minutes before class starts do you prefer to arrive at your classroom building? Please indicate your preference by circling the appropriate time below

0 ½ 1 ½ 2 ½ 3 ½ 4 ½ 5 ½ 6 ½ 7 ½ 8 ½ 9 ½ 10 or more
minutes before class starts

21. How many minutes after class ends do you prefer to leave your class building? Please indicate your preference by circling the appropriate time below.

0 ½ 1 ½ 2 ½ 3 ½ 4 ½ 5 ½ 6 ½ 7 ½ 8 ½ 9 ½ 10 or more
minutes after class starts

22. If you have a one hour break between classes where would you prefer to go if it did not take longer than 10 minutes to make the trip?

1. _____return to dorm or living area
2. _____remain in classroom area
3. _____go to departmental library
4. _____go to main library
5. _____go to union or international center
6. _____other (please specify) _____

23. Please indicate the approximate percentage of the regular on campus trips that you made last week according to the following purposes. (Do not include trips made to other parts of your living complex.)

23. Continued

1. _____to regular scheduled classes
2. _____to regular scheduled work assignments
3. _____regular study trips
4. _____social and other trips

24. Approximately what percent of your trips last week were made

1. _____at night
2. _____during the school day

25. During spring term your longest regular trip is between

_____(building name) and _____

26. Please indicate your preference as to class location.

1. _____all classes located in your living complex
2. _____all classes in the same class building but not in your residence hall area.
3. _____most of your classes in the same building but one or two classes in a different area
4. _____each class in a different building

27. What is the primary method of campus travel of most of your friends?

1. _____walking
2. _____bus
3. _____bike
4. _____car

28. Do you usually travel on campus with a friend?

1. _____yes
2. _____no

29. Often people discuss the merits of bus ridership before actually buying a bus pass. Have you discussed the merits of bus ridership with anyone? If you do not ride the bus, did you discuss the merits of bus ridership with anyone before deciding not to ride?

1. _____yes
2. _____no

30. Who was most influential in helping you arrive at your decision?

1. _____your parents
2. _____your spouse
3. _____your roommate
4. _____a very close friend
5. _____a casual acquaintance
6. _____other_____

31. Did the person you checked in number 30 recommend riding the bus?

1. _____yes 2. _____no

32. Does this person (the one who was most influential) ride the MSU bus?

1. _____yes 2. _____no

33. Do you feel most bus riders are apprehensive about missing the bus and arriving late?

1. _____yes 2. _____no

34. How much time do you try to allow so that you will not miss the bus? If you do not ride the bus, how much time do you feel it would be necessary to allow?

0 ½ 1 ½ 2 ½ 3 ½ 4 ½ 5 ½ 6 ½ 7

zero minutes seven minutes

35. Which of the following best describes your scheduling behavior?

1. _____I learn the bus schedule and arrive at the bus stop to meet a particular bus.
2. _____I go to the bus stop when I am ready to leave and take the first bus that arrives.

36. Which do you feel is most important?

1. _____For the bus to be precisely on time even though it will not be able to wait for straggling students.
2. _____For the driver to make every effort to pick up all riders who are waiting for the bus even though the bus will be more crowded and may be late at the next stop.
3. _____For the driver to limit crowding even though it means that he must leave some students behind.

37. In order to determine how well the MSU bus system meets your expectations it is necessary to obtain your evaluation of the system. First, rank the following eight attributes to indicate which you feel are most important. Place a 1 by the factor that is most important, a 2 by the second most important factor, etc. If you do not ride the bus your opinions are still important.

1. _____frequency of service (waiting time between buses)
2. _____dependability of service (the importance of arriving at the same time each day)

37. Continued

3. _____cleanliness of the bus

4. _____attitude of the bus driver

5. _____cost of bus pass

6. _____degree of crowding of bus

7. _____directness of route

8. _____coordination of bus and class schedules

Circle the number on the scale below to indicate your ranking of the present MSU bus system. Remember your opinion is still valuable even if you do not ride the bus.

a) frequency (waiting time between buses)

1 2 3 4 5 6 7

ACCEPTABLE UNACCEPTABLE

b) dependability

1 2 3 4 5 6 7

ALWAYS ON TIME ALWAYS LATE

c) Cleanliness

1 2 3 4 5 6 7

VERY CLEAN VERY DIRTY

d) bus drivers

1 2 3 4 5 6 7

VERY COURTEOUS AND HELPFUL VERY UNFRIENDLY

e) cost of bus pass

1 2 3 4 5 6 7

VERY LOW FAIR PRICE VERY HIGH

f) control of crowding

1 2 3 4 5 6 7

NO CROWDING VERY CROWDED

g) convenience of routes

1 2 3 4 5 6 7

VERY CONVENIENT VERY INCONVENIENT

h) schedules

1 2 3 4 5 6 7

COORDINATED BUS AND CLASS SCHEDULES UNCOORDINATED BUS AND CLASS SCHEDULES

38. How would you rate the MSU bus system overall?

1	2	3	4	5	6	7
EXCELLENT						VERY POOR

39. Do you feel that the university should adopt a free bus system?

1. _____yes 2. _____no

40. How should this bus system be supported?

1. _____by an increase in student fees
2. _____by diverting funds from academic construction
3. _____by diverting funds from residential construction
4. _____by diverting funds from athletic, social, and cultural programs
5. _____other (please indicate) _____

41. What is the major reason that you do or do not ride the MSU bus system?

42. What would you like to see done to improve the MSU bus system?

43. If you have any other comments not contained in this questionnaire feel free to respond.

APPENDIX C

TEXT OF INITIAL TELEPHONE CONTACT MADE

PRIOR TO THE MAILING OF THE SURVEY

Initial Telephone Contact:

A. Introduction and purpose--name--I am a member of a group of graduate students doing a research study on the MSU bus system to determine how service can be improved without increasing the cost of the bus pass.

B. Their role--Before we can suggest changes to be made we need to know what service you desire. To facilitate the gathering of this information we have developed a survey which asks you about your campus travel habits and preferences. The administration has promised to use the results of this study to make changes in the bus system next fall.

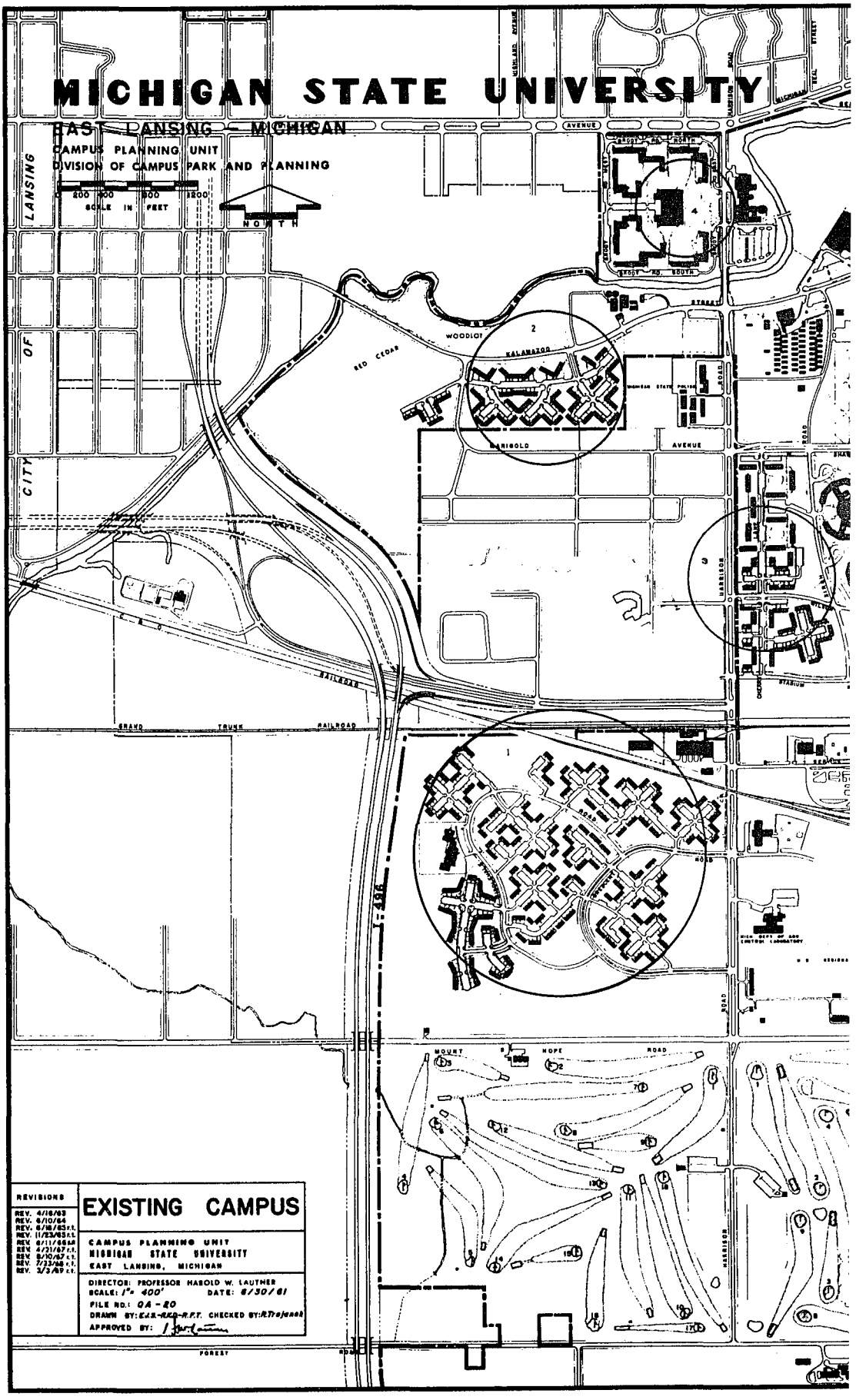
C. Commitment--Will you answer this survey so that we can determine your travel needs?

