SWIFT

Seattle Wide-area Information For Travelers

Consumer Acceptance Study

Contract Number: WSDOT Y-5908

Prepared for:
Washington State Department of Transportation
1107 N.E. 47th Street, Rm. 535
Seattle, Washington 98105

Prepared by:
Jeffrey Trombly Ph.D.
Bruce Wetherby Ph.D.
Andrew Dixson

Science Applications International Corporation
7927 Jones Branch Drive Suite 200
McLean Virginia 22102

WA-RD 462.2
October 19, 1998

SAIC Science Applications International Corporation
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EXECUTIVE SUMMARY

The Seattle Wide-area Information for Travelers (SWIFT) 0perational Test was intended to evaluate the performance of a large-scale, urban Advanced Traveler Information System (ATIS) deployment in the Seattle area. With the majority of the SWIFT system completed by June 30, 1996, the SWIFT Field Operational Test (FOT) evaluation was conducted from July 1, 1996 through September 20, 1997. The unique features of the SWIFT ATIS included the provision of information for multiple transportation modes, the delivery of this information using three different devices and the use of FM sideband as the primary communications medium. A total of 690 system users were recruited during the course of the study, including 520 Seiko MessageWatch users, 90 users of the Delco in-vehicle-navigation device and 80 users of the SWIFT portable computers.

Purpose of Test. The *SWIFT Consumer Acceptance Study* was one of five component studies to the overall system evaluation. This report details the findings for the *SWIFT Consumer Acceptance Study* based on the evaluation objectives that were identified in the SWIFT Evaluation Plan (1995). The primary objectives of the *SWIFT Consumer Acceptance Study* were to assess the following:

- Importance of traveler information in travel planning
- Usefulness of SWIFT traveler information in travel planning
- Minimum set of user services and device features required to provide viable product and services
- User perceptions of SWIFT device usefulness
- Willingness-to-pay for different services.
- User perceptions of changes in travel convenience and efficiency
- User perceptions of changes in traffic congestion, air quality, energy consumption, and safety.

Additional *SWIFT Consumer Acceptance Study* objectives, conducted in support of the *SWIFT Architecture Study*, were to assess the following:

- SWIFT system reliability from a user perspective
- SWIFT system availability from a user perspective.

Methods. A variety of data-collection efforts were completed, including questionnaires, focus groups and telephone interviews. The questionnaires contained items that addressed objectives set out in the evaluation plan. The focus groups were conducted with small groups of users to obtain qualitative impressions from a smaller subset of users who were encouraged to speak openly and share their perceptions with other users.

The *SWIFT Consumer Acceptance Study* focused on measurement and analysis of user perceptions toward SWIFT system usefulness and performance. No attempt was made to quantify the system level impacts of SWIFT services on congestion, air quality, energy consumption or safety in the Seattle region. Rather, the assessment of system-level transportation impacts was limited to examining subjective data (e.g., traveler's perceptions) collected from users and determining whether these perceptions were consistent with a benefit.

Perceptions of Importance of Traveler Information

Results indicated that SWIFT users tended to place a high degree of importance on incident and congestion-related information in travel planning. Incident location and duration information was rated quite high in importance along with general traffic congestion information. For the group as a whole, information concerning bus schedule and route information and bus-location information was rated very low in importance, although these ratings were much higher in those users that actually used the bus. This was consistent with the automobile dependence reported by the group, and suggests that information concerning non-automobile options would not be used by the automobile-dependent group. Since users of the SWIFT portable computer were recruited from among transit users, this group generally rated transit information higher than other device users groups. However, the importance of this information was not as high as congestion and incident-related information.

Receipt of various general-information messages was not rated very high in importance by questionnaire respondents, with the exception of weather, sports and news items. Most SWIFT respondents indicated that the receipt of financial and other environmental information was not important. Of course, from a transportation-impact point of view, the receipt of these general-information messages was inconsequential. However, if device users were attracted by these messages it may make such services commercially viable to augment any potential benefit perceived by users through the receipt of travel-related information.

Perceptions of SWIFT Traveler Information Usefulness

Users tended to view the messages they received from the SWIFT systems as accurate, reliable, timely, easy to understand and useful. Among device types, respondents representing users of the Seiko MessageWatch expressed concern with the timeliness of incident-related messages. In addition, these respondents tended to rate ease of understanding lower than other user groups. Users of the Delco in-vehicle-navigation devices and SWIFT portable computers experienced problems in receiving personal-paging messages and these problems were reflected in respondent ratings.