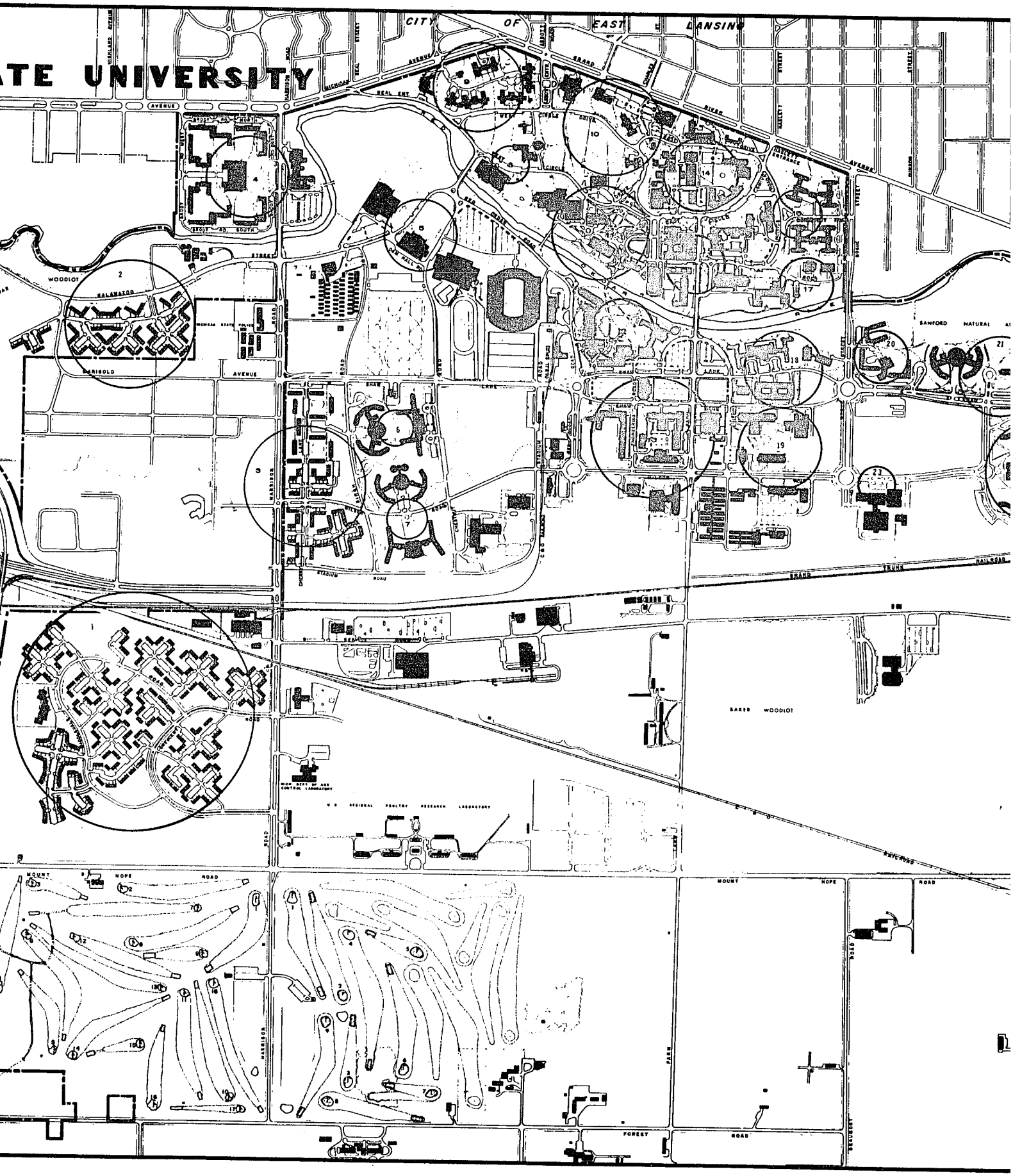
(Yes) I will mail the survey to you tonight so you should receive it tomorrow. To return it simply fold it with the front sheet on the outside, staple, or tape it closed and place it in the campus mail. If you have any difficulty with any of the questions, please feel free to call me--I will place my number on the top of the first page. Thank you.

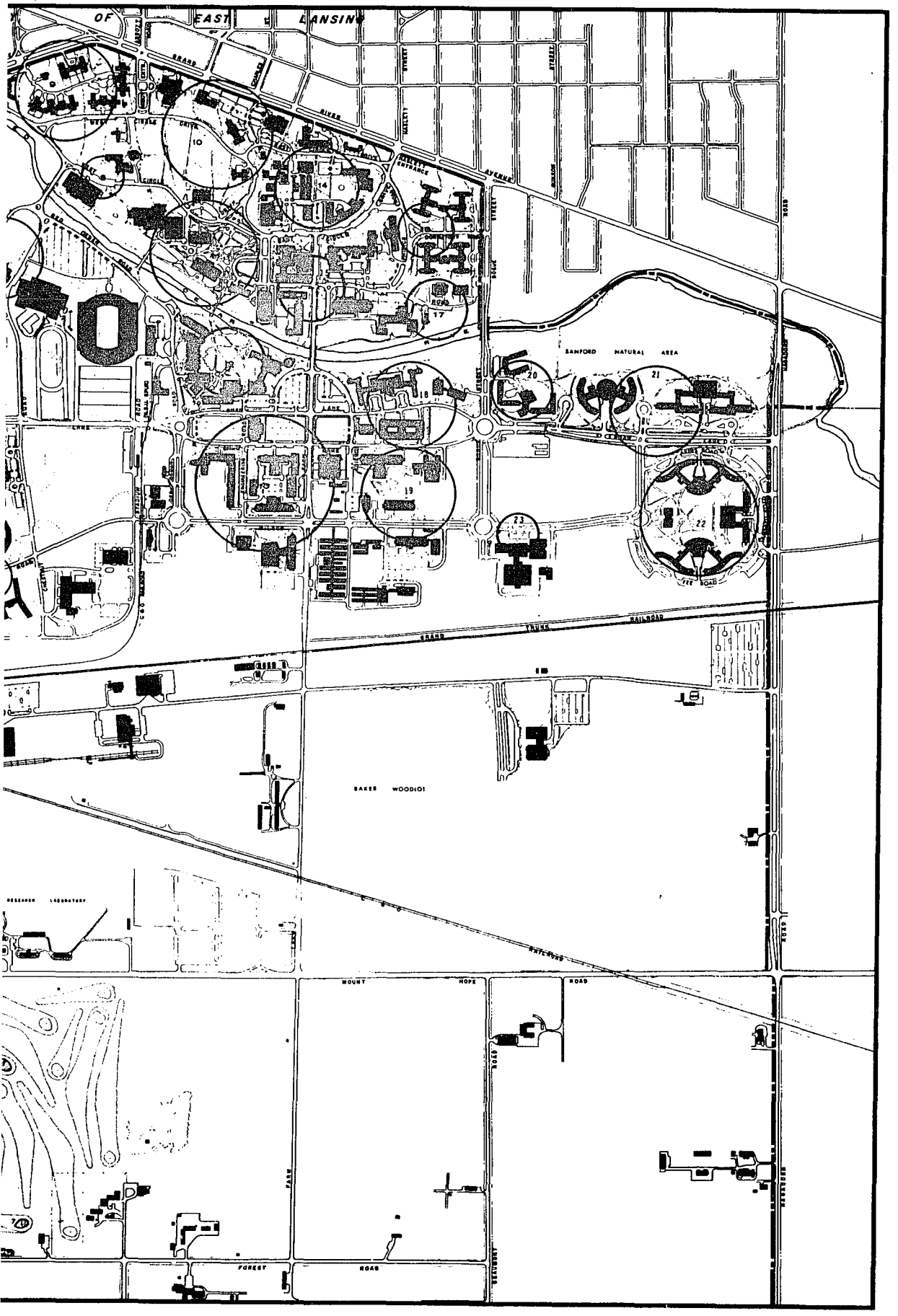
(No)--Why? Record answer beside name.

APPENDIX D

PHOTO-REDUCTION OF MICHIGAN STATE UNIVERSITY CAMPUS MAP INDICATING GROUPINGS OF BUILDINGS INTO TRAVEL CENTERS


MICHIGAN STATE UNIVERSITY
EAST LANSING - MICHIGAN
CAMPUS PLANNING UNIT
DIVISION OF CAMPUS PARK AND PLANNING
SCALE IN FEET
NORTH
LANSING
CITY
OF
RED CEDAR
WOODLOT
KALAMAZOO
MARIGOLD
AVENUE
GRAND TRUNK RAILROAD
MOUNT HOPE ROAD
FOREST
REVISIONS
REV. 4/16/63
REV. 6/10/64
REV. 6/18/65 r.l.
REV. 11/23/65 r.l.
REV. 6/11/66 r.l.
REV. 4/21/67 r.l.
REV. 8/10/67 r.l.
REV. 7/23/68 r.l.
REV. 3/3/69 r.l.
EXISTING CAMPUS
CAMPUS PLANNING UNIT
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN
DIRECTOR: PROFESSOR HAROLD W. LAUTNER
SCALE: 1" = 400'
DATE: 6/30/61
FILE NO.: CA-80
DRAWN BY: E.A.B.-R.E.C.-R.F.T. CHECKED BY: R.Trojanek
APPROVED BY:


TE UNIVERSITY
CITY OF EAST LANSING
WOODLOT
KALAMAZOR
AVENUE
MARIBOLD
SAMFORD NATURAL
BAKER WOODLOT
MOUNT HOPE ROAD
FOREST ROAD


OF EAST LANSING
SANFORD NATURAL AREA
BAKER WOODLOT
MOUNT HOPE ROAD
FOREST ROAD

APPENDIX E

DETAIL DATA FOR ORIGIN-DESTINATION GROUPINGS

ORIGIN - DESTINATION GROUP PROFILE

Group No.	Access to:	Shortest Walking Distance from Group Center	Walking Time in Minutes
1.	Spartan Village Harrison & Crescent	1400'	4.300
2.	University Village Max Apt. from Center	700'	2.160
3.	Cherry Lane to Shaw Lane to Birch & Wilson to Wilson & Harrison	 1000' 650' 300'	 3.080 2.000 .924
4.	Brody Area Rather Bryan Butterfield Armstrong Bailey Emmons Cafeteria Kellogg Center	 350' 550' 250' 550' 350' 250' 0 450'	 1.080 1.690 .770 1.690 1.080 .770 - 1.380
5.	Dem Hall Area Dem Hall Jenison Men's IM	 0 350' 350'	 - 1.080 1.080
6.	Case - Wonders Case Wonders	 150' 200'	 .462 .615
7.	Wilson - Holden Holden Wilson	 200' 200'	 .615 .615
8.	Music - Women's IM Music Women's IM	 150' 100'	 .462 .308
9.	West Circle Dorms Williams Yakeley Gilchrist	 500' 150' 300'	 1.540 .462 .924

APPENDIX E TABLE--Continued

Group No.	Access to:	Shortest Walking Distance from Group Center	Walking Time in Minutes
9.	West Circle Dorms		
	Landon	200'	.615
	Campbell	500'	1.540
	Mary Mayo	150'	.462
	Wills House	250'	.770
10.	Union - Olin		
	Union	500'	1.540
	Home Economics	250'	.770
	Morrill	100'	.308
	Olin	550'	1.690
	Linton Hall	400'	1.230
	Eustace Hall	450'	1.380
	Beaumont Tower	500'	1.540
11.	Library - Ad Building		
	Library	500'	1.540
	Olds Hall	300'	.924
	Ad. Building	100'	.308
	Computer Center	400'	1.230
	Museum	550'	1.690
12.	Wells - Erickson		
	Wells	200'	.615
	International Center	250'	.770
	Erickson	200'	.615
13.	Engineering - Anthony		
	Meat Lab	100'	.308
	Engineering Building	350'	1.080
	Judging Pavilion	400'	1.230
	Anthony	100'	.308
	Foods Science	250'	.770
	Packaging	550'	1.690
	Natural Resources	600'	1.850
	Agricultural Engineering	500'	1.540
14.	Berkey - Nat. Science		
	Berkey	400'	1.230
	Horticulture House	50'	.154
	Student Services	350'	1.080
	Natural Science	150'	.462
	Soil Science	150'	.462

APPENDIX E TABLE--Continued

Group No.	Access to:	Shortest Walking Distance from Group Center	Walking Time in Minutes
14. (cont.)	Berkey - Nat. Science		
	Agriculture Hall	400'	1.230
	Marshall Hall	350'	1.080
	Journalism	350'	1.080
	Chittenden Hall	450'	1.380
	Cook Hall	550'	1.690
	Home Management	550'	1.690
15.	Bessey - Kedzie		
	Kedzie	150'	.462
	Giltner	300'	.924
	Auditorium	250'	.770
	Bessey	200'	.615
16.	Abbott - Snyder		
	Mason	150'	.462
	Abbott	250'	.770
	Phillips	150'	.462
	Snyder	250'	.770
	Physics	250'	.770
17.	Kresge Art Center		
	Kresge	300'	.924
	Chapel	100'	.308
	Baker Hall	150'	.462
	Psychology Research	250'	.770
18.	Shaw-Eppley		
	E. Shaw	200'	.615
	W. Shaw	400'	1.230
	Shaw Lot	150'	.462
	Eppley	250'	.770
	Planetarium	550'	1.690
19.	Science Area		
	Chemistry	250'	.770
	Cyclotron	250'	.770
	Biochemistry	150'	.462
	Plant Biology Lab	450'	1.380
20.	Owen - Van Housen		
	Owen	150'	.462
	Van Housen	200'	.615

APPENDIX E TABLE--Continued

Group No.	Access to:	Shortest Walking Distance from Group Center	Walking Time in Minutes
21.	McDonel - Holmes		
	McDonel	400'	1.230
	Holmes	250'	.770
22.	East Campus		
	Conrad	250'	.770
	Akers	300'	.924
	Fee	300'	.924
	Hubbard	300'	.924
23.	Vet Clinic	0	-

APPENDIX F

BUILDING-GROUP CODE REFERENCE CHART

BUILDING - GROUP CODE REFERENCE CHART

Building	Group Code
Abbott	16
Administration	11
Agricultural Engineering	13
Agriculture Hall	14
Akers	22
Anthony	13
Armstrong	4
Auditorium	15
Bailey	4
Baker	17
Beaumont Tower	10
Bessey	15
Berkey	14
Biochemistry	19
Bryan	4
Butterfield	4
Campbell	9
Case	6
Chapel	17
Chemistry	19
Cherry Lane	3
Chittenden Hall	14
Computer Center	11
Conrad	22
Cook	14
Cyclotron	19
Demonstration Hall	5
Emmons	4
Engineering	13
Eppley	18
Erickson	12
Eustace	10
Fee	22
Food Science	13
Gilchrist	9
Giltner	15
Holden	7
Holmes	21
Home Economics	10
Home Management	14
Horticulture and Greenhouses	14
Hubbard	22
International Center	12
Jenison	5
Journalism	14
Judging Pavilion	13
Kedzie	15
Kellogg Center	4
Kresge	17
Landon	9
Library	11
Linton	10
Mason	16
Marshall	14
Mayo	9
McDonel	21
Meat Lab	13
Men's Intramural	5
Morrill	10
Museum	11
Music	8
Natural Resources	13
Natural Science	14
Olds Hall	11
Olin Health Center	10
Owen	20
Packaging	13
Phillips	16

APPENDIX F TABLE--Continued

Building	Group Code
Physics	16
Psychology Research	17
Planetarium	18
Plant Biology	19
Rather	4
Shaw	18
Snyder	16
Soil Science	14
Spartan Village	1
Student Services	14
Union	10
University Village	2
Van Hoosen	20
Vet Clinic	23
Wells Hall	12
Williams	9
Wills House	9
Wilson	7
Women's Intramural	8
Wonders	6
Yakeley	9

APPENDIX G

BUS TIME AND WALKING DISTANCE

BETWEEN ORIGIN AND DESTINATION

BUS TIME AND WALKING DISTANCE
BETWEEN ORIGIN AND DESTINATION

Destination Group Number	Origin Group Number						
	1	2	3	4	5	6	7
1		7750' 27	4150' 7	7250' 24	7250' 8	4950' 6	4150' 5
2	7750' 7		4300' 17	2700' 1	3300' 3	3950' 15	4750' 16
3	4150' 7	4300' 21		3650' 18	3000' 3	1250' 1	1250' 1
4	7250' 27	2700' 3	3650' 20		2150' 2	3250' 18	4150' 19
5	7250' 22	3300' 6	3000' 15	2150' 3		2100' 13	3150' 14
6	4950' 8	3950' 20	1250' 2	3250' 17	2100' 2		1200' 1
7	4150' 8	4750' 21	1250' 1	4150' 18	3150' 3	1200' 1	
8	8450' 24	4550' 7	4250' 17	3000' 4	1350' 8	3400' 15	4350' 16
9	8850' 21	3300' 5	4650' 14	3400' 2	1800' 8	3850' 12	4650' 13

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number						
	8	9	10	11	12	13	14
1	8450' 21	8850' 20	9500' 21	8550' 9	7150' 9	6900' 9	9350' 18
2	4550' 5	3300' 5	4400' 6	5250' 6	5700' 8	6200' 12	6550' 5
3	4250' 15	4650' 14	4750' 15	4350' 4	3850' 4	3850' 5	5650' 10
4	8450' 4	3400' 4	4200' 5	3900' 5	4450' 11	5500' 15	5100' 4
5	1350' 2	1800' 2	2550' 3	2000' 3	2400' 5	3500' 9	3300' 3
6	3400' 13	3850' 13	4250' 14	3350' 4	2900' 4	3150' 5	4400' 9
7	4350' 14	4650' 14	5100' 15	4250' 5	3000' 5	2750' 6	5000' 10
8		900' 1	1200' 2	1250' 0	2350' 8	3450' 12	2050' 3
9	900' 0		1500' 1	2200' 13	3550' 7	4600' 11	2550' 2

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number						
	15	16	17	18	19	20	21
1	8450' 17	9550' 17	9200' 17	8500' 12	8200' 12	9600' 19	10,750' 20
2	6250' 7	7450' 5	7650' 5	7450' 8	6900' 8	8550' 13	9700' 14
3	5100' 9	6200' 9	5850' 9	5200' 6	5100' 6	6300' 13	7300' 14
4	4900' 10	6100' 8	6400' 8	5600' 11	7100' 11	7000' 16	7800' 17
5	2950' 4	4150' 3	4350' 3	3950' 5	5000' 5	4950' 10	6150' 11
6	4100' 8	5300' 8	4950' 8	4350' 5	4350' 6	5450' 13	6550' 14
7	4300' 9	5400' 9	5050' 9	4350' 6	4050' 6	5450' 13	6400' 14
8	2300' 7	3100' 4	3500' 4	3950' 8	4450' 8	5050' 13	6200' 14
9	3050' 6	3650' 3	4250' 3	4700' 7	5200' 7	5800' 12	6900' 13

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number		
		22	23
	1	10,750' 22	9050' 19
	2	10,300' 16	7950' 13
	3	7700' 16	6000 13
	4	8450' 19	8150' 16
	5	7650' 13	6050' 10
	6	6900' 15	5250' 13
	7	6600' 16	4900' 13
	8	6800' 16	5500' 13
	9	7550' 15	8600' 12

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number							
		1	2	3	4	5	6	7
	10	9500' 20	4400' 7	4750' 13	4200' 4	2550' 9	4250' 11	5100' 12
	11	8550' 25	5250' 6	4350' 18	3900' 3	2000' 9	3550' 16	4250' 17
	12	7150' 11	5700' 11	3850' 4	4450' 8	2400' 11	2900' 2	3000' 3
	13	6900' 12	6200' 11	3850' 5	5500' 8	3500' 14	3150' 3	2750' 4
	14	9350' 20	6550' 6	5650' 13	5100' 3	3300' 11	4400' 11	5000' 12
	15	8450' 17	6250' 10	5100' 10	4900' 7	2950' 13	4100' 8	4300' 9
	16	9500' 18	7450' 10	6200' 11	6100' 7	4150' 17	5300' 9	5400' 10
	17	9200' 18	7650' 10	5850' 11	6400' 7	4350' 17	4950' 9	5050' 10
	18	8500' 14	7450' 11	5200' 7	5600' 8	3950' 14	4350' 5	4350' 6

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number							
		8	9	10	11	12	13	14
	10	1200' 0	1500' 0		1150' 0	2200' 6	3400' 10	1150' 1
	11	1250' 1	2200' 2	1150' 3		1200' 0	2400' 13	1300' 14
	12	2350' 5	3550' 6	2200' 7	1200' 4		1200' 2	2450' 2
	13	3450' 9	4600' 10	3400' 11	2400' 8	1200' 2		2900'
	14	2050' 4	2550' 5	1150' 0	1300' 2	2450' 5	2900' 9	
	15	2300' 4	3050' 5	1900' 5	1050' 2	1500' 0	1950' 5	850' 5
	16	3100' 10	3650' 11	2250' 12	2250' 9	2550' 3	3000' 7	1050' 0
	17	3500' 10	4250' 11	3000' 12	2250' 9	2200' 3	2650' 7	2000' 0
	18	3950' 5	4700' 6	3500' 6	2600' 4	1850' 0	1800' 2	2650' 7

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number						
	15	16	17	18	19	20	21
10	1900' 5	2250' 2	3000' 2	3500' 6	4000' 6	4600' 11	5700' 12
11	1050' 8	2250' 6	2250' 6	2600' 9	3100' 9	3400' 14	4800' 15
12	1500' 1	2550' 2	2200' 2	1850' 2	2150' 2	2950' 3	4050' 6
13	1950' 4	3000' 5	2650' 5	1800' 2	1350' 0	2900' 6	3650' 10
14	850' 4	1050' 1	2000' 1	2650' 5	3150' 5	3750' 10	4850' 11
15		1150' 0	1200' 0	1800' 1	2300' 1	2900' 6	4000' 7
16	1150' 2		800' 0	2300' 3	3100' 3	2050' 8	3350' 9
17	1200' 2	800' 0		1450' 3	2250' 3	1200' 8	2500' 9
18	1800' 1	2300' 8	1450' 8		900' 0	1100' 2	2200' 3

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number		
		22	23
	10	6350' 14	5050' 11
	11	5450' 17	4150' 14
	12	4700' 8	3200' 3
	13	4050' 10	2400' 6
	14	5500' 13	4200' 10
	15	4350' 9	4650' 6
	16	4250' 12	3250' 8
	17	3400' 12	2400' 8
	18	2850' 6	1500' 2

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number						
	1	2	3	4	5	6	7
19	8200' 17	6900' 13	5100' 10	7100' 10	5000' 17	4350' 8	4050' 9
20	9600' 18	8550' 14	6300' 11	7000' 11	4950' 19	5450' 9	5450' 10
21	10,750' 18	9700' 15	7300' 11	7800' 12	6150' 20	6550' 9	6400' 10
22	10,750' 21	10,300' 16	7700' 14	8450' 13	7650' 22	6900' 13	6600' 14
23	9050' 18	7950' 14	6000' 11	8150' 11	6050' 19	5250' 9	4900' 10

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number							
		8	9	10	11	12	13	14
	19	4450' 8	5200' 9	4000' 10	3100' 7	2150' 1	1350' 5	3150' 5
	20	5050' 10	5800' 11	4600' 12	3400' 9	2950' 3	2900' 7	3750' 7
	21	6200' 11	6900' 12	5700' 13	4800' 10	4050' 4	3650' 8	4850' 8
	22	6800' 13	7550' 14	6350' 15	5450' 12	4700' 6	4050' 10	5500' 10
	23	5500' 10	8600' 11	5050' 12	4150' 9	3200' 3	2400' 7	4200' 7

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number							
		15	16	17	18	19	20	21
	19	2300' 4	3100' 4	2250' 4	900' 1		1650' 3	2300' 6
	20	2900' 6	2050' 6	1200' 6	1100' 3	1650' 2		1300' 1
	21	4000' 7	3350' 7	2500' 7	2200' 4	2300' 3	1300' 1	
	22	4350' 9	4250' 9	3400' 9	2850' 6	2650' 5	2100' 3	1050' 2
	23	4650' 6	3250' 6	2400' 6	1500' 3	1050' 2	1750' 0	1600' 1

APPENDIX G TABLE--Continued

Destination Group Number	Origin Group Number		
		22	23
	19	2650' 8	1050' 3
	20	2100' 3	1750' 0
	21	1050' 2	1600' 1
	22		1700' 3
	23	1700' 3	

APPENDIX H

BUS FREQUENCY TO EACH GROUP AREA

BUS FREQUENCY TO EACH GROUP AREA

Group Number	Day Frequency	Night Frequency
1	15 Minutes	20 Minutes
2	8	20
3	7-1/2	20
4	8	20
5	8	20
6	7-1/2	20
7	7-1/2	20
8	4	20
9	4	20
10	4	20
11	4	20
12	7-1/2	20
13	7-1/2	20
14	4	20
15	4	20
16	4	20
17	4	20
18	4	20
19	4	20
20	4	20
21	4	20
22	4	20
23	4	None

APPENDIX I

MICHIGAN STATE UNIVERSITY

PASS SALES BY QUARTER

MSU BUS PASS SALES

Year	Quarter	Quarterly Bus Passes	Winter-Only Bus Passes	Commuter Passes
1964	Fall	3173[a]		1208[a]
1965	Winter	6164		1054
	Spring	3232		911
	Summer	935[b]		380
	Fall	6619		1137
1966	Winter	9935		979
	Spring	4834		887
	Summer	956[c]		354
	Fall	9140		1212
1967	Winter	11771		1037
	Spring	5999		943
	Summer	1247[d]		251
	Fall	8483[e]		1264[e]
1968	Winter	6830	2822	1098
	Spring	5194		839
	Summer	786[f]		g
	Fall	8318		1067
1969	Winter	6697	3035	1060
	Spring	6111		856
	Summer	567[h]		g
	Fall	8956		1230
1970	Winter	7149	2822	1216
	Spring	5487		967

MSU BUS PASS SALES (Footnotes)

[a]All campus passes issued between fall 1964 and fall 1967 were priced at $12 per quarter. Commuter passes were priced at $6 per quarter and were only good from the commuter lot to Shaw lot.

[b]Although 935 summer term bus passes were sold, they were not all for the full term. During this term 349 full-term passes were sold for $12 each. 504 passes were sold for the first five weeks and 82 passes were sold for the second five weeks. The five-week passes were sold for $6 each. The five-week passes are required for summer quarter since many courses are taught on a five-week accelerated basis.

[c]414 full-term passes, 449 first five-week passes, 93 second five week passes.

[d]533 full-term passes, 591 first five-week passes, 123 second five-week passes.

[e]The pass price was increased to $14 per quarter for all campus passes and $8 for commuter passes.

[f]433 full-term passes, 285 first five-week passes, 68 second five-week passes.

[g]Commuter lot was closed during the summer term so no bus service was provided.

[h]336 full-term passes, 217 first five-week passes, 14 second five-week passes.

APPENDIX J

LEAST SQUARES MULTIPLE REGRESSION ANALYSIS TO DETERMINE MAJOR FACTORS AFFECTING BUS RIDERSHIP

APPENDIX J

LEAST SQUARES MULTIPLE REGRESSION ANALYSIS TO DETERMINE MAJOR FACTORS AFFECTING BUS RIDERSHIP

The purpose of this analysis was to determine which travel characteristics had the greatest influence on the propensity to buy passes. The data used to calculate these factors was obtained from two sources. First, travel patterns and demographic data were taken from the survey which had been keypunched onto punched cards. Appendix L indicates the format used for these cards. The distances involved in traveling between various origins and destinations were taken from the origin-destination map (Appendix D) and the bus times were obtained from Henry Jolman, foreman of the bus service. (See Appendix G for origin-destination bus travel times and walking distances.) The bus system frequencies were taken from the printed bus schedule. (See Appendix H.)

A transformation program was then written to calculate and group the following variables for entry into the least squares multiple regression program.

Bus ridership during spring term 1970 (X_1), the dependent variable, was taken directly from survey question 6. If the person purchased a bus pass during spring quarter 1970 this value was 1; otherwise it was set equal to zero.

Total distance traveled each week (X_2), had to be calculated from the information given in survey questions 17, 18, and 19 and from the distances measured on the origin-destination map and stored in

core. It was calculated as follows:

$$X_2 = \sum_{i=1}^{n} (\text{distance})_{ij} \cdot (\text{trips})_{ij}$$

Where

distance = walking distance as measured from the origin-destination map in thousands of feet. (See Appendix G.)

trips = number of weekly trips made between that origin and destination for that purpose. (See survey questions 17, 18, and 19 column 4).

n = number of entries made in questions 17, 18 and 19.

i = origin as given in questions 17, 18, and 19.

j = destination as given in questions 17, 18, and 19.

Total number of trips made each week (X_3) was taken from questions 17, 18, and 19, column 4. If the respondent indicated a trip made between two points located in the same group area, i.e., origin and destination were both in Spartan Village, then the trip was ignored.

Frequency of daytime bus service to student's residence area (X_4) was determined as follows:

X_4 = Frequency_i

where:

Frequency = number of minutes between buses on regular daytime routes as they pass student's living area. (See Appendix H.)

i = student's living area-from question 13

Weekly time advantage (X_5) was a measure of the minutes saved each week by taking the bus instead of walking. This was calculated as follows:

$$X_5 = (X_2/325 - \sum_{i=1}^{n} (\text{bus time})_{ij}$$

where:

X_2 = total weekly travel distance in feet

325 = average walking speed in feet per minute as measured by the University Campus Park and Planning Office

n = Total number of trips made by the individual during the week

bus time = bus time required to travel between the two points. (See Appendix G.)

i = origin of trip

j = destination of trip

The weekly time constraint (X_6) was a measure of the class or work time lost due to being unable to walk to class or work within the time available.

$$X_6 = \sum_{k=1}^{n} [(d_{ij}/325 - T_{ij})_k \circ u(x)_k]$$

where: $x = d_{ij}/325 - T_{ij}$

and $u(x) = 0$ when $x \leq 0$

$u(x) = 1$ when $x > 0$

n = total number of weekly trips made

d_{ij} = distance involved in trip k

T_{ij} = time available to make trip k from questions 17, 18, and 19 column 5

ij = origin and destination for trip k

Classload (X_7) is a measure of the number of class credit hours taken during spring quarter 1970. This value was taken directly from question 14.

Workload (X_8) was a measure of the number of hours worked during spring quarter 1970. This was taken from question 16.

Prior bus usage (X_9) was a measure used to determine if students who rode a city bus prior to entering MSU were more likely to ride the bus when they entered the university. This measurement was taken from question 11.

Attitude (X_{10}) toward the MSU system was thought to be an indication of consumer acceptance and its effect on ridership. This measure was taken from question 38.

The percentage of trips made at night (X_{11}) taken from question 24, was included to indicate the importance of night travel on bus ridership.

The distance of the longest trip (X_{12}) made during the week was taken from question 25 to determine whether people bought a bus pass to ease their longest journey during the week.

$$X_{12} = \text{distance}_{ij}$$

where:

i = origin from question 25

j = destination from question 25

distance = distance from Appendix G

Class (X_{13}) was taken from question 1.

Marital Status (X_{14}) and sex (X_{15}) were dummy variables constructed from question 2. X_{14} was set equal to zero if the person were single and equal to one if married. X_{15} was set equal to zero if the person were a male; otherwise it was set equal to one.

The distance from the student's living area to the center of the campus (X_{17}) was calculated as follows:

$$X_{17} = \text{distance}_{i\ 15}$$

where:

distance = distance from Appendix G

i = location of campus residence area from question 13

15 = location of campus center--Farm Lane and Auditorium Road

The square of distance X_{17} (X_{18}) was used to reflect the exponential qualities observed in the bus ridership profile.

These sixteen variables were entered into the least squares multiple regression program created as part of the STAT series prepared by the Michigan State University Agricultural Experiment Station.[1]

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[1]The Agricultural Experiment Station at Michigan State University has produced a series of statistical programs which are described in forty mimeographed writeups, each writeup describing a different feature of the program. The least squares multiple regression routine is described in description number 7. The least square routine with automatic stepwise

In the first pass the least squares deletion option was used to eliminate all independent variables that did not reject the null hypothesis, i.e., that the variable did not account for any of the variance, at the ninety-five per cent confidence level.

The purpose of the deletion run was to eliminate all variables which were not statistically significant themselves. Normally the printout from this run also gives the statistics for the total regression equation but such is not the case when the dependent variable is binary in nature as it was in this instance. Johnston's methodology[2] was used as follows to compensate for the heteroscedasticity of the disturbances.

Step 1: Use the regular least squares multiple regression analysis to determine the β regression coefficients for each of the independent variables.

Step 2: Calculate weighting variable for each individual observation.

$$\text{weighting variable}_i = [\beta X_i(1 - X_i)]^{-1/2}$$

---

deletion of variables is covered in description number 8. Lastly, the least squares routine with the weighting of variables is defined in description number 12.

[2]The classical least squares approach assumes homoscedastic disturbances throughout the entire range of the dependent variable. This is not the case for the dummy dependent variable since all values had to be either 0 or 1. A brief description of the problem and a suggested method for compensating for the heteroscedasticity of the disturbances where there may be interaction between the independent variables is given in J. Johnston, Econometric Methods (New York: McGraw Hill, 1963), pp. 207-211 and 227-228. Johnston states that a more detailed, theoretical analysis is given in G. H. Orcutt, Martin Greenberger, John Korbel, and Alice M. Rivlin, Microanalysis of Socio-economic Systems: A Simulation Study (New York: Harper and Row, 1961).

where:

$$\beta = \begin{bmatrix} b_1 \\ b_2 \\ \cdots \\ b_m \end{bmatrix} \qquad X_i = [x_{i1}\ x_{i2}\ \cdots\ x_{im}]$$

x_{i1} = value of variable x_1 for individual observation i

Step 3: Run data through weighted least squares multiple regression program using the weighting variables calculated in step 2.

As a result of this compensation, explained variance, R^2, was increased from 19.42 per cent to 24.03 per cent. This transformation yields almost 24 per cent improvement in the predictive ability of the relationship.

Results of least squares multiple regression analysis.--Table J-1 is a summary of the detailed results of the weighted least squares run.

In addition to the raw data from this run it is necessary to indicate the manner in which the individual variable was determined. This was done by comparing the R^2 deletes column for each individual variable with the total R^2 value of 24.03 per cent for the entire equation. The following individual effects determined on this basis are given in Table J-2.

TABLE J-1

STATISTICS ON LEAST SQUARES VARIABLES

X(1) = P(X(2) ... X(4), X(11), X(13), X(15), X(18))

DEPENDENT VARIABLE--X(1) RIDERSHIP

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG. OF FREEDOM	MEAN SQUARE	F	SIG
Regression (about mean)	18.39544913	7	2.62792130	18.3452	0.0005
Error	58.15873224	406	0.14324811		
Total (about mean)	76.55418136	413			

OBSERVATIONS	MULTIPLE CORR. COEF. R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
414	0.2403	0.4902	0.2272	0.4766	0.37848132

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRORS OF BETAS	TB	FB	SIG	PARTIAL CORR. COEFS.	R2 DELETES
Constant	0	0.65890334	0.08050189			8.1849	66.9933	0.0005		
Distance	X_2	0.00733927	0.00126089	0.45904	0.07886	5.8207	33.8805	0.0005	0.27753	0.17690
Trips	X_3	-0.02437434	0.00532765	-0.33870	0.07403	-4.5751	20.9312	0.0005	-0.22142	0.20113
Freq. Bus	X_4	-0.07474692	0.01366380	-0.47496	0.08685	-5.4684	29.9037	0.0005	-0.26192	0.18434
Night Bus	X_{11}	-0.00402678	0.00117113	-0.15498	0.04507	-3.4384	11.8223	0.001	-0.16821	0.21817
Class	X_{13}	-0.03153654	0.01249920	-0.12559	0.04978	-2.5231	6.3660	0.012	-0.12425	0.22838
Sex	X_{15}	-0.09753282	0.03856375	-0.11209	0.04432	-2.5291	6.3965	0.011	-0.12454	0.22832
Sqeddist	X_{18}	0.01328636	0.00298204	0.45143	0.10132	4.4555	19.8512	0.0005	0.21591	0.20315

TABLE J-2: VARIANCE EXPLAINED BY INDIVIDUAL VARIABLE

Variable	Variance Explained By Individual Variable
Distance	6.34%
Frequency of bus service	5.60%
Number of weekly trips	3.92%
Dorm-campus distance squared	3.72%
Per cent of travel at night	2.21%
Class	1.19%
Sex	1.20%

The degree of interaction between each of these individual variables can be determined by comparing the variance explained by the total overall regression and the sum of the individual effects.

Total effect	Total individual effect	Interaction effect
24.03%	24.18%	.15%

Consequently the interaction can be considered to be negligible.

Table J-3 on the following page provides basic statistics on the transformed variables after they were weighted to compensate for the heteroscedasticity of the disturbances. The following two pages provide a listing of the transformation program used to prepare the data for the weighted least squares program. The constants in statement 1627 were obtained from the preceding least squares program as explained under step 2 above.

TABLE J-3

STATISTICS ON TRANSFORMED VARIABLES

LABEL	VAR	MINIMUM VALUE	MAXIMUM VALUE	MEAN	STANDARD DEVIATIONS	SUM	SUM OF SQUARES	SUM OF SQUARED DEVIATION FROM THE MEAN
Riders	1	0.00000	1.00000	0.24488	0.4305360	101.38007	101.38007	76.55418
Distance	2	0.00000	196.35000	45.11996	26.9279669	18679.66253	1142298.24500	299472.65972
Trips	3	0.00000	36.00000	13.42706	5.9825684	5558.80317	89420.12262	14781.73452
Freq. Bus	4	0.00000	15.00000	6.05536	2.7357194	2506.91927	18271.25842	3090.95835
Nightbus	11	-0.00000	80.00000	17.22288	16.5696852	7130.27305	236194.84451	113390.99670
Class	13	-0.00000	8.00000	2.54440	1.7146151	1053.38169	3894.40527	1214.18068
Sex	15	0.00000	1.00000	0.57608	0.4947766	238.49517	238.49517	101.10400
Sqeddist	18	1.32250	71.40250	18.10161	14.6284187	7494.06848	224032.87218	88378.13207

SIMPLE CORRELATIONS

Riders	1	1.00000							
Distance	2	0.26524	1.00000						
Trips	3	0.02671	0.68234	1.00000					
Freq. Bus	4	-0.00109	0.22904	-0.15604	1.00000				
Nightbus	11	-0.14111	0.03127	-0.08565	-0.00633	1.00000			
Class	13	-0.01847	0.07524	-0.19464	0.40598	0.00127	1.00000		
Sex	15	-0.15248	0.00506	-0.01551	0.18799	0.02193	0.12149	1.00000	
Sqeddist	18	0.19004	0.35653	-0.13597	0.85718	-0.06619	0.47250	0.13284	1.00000
		1	2	3	4	11	13	15	18
		Riders	Distance	Trips	Freq. Bus	Nightbus	Class	Sex	Sqeddist

TABLE J-4

INPUT DATA TRANSFORMATION PROGRAM

```
      PROGRAM SURVEY
C     MATRIX (J,J, 1) = DISTANCE
C     MATRIX (J,J, 2) = BUS TIME
      DIMENSION KOUNT(24)
      DIMENSION MATRIX(23,24,3),FREAK(23),DEST(16),
     2RIGIN(16),TRIP(16),TIM(16)
C
C     THE FIRST SECTION OF THIS PROGRAM READS CARDS
C     CONTAINING THE DISTANCE AND BUS TIMES BETWEEN EACH
C     ORGIN AND DESTINATION AS WELL AS THE FREQUENCY OF BUS
C     SERVICE TO EACH AREA SO THAT VARIABLES X2, X4, X5, X12
C     AND X17 COULD BE CALCULATED.
C
      READ(60,100)(((MATRIX(I,J,K),J=1,23),I=1,23),K=1,2)
  100 FORMAT(16I5)
      READ(60,86)(FREAK(I),I=1,23)
   86 FORMAT(19F4.1/4F4.1)
C
      DO 6 I=1,24
      KOUNT(I)=I
    6 CONTINUE
      WRITE(61,999)
  999 FORMAT(*1*,2X,*ORIGIN*,43X,*DESTINATION*)
      WRITE(61,98) (KOUNT(I),I=1,13)
   98 FORMAT(11X,12(I2,8X),I2)
      DO 31 I=1,23
      WRITE(61,97)I,((MATRIX(I,J,K),J=1,13),K=1,3)
   97 FORMAT(*-*,I2, 13(3X,I7)/(3X,13(3X,I7)))
   31 CONTINUE
      WRITE (61,85) (KOUNT(I),I=14,24)
   85 FORMAT(*1*,11X,11(I2,8X))
      DO 32 I= 1,23
      WRITE(61,96)I,((MATRIX(I,J,K),J=14,24),K=1,3)
   96 FORMAT(*-*,I2,11(3X,I7)/(3X,11(3X,I7)))
   32 CONTINUE
      WRITE(61,8)(FREAK(M),M=1,23)
    8 FORMAT(*-*,10X,23(F4.1,1X))
C
C     THIS SECTION READS THE DATA CARDS FOR EACH
C     OBSERVATION.
C
 1111 BUS=0.0$X2=0.0$X3=0.0$TIME=0.0$SAVE=0.0$X5=0$X6=0.0
    1 READ(60,101)NUMBER,X13,X24,X1,X9,X41,X7,X8
  101 FORMAT(F4.1,F1.0,F1.0,6X,F1.0,12X,F1.0,2X,F2.0,F2.0,
     22X,F2.0)
      IF(EOF,60)2, 3678
```

TABLE J-4 (CONTINUED)

```
 3678 IF(X24.EQ.1.0.OR. X24.EQ.2.0) GO TO 666
      X14=1 $GO TO 667
  666 X14=0
  667 IF(X24.EQ.1.0.OR.X24.EQ.3.0)GO TO 668
      X15=0 $ GO TO 23
  668 X15=1
   23 READ(60,123)(DEST(I),RIGIN(I),TRIP(I),TIM(I),I=1,16)
  123 FORMAT(5X,8(4F2.0,1X)/5X,8(4F2.0,1X))
    4 READ(60,104)X11,N21,N20,X10
  104 FORMAT(17X,F2.0,I2,I2,28X,F1.0)
      DO 7 M=1,16
      I=RIGIN(M)
      J=DEST(M)
      IF(RIGIN(M).EQ.0.0) GO TO 8
      IF(RIGIN(M).EQ.DEST(M))GO TO 707
      WALK=(MATRIX(I,J,1)/325)-(TIM(M))
      IF(WALK.LE.0.0) GO TO 61
      X6=WALK+X6
   61 BUS=MATRIX(I,J,2)*TRIP(M)+BUS
      X2=MATRIX(I,J,1)*TRIP(M)+X2
      TIME=TIM(M)*TRIP(M)+TIME
      X3=TRIP(M)+X3
  707 CONTINUE
    7 CONTINUE
    8 X5=(X2/325.0)-BUS
   12 X12=FLOAT(MATRIX(N21,N20,1))
      X4=FREAK(X41)
      I=X41
      X17=MATRIX(I,15,1)
      X17=X17/1000.0
      X18=X17**2
      X2=X2/1000.0
      X12=X12/1000.0
      X19=X3**2
      X20=X3**3
C
C     THE CONSTANTS IN STATEMENT 1627 WERE OBTAINED FROM
C     THE FIRST LEAST SQUARES PASS. THEY ARE THE BETA VALUES
C     FOR THE VARIABLES THAT WERE STATISTICALLY SIGNIFICANT
C     AT THE 95% LEVEL.
C
 1627 SIGMA=0.66939833+0.00663962*X2-0.02252124*X3-0.0757274
     23*X4-0.00323548*X11-0.03493648*X13-0.09959257*X15+0.01
     3361811*X18
      SIGMA = SIGMA - SIGMA**2
      X16=1.0/SQRT(ABS(SIGMA))
      WRITE(32,105)X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X1
     23,X14,X15,X16,X17,X18,X19,X20
```

TABLE J-4 (CONTINUED)

```
  105 FORMAT(F1.0,2F9.3,F4.1,2F9.0,2F2.0,2F2.0,F2.0,F7.3,3F2
     2.0,F15.9,F7.3,F10.6,F10.3,F12.3)
      WRITE(61,106)X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X1
     23,X14,X15,X16,NUMBER,SIGMA,X17,X18
  106 FORMAT(* *,F1.0,2F9.3,F4.1,2F9.0,2F2.0,2F2.0,F2.0,F7.3
     2,3F2.0,F15.9,F7.1,F15.9,F10.3,F10.6)
      GO TO 1111
    2 CONTINUE
      END
RUN,1.00,1000
```

APPENDIX K

LEAST SQUARES MULTIPLE REGRESSION ANALYSIS OF THE EFFECT OF WEATHER ON BUS RIDERSHIP

APPENDIX K

LEAST SQUARES MULTIPLE REGRESSION ANALYSIS OF THE EFFECT OF WEATHER ON BUS RIDERSHIP

The purpose of this analysis as stated in Chapter III was to see whether various weather factors affected daily bus ridership. Data were obtained as follows:

Daily Bus Ridership--these data were obtained from the daily counts made by each bus driver on each run and totaled at the end of the day by the office staff.

Gate cards--Faculty and staff members can ride the bus system without charge by showing the gate card they normally use to gain entry to faculty parking areas. Since the drivers keep a daily count of the number of gate cards used as boarding passes on each run, this count was used to establish the number of faculty and staff members who used the bus.

Weather measures--Daily indicators of weather were obtained from the Local Climatologists Data published monthly by the Environmental Data Service of the United States Department of Commerce. Data obtained included:

a. average daily temperature in degrees Fahrenheit
b. daily precipitation in inches of water between 7 A.M. and 7 P.M.
c. average daily wind speed in miles per hour

d. average daily sky cover from sunrise to sunset in tenths

e. daily humidity readings at 1 P.M. Eastern Standard Time

f. average daily wind chill index (average daily temperature in degrees Fahrenheit minus average daily wind speed in miles per hour).

These data were collected for fall quarter 1969. Unusual days such as Thanksgiving holidays, the days the drivers were on strike, and "Moratorium Day" were omitted since they did not represent typical ridership patterns.

The daily bus ridership for both faculty and staff and for students was adjusted to eliminate the daily fluctuation. This was necessary since Mondays and Wednesdays were typically heavy ridership days with Thursday and Fridays substantially lighter. Daily index numbers for student riders are given in Table K-1 below.

TABLE K-1

DAILY BUS RIDERSHIP INDEX NUMBERS
FALL QUARTER 1969

Day	Index Number
Monday	1.080
Tuesday	1.002
Wednesday	1.010
Thursday	0.973
Friday	0.935

Adjusted daily ridership was defined as the actual ridership divided by the daily index number. Table K-2 indicates the adjusted number of student riders and Table K-3 indicates the adjusted number of faculty and staff riders.

These adjusted bus ridership data were entered into the least squares multiple regression program[1] with one run using student ridership as the dependent variable and the other run using faculty and staff ridership as the dependent variable.

Table K-4 gives the simple correlations between each of the entered variables. Table K-5 presents the analysis of variance and regression data for student ridership with respect to all six weather variables. Table K-6 presents the same data; however, faculty and staff ridership has been substituted as the dependent variable. Tables K-7 and K-8 present a simple regression against the most significant single variable--average wind speed. Student ridership is the dependent variable in Table K-7 and faculty and staff ridership is the dependent variable in Table K-8.

---

[1]The Agricultural Experiment Station at Michigan State University has produced a series of statistical programs which are described in 40 mimeographed descriptions. Each description describes a different feature of the program. The least squares multiple regression routine is described in description number 7.

TABLE K-2

NUMBER OF STUDENT BUS RIDERS (ADJUSTED)

Week	Mon.	Tue.	Wed.	Thur.	Fri.
1	37142	38646	40824	36245	34949
2	38738	37161	22947	38898	39256
3	36193	35052	39602	36638	35519
4	34946	35343	37858	36937	35925
5	36036	37489	30712	34710	33579
6	37191	36409	41467	37708	38132
7	34623	36217	39511	39044	35956
8	35713	34304	38726	30677	37323

TABLE K-3

NUMBER OF FACULTY AND STAFF BUS RIDERS (ADJUSTED)

Week	Mon.	Tue.	Wed.	Thur.	Fri.
1	91	81	76	44	124
2	72	66	33	51	19
3	57	71	48	87	30
4	73	49	83	88	81
5	71	54	89	44	57
6	71	81	74	69	116
7	59	75	118	122	127
8	64	86	68	72	59

TABLE K-4

SIMPLE CORRELATIONS

		Ridership	Avg.Temp.	Avg.Wind	Precipi-tation	Skycover	Humidity	Chillidx	Gatecards
Pass	1	1.00000							
Avg. Temp	2	0.05081	1.00000						
Avg. Wind	3	0.26617	0.24093	1.00000					
Precipitation	4	0.01167	0.27676	0.37863	1.00000				
Skycover	5	0.19722	0.21234	0.28921	0.36381	1.00000			
Humidity	6	0.05670	0.21170	0.19276	0.51177	0.70314	1.00000		
Chillidx	7	0.00111	0.93727	-0.06250	0.13641	0.09506	0.14734	1.00000	
Gatecard	8	0.02313	-0.20513	-0.06847	0.05862	0.13525	0.22556	-0.17193	1.00000
		1	2	3	4	5	6	7	8

TABLE K-5

STUDENT RIDERSHIP VS WEATHER

X(1) = P(X(2) ... X(7))

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG. OF FREEDOM	MEAN SQUARE	F	SIG
Regression (about mean)	29919744.36669922	6	4986624.06103516	0.9251	0.490
Error	172500047.32421875	32	5390626.47888184		
Total (about mean)	202419791.69140625	38			

OBSERVATIONS	MULTIPLE CORR. COEFS.				S STANDARD ERROR OF ESTIMATE
	R2	R	R BAR 2	R BAR	
39	0.1478	0.3845	-0.0120	0.0000	2321.77227110

	Var	Regression Coefficients	Std. Errors of Coefficients	Beta Weights	Std. Errors of Betas	TB	FB	Sig	Partial Corr.Coefs.	R2 Deletes
Constant	0	35430.98155594	2684.14516866			13.2001	174.2426	0.0005		
Avg.Temp	2	-229.24737712	192.62920822	-1.14855	0.96509	-1.1901	1.4163	0.243	-0.20587	0.11009
Avg.Wind	3	371.14463598	204.74272547	0.58434	0.32235	1.8127	3.2860	0.079	0.30516	0.06030
Precip.	4	-1901.70611003	5123.15987432	-0.07711	0.20774	-0.3712	0.1378	0.713	-0.06548	0.14414
Skycover	5	23.15519347	18.87769348	0.29732	0.24240	1.2266	1.5045	0.229	0.21191	0.10774
Humid	6	-23.18206505	40.32377460	-0.14711	0.25589	-0.5749	0.3305	0.569	-0.10111	0.13901
Chillidx	7	218.64982485	182.13725615	1.11807	0.93136	1.2005	1.4411	0.239	0.20759	0.10943

TABLE K-6

FACULTY AND STAFF RIDERSHIP VS WEATHER

(UNRESTRICTED LEAST SQUARES)

X(8) = P(X(2) ... X(7)) Dependent Variable--X(8) Gatecard

AOV FOR OVERALL REGRESSION

	Sum of Squares	Deg. of Freedom	Mean Square	F	Sig
Regression (about mean)	2994.14370316	6	499.02395052	0.8047	0.574
Error	19845.59988642	32	620.17499645		
Total (about mean)	22839.74358940	38			

OBSERVATIONS	MULTIPLE CORR. COEFS.				S STANDARD ERROR OF ESTIMATE
	R2	R	R BAR 2	R BAR	
39	0.1311	0.3621	-0.0318	0.0000	24.90331296

	Var	Regression Coefficients	Std. Errors of Coefficients	Beta Weights	Std. Errors of Betas	TB	FB	Sig	Partial Corr.Coefs.	R2 Deletes
Constant	0	71.31520629	28.79012210			2.4771	6.1359	0.019		
Avg.Temp	2	-1.73422864	2.06613953	-0.81796	0.97451	-0.8394	0.7045	0.407	-0.14677	0.11196
Avg.Wind	3	0.61888565	2.19606903	0.09173	0.32550	0.2818	0.0794	0.780	0.04976	0.12894
Precip.	4	7.54312402	54.95097658	0.02880	0.20977	0.1373	0.0188	0.892	0.02426	0.13058
Skycover	5	0.03126159	0.20248201	0.03779	0.24476	0.1544	0.0238	0.878	0.02728	0.13045
Humid	6	0.43181764	0.43251252	0.25798	0.25839	0.9984	0.9968	0.326	0.17381	0.10403
Chillidx	7	1.15276348	1.95360292	0.55493	0.94045	0.5901	0.3482	0.559	0.10375	0.12164

TABLE K-7

STUDENT RIDERSHIP VS WEATHER

(UNRESTRICTED LEAST SQUARES)

X(1) = P(X(3)) Dependent Variable--X(1) Pass

AOV FOR OVERALL REGRESSION

	Sum of Squares	Deg. of Freedom	Mean Square	F	Sig
Regression (about mean)	14341142.53100586	1	14341142.53100586	2.8213	0.101
Error	188078649.16015625	37	5083206.73400879		
Total (about mean)	202419791.69140625	38			

OBSERVATIONS	MULTIPLE CORR. COEFS. R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
39	0.0708	0.2662	0.0457	0.2139	2254.59680074

	Var	Regression Coefficients	Std. Errors of Coefficients	Beta Weights	Std. Errors of Betas	TB	FB	Sig	Partial Corr.Coefs.	R2 Deletes
Constant	0	34848.95250416	1161.09796414			30.0138	900.8277	< 0.0005		
Avg. Wind	3	169.05952368	100.65066564	0.26617	0.15847	1.6797	2.8213	0.101	0.26617	0.00000

TABLE K-8

FACULTY AND STAFF RIDERSHIP VS WEATHER

(UNRESTRICTED LEAST SQUARES)

X(8) = P(X(3)) Dependent Variable--X(8) Gatecard

AOV FOR OVERALL REGRESSION

	Sum of Squares	Deg. of Freedom	Mean Square	F	Sig
Regression (about mean)	107.06687675	1	107.06687675	0.1743	0.679
Error	22732.67671251	37	614.39666791		
Total (about mean)	22839.74358940	38			

OBSERVATIONS	MULTIPLE CORR. COEFS.				S STANDARD ERROR OF ESTIMATE
	R2	R	R BAR 2	R Bar	
39	0.0047	0.0685	-0.0222	0.0000	24.78702620

	Var	Regression Coefficients	Std. Errors of Coefficients	Beta Weights	Std. Errors of Betas	TB	FB	Sig	Partial Corr.Coefs.	R2 Deletes
Constant	0	78.57745866	12.76510534			6.1556	37.8920	< 0.0005		
Avg. Wind	3	-0.46192911	1.10655293	-0.06847	0.16401	-0.4174	0.1743	0.679	-0.06847	0.00000

APPENDIX L

FORMAT OF PUNCHED CARD USED IN PROCESSING DATA

ITEM	CARD COLUMNS	SURVEY QUESTION
Card 1		
Survey number	1-3	
Card number	4	
Class	5	1
Sex-marital status	6	2
College	7-8	3
Term enrolled at MSU	9-10	4
Term bus pass purchased	11-12	5
Specific terms bus pass purchased	13-21	6
Age	22	7
Home area	23	8
Vehicles owned	24	9
High school travel mode	25	10
Frequency of bus use prior to MSU	26	11
Rating of pre-MSU bus service	27	12
Residency category	28	13
Dorm location	29-30	13
Current quarter credit load	31-32	14
Hours taken in residence hall	33-34	15
Work hours during current quarter	35-36	16
Work location	37-38	
Cards 2 and 3		
Survey number	1-3	
Card number	4	
Day or night trip	5	17,18,19
Trip destination	6-7	17,18,19
Trip origin	8-9	17,18,19
Number of trips each week	10-11	17,18,19
Time available each week	12-13	17,18,19

The above format was repeated seven times on card 2 and eight times on card 3 as needed.

ITEM	CARD COLUMNS	SURVEY QUESTION
Card 4		
Survey number	1-3	
Card number	4	
Arrival preference	5-6	20
Departure preference	7-8	21
Break destination	9	22
Percentage of trips by category	10-17	23
Percentage of trips at night	18-19	24
Origin of longest trip	20-21	25
Destination of longest trip	22-23	25
Class location preference	24	26
Travel mode of friends	25	27
Travel companion	26	28
Did person seek information	27	29
Information source	28	30
Recommendation	29	31
Ridership of information source	30	32
Apprehension about bus schedule	31	33
Desired waiting time	32-33	34
Scheduling method	34	35
Desired service	35	36
Ranking of service variables	36-43	37
Rating of MSU system	44-51	37
Overall rating of MSU system	52	38
Free bus system adoption	53	39
Support of free bus system	54	40

APPENDIX M

DETAILED EXAMINATION OF MICHIGAN STATE UNIVERSITY BUS UTILIZATION

1969-70 WEEKDAY BUS UTILIZATION

(Number of Buses)

Route	A.M. 7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10
							FALL TERM									
Brody	5	5	5	5	5	5	5	5	5	5	5	5	2	2	2	2
Spartan	4	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
Commuter	3	2	2	2	2	2	2	2	2	2	2	2/				
Circle	4	4	4	4	4	4	4	4	4	4	4/					
Express	4	4	4	4	4	4	4	4	4/							
Total	20	18	18	18	18	18	18	18	18/14	14	14/10	9	4	4	4	4
Excess Capacity	5	7	7	7	7	7	7	7	7/11	11	11/15	16	21	21	21	21
							WINTER TERM									
Brody	7	7	7	7	7	7	7	7	7	7	7	7	2	2	2	2
Spartan	5	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2
Commuter	3	2	2	2	2	2	2	2	2	2	2	2/				
Circle	5	5	5	5	5	5	5	5	5	5	5/					
Express	5	5	5	5	5	5	5	5	5/							
Total	25	23	23	23	23	23	23	23	23/18	18	18/13	11/9	4	4	4	4
Excess Capacity	3	5	5	5	5	5	5	5	5/10	10	10/15	17/19	24	24	24	24
							SPRING TERM									
Brody	5	5	5	5	5	5	5	5	5	5	5	5	2	2	2	2
Spartan	4	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
Commuter	2	1	1	1	1	1	1	1	1	1	1	1/				
Circle	4	4	4	4	4	4	4	4	4	4	4/					
Express																
Total	15	13	13	13	13	13	13	13	13	13	13/9	8/7	4	4	4	4
Excess Capacity	8	10	10	10	10	10	10	10	10	10	10/14	15/16	19	19	19	19
							SUMMER TERM									
Brody	1	1	1	1	1	1	1	1	1	1	1					
Spartan	2	2	2	2	2	2	2	2	2	2	2					
Total	3	3	3	3	3	3	3	3	3	3	3					
Excess Capacity	20	20	20	20	20	20	20	20	20	20	20					

1969-1970 WEEKEND BUS UTILIZATION

(Number of Buses)

Fall	7 A.M. - 11 P.M.
Brody	2
Spartan	2
Total	4
Excess Capacity	21
Winter	
Brody	2
Spartan	2
Total	4
Excess Capacity	24
Spring	
Brody	2
Spartan	2
Total	4
Excess Capacity	19
Summer	
Excess Capacity	23

APPENDIX N

QUARTERLY FINANCIAL STATEMENT

ADJUSTMENT DATA

APPENDIX N

QUARTERLY FINANCIAL STATEMENT ADJUSTMENT DATA

	1964-65	1965-66	1966-67	1967-68	1968-69
1/4 Annual Interest	4,648.37	5,336.32	6,035.79	5,493.11	4,479.68
1/4 Annual Overhead	750.00	750.00	750.00	750.00	750.00
Quarterly Purchase Reserve				15,000.00[a]	15,000.00[a]
Quarterly Adjustment	(5,387.37)	(6,086.32)	(6,785.79)	8,756.89	9,770.32

[a]Purchase reserve transfer was not made summer quarter.

NOTE: Adjusted Income = Reported Income - 1/4 annual interest charge - 1/4 annual overhead + quarterly purchase reserve.

APPENDIX O

BUS SYSTEM GUIDELINES AS DRAWN UP BY MICHIGAN STATE UNIVERSITY AND BLACK STUDENT GROUP

MICHIGAN STATE UNIVERSITY - CAMPUS BUS SYSTEM

Guidelines for Passengers

1. The buzzer cord to signal a desired stop should not be pulled until after the bus leaves or passes the preceding bus stop. The buzzer cord should be pulled in time to permit safe operation of the bus as it approaches the desired stop.

2. Only the bearer of a pass will be allowed to ride the bus. Once the passenger has entered the bus, he cannot allow another individual to use his pass by handing it out through the window or to someone exiting the bus.

3. If a bus pass is mutilated or defaced, it will not be accepted as a legitimate pass. A mutilated or defaced pass may be exchanged for a new one at no cost at Room #142, John A. Hannah Administration Building. Expired bus passes are void and will not be honored.

4. Passengers should not walk in front of the bus upon exiting. Passengers should exit at the rear door and enter at the front door.

5. Passengers will be loaded at bus stops only. No one should sit or stand on the curb at the bus stop at any time.

6. Passengers should refrain from conversation with the driver.

7. Passengers are not to stand in front of the white safety line at the entrance to the bus. The drivers are not to proceed if loading is such that the area in front of the white line is occupied by passengers.

MICHIGAN STATE UNIVERSITY - CAMPUS BUS SYSTEM

Operating Guidelines for Drivers

1. Buses will load and unload passengers at any time the bus is normally stopped at bus stops. Unloading at other locations where the vehicle is normally stopped may be permitted by the driver if traffic conditions permit. There will be no additional stops, with the exception that blind passengers or crippled passengers will be helped in any manner determined feasible by the driver.

Once a bus has started in motion, it will not stop to allow the loading of any additional passengers. Shaw Lot will be the only exception to this guideline.

Drivers will follow the practice of common courtesy. Safe load limits, traffic conditions, and safety of the passenger and vehicle will be the factors determining when the driver will not permit additional passengers to load. Standing passengers must be behind the white line.

2. Drivers are to maintain to the best of their ability a schedule that corresponds to the printed bus schedule. Time of departure should not be before the scheduled time but can be after at the discretion of the driver.

3. Conversation between the driver and the rider will be limited to a courteous greeting and answers to direct questions. There will be no talking between drivers and passengers while the bus is in motion.

4. Initial contact with a passenger by the driver should be verbal and performed in a courteous manner. Physical restraint of the passenger should not be employed by the driver.

5. If a problem occurs that threatens the security of the passenger, the driver, or the bus, the driver will have the prerogative to shut down the bus and to leave to call the appropriate authorities. When so doing, the driver will remove the key and open the two doors so that passengers will be able to exit and board other buses.

6. The bus will not normally be pulled off its route for any reason pertaining to conflict with passengers unless the driver determines the situation to be an emergency.

7. The driver will check all passes under normal operating conditions. When a questionable (forged - mutilated) pass is presented, the driver will ask the rider for the pass and identification. The driver has the authority to confiscate a forged or mutilated pass. If a conflict occurs, the driver will ask the rider to leave the bus. If the rider refuses and further conflict is evident, the driver will have the prerogative to shut down the bus and to leave to call the appropriate authorities. When so doing, the driver will remove the key and open the two doors so that passengers will be able to exit and board other buses.

8. Bus drivers will wear identification tags and will also identify themselves at the request of a passenger.

APPENDIX P

ANNOUNCEMENT OF BUS SYSTEM BOYCOTT BY MEMBERS OF WONDERS DORM COUNCIL

Dear Resident of South Complex,

You are probably aware of and have heard students complaining of the inequality of bus service that our complex receives. As is evident, the other complexes have more efficient service. In addition, their buses run directly through main campus.

The members of Wonders General Council feel that it is time for South Complex to voice its complaints. Thus, we would like to urge you to,

1. Review your spring term schedule, and if at all possible, do not buy a bus pass.
2. We realize that in many cases not buying a bus pass will be an impossibility. For those of you who must ride the busses spring term, we would like to suggest a line of action as demonstrative as boycotting the sale of passes. Every time a bus is late, every time a bus passes you by, every time you have to stand in the rain or a driver is discourteous to you, please call the following number to voice your complaint. Call,

35280

Central Bus Services

The important idea is making the voice of South Complex heard outside of our dorms. We would appreciate your cooperation and any suggestions.

Sincerely,

Vicki Jacobs
32328

Jean Malesky
32465

Wonders General Council

[NOTE: The telephone number given in this announcement is listed in the MSU Telephone Directory under the heading of "Bus Service." In the evenings it is answered by one of the motor pool mechanics.]

APPENDIX Q

MEADOWBROOK TRACE BUS SCHEDULE

MEADOWBROOK TRACE Apartments
4925 DUNCKEL RD. LANSING, MICHIGAN 48910
PHONE 517/ 393-0210

Meadowbrook Trace Bus Schedule :

Leave Meadowbrook	Leave Show Lot, MSU
7:25 A.M.	8:00 A.M.
8:35 A.M.	9:10 A.M.
9:45 A.M.	10:20 A.M.
10:55 A.M.	11:30 A.M.
12:05 P.M.	12:40 P.M.
1:15 P.M.	1:50 P.M.
2:25 P.M.	3:00 P.M.
3:35 P.M.	4:10 P.M.
4:45 P.M.	5:20 P.M.

Pick up at Meadowbrook Trace on Beau Jardin Dr. by A-2, C-1, and the Big Tree.

APPENDIX R

RESIDENCY AND ENROLLMENT STATISTICS FOR MICHIGAN STATE UNIVERSITY BY QUARTER FROM 1964 TO 1969

APPENDIX R

RESIDENCY AND ENROLLMENT STATISTICS FOR MICHIGAN STATE UNIVERSITY BY QUARTER FROM 1964 TO 1969

YEAR	QUARTER	ENROLLMENT	RESIDENTS ON CAMPUS
1964	Fall	31,268	17,945
1965	Winter	29,316	16,903
	Spring	28,364	16,188
	Summer	10,371	2,714
	Fall	35,451	20,181
1966	Winter	33,242	19,473
	Spring	32,140	18,529
	Summer	11,884	2,473
	Fall	38,107	21,357
1967	Winter	35,475	20,435
	Spring	34,122	19,463
	Summer	13,664	2,681
	Fall	38,758	21,119
1968	Winter	36,265	20,154
	Spring	35,072	19,308
	Summer	15,003	2,787
	Fall	39,949	21,519
1969	Winter	37,557	20,415
	Spring	36,607	19,308
	Summer	16,009	2,293

SOURCES: Office of the Registrar, Michigan State University, Annual Report, 1969; Division of Dormitories and Food Services, Michigan State University, "Weekly Housing Report."

The total number of dormitory residents was taken from the 2nd week report for each quarter listed in this appendix.

The estimated census for married student housing was obtained from Mr. John Roetman, Manager of the MSU Married Housing Office.

APPENDIX S

RESIDENCY AND RIDERSHIP STATISTICS FOR MICHIGAN STATE UNIVERSITY BY QUARTER FROM 1964 TO 1969

RESIDENCY AND RIDERSHIP STATISTICS FOR MICHIGAN STATE UNIVERSITY

BY QUARTER FROM 1964 TO 1969

Year	Quarter	Residents on Campus	Bus Pass Sales	Per Cent Ridership
1964	Fall	17,945	3,173	17.7
1965	Winter	16,903	6,164	36.5
	Spring	16,188	3,232	20.0
	Summer	2,714	935	34.5
	Fall	20,181	6,619	32.8
1966	Winter	19,473	9,935	51.0
	Spring	18,529	4,834	26.1
	Summer	2,473	956	38.7
	Fall	21,357	9,140	42.8
1967	Winter	20,435	11,771	57.6
	Spring	19,463	5,999	30.8
	Summer	2,681	1,247	46.5
	Fall	21,119	8,483	42.1
1968	Winter	20,154	9,652	47.9
	Spring	19,308	5,194	26.9
	Summer	2,787	786	28.2
	Fall	21,519	8,318	38.7
1969	Winter	20,415	9,732	47.7
	Spring	19,308	6,111	31.7
	Summer	2,293	567	24.7

SOURCES: The total number of dormitory residents was taken from the second week report for each quarter listed in this appendix.

The estimated census for married student housing was obtained from Mr. John Roetman, Manager of the MSU Married Housing Office. This estimate was very accurate for the fall, winter, and spring quarter. Summer quarter, however, could not be estimated closely since it was not known how many of the married housing residents attended school during summer quarter.

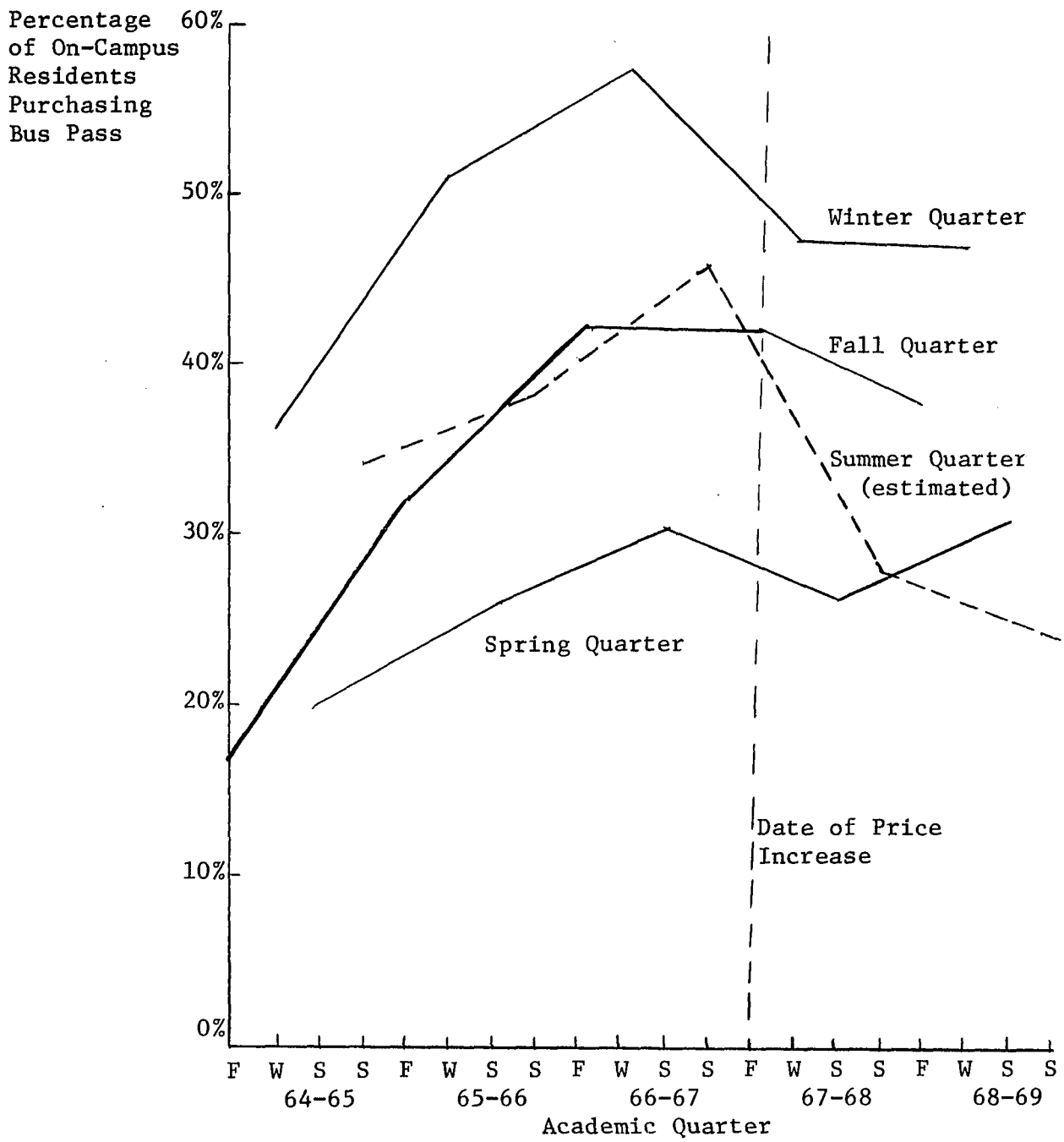

Fig. S-1.--Bus pass sales trend among on-campus residents only.