The map-based display provided by the SWIFT portable computer resulted in generally higher ratings for this device over other devices in understanding incident location and the nature of congestion. Seiko MessageWatch users reported difficulty in understanding the extent of expected delay as well as the nature of congestion, while Delco in-vehicle-navigation device respondents reported difficulty in understanding the period of time for which a message applied.

Generally speaking, SWIFT participants endorsed a wide-range of improvements to messages provided by the SWIFT system. Most seemed to consider the operational test as a suggestion of what might be possible, rather than a demonstration of a final product. Among Seiko MessageWatch users, respondents expressed a desire for improved timeliness of messages as a top priority. Delco in-vehicle-navigation device respondents endorsed the need to develop route-specific messages and SWIFT portable computer respondents expressed a desire to cover more roads as a high-priority improvement.

Perceptions of Desired Services and Features

An examination of user perceptions regarding the physical and operational performance of their SWIFT devices reveals the following:

Delco in-vehicle navigation device— respondents reported a high level of satisfaction with the physical characteristics of the device. The most frequently encountered problems included difficulty in operating the message-filtering feature and difficulty in reading the monitor in sunlight. Respondents expressed a high level of dissatisfaction with the personal-paging feature and were somewhat neutral toward the voice sound "reading" messages. Respondents, however, did not perceive the "voice" announcement of messages a safety concern. Respondents endorsed a number of improvements to the unit features and operation, including the addition of a map-based display, provision of route-specific information and alternative-route information.

Portable Computer— results indicated that users were extremely dissatisfied with the Dauphin device both in terms of physical and operational characteristics. The IBM and Toshiba Portable Computers were rated more positively, but in general respondents were dissatisfied with the size and weight of the devices and the design of the communications connection (i.e., separate SWIFT portable computers and RRMs connected by a serial cable). Respondents using the IBM and Toshiba rated the information display feature of these devices quite high (in particular, the map information provided), and generally endorsed the need for a smaller, lighter and more portable device with an easier communications connection.

Seiko MessageWatch— Respondents rated the physical and operational characteristics of the device very high. However, improvements to the message display, including background lighting and message encoding, were recommended. Respondents endorsed a need for a full alphanumeric display, more storage capability, and different types of bands. Finally, respondents found travel profiles easy to use but quite limiting in some cases. Respondents suggested that on-line update capability would provide the flexibility to maximize the usefulness of profile data.

Perceptions of SWIFT Usefulness

Participants were clearly making use of the SWIFT information for travel planning. The results indicated that most users were consulting their devices to make travel-related decisions at least weekly. The results indicated that many device users relied upon commercial broadcasts as a first choice in trip planning with the SWIFT device used as a primary source for a significant number of participants. Users of the Seiko MessageWatch and Delco in-vehicle-navigation device found their devices to be convenient, comfortable, safe and easy to use. Users of the SWIFT portable computer generally rated their devices lower in these areas.

Perceptions of Willingness-to-Pay

SWIFT participants were eager to maximize opportunities to avoid congestion and improve travel convenience, safety and efficiency. Therefore, given some improvements in the service, they expressed a willingness to pay for the service. In focus groups, estimates of the value of

SWIFT service tended to range between $5 and $10 per month. In questionnaires, willingness-to-pay was derived by asking participants to compare the value of other services with that of SWIFT. In this comparison, SWIFT was viewed as more valuable than on-line services (e.g., MSN, America On-line), satellite television, and 4-hours of parking in downtown Seattle. Traffic information on the radio was rated higher in value than SWIFT and similar to telephone voice mail and cellular phone service. Based on this comparison of value with other products and services, it was concluded that users might be willing to pay up to $20 per month for a SWIFT service

Perceptions of Changes in Travel Convenience and Efficiency

Users tended to perceive that SWIFT services allowed them to reduce stress and commute times, and allowed them to "keep moving." Reducing travel distance or changing means of travel were not viewed as major benefits. User of transit-related information stated that the SWIFT services provided them an opportunity to improve transfers, reduce stress and stay inside while waiting for the bus.

Users reported that radio traffic reports, actually encountering the incident, and SWIFT travel messages were key factors in influencing route choice decisions on a weekly basis. In the majority of cases, commuters implemented route-changing behavior to avoid congestion and did not report frequent mode changes in response to congestion.

Portable computer users were surveyed twice near the end of the SWIFT FOT regarding their use of real-time transit information. In these two surveys, one a telephone interview and the second a written questionnaire that was completed upon device return, 54% of the surveyed SWIFT portable computer users, on average, indicated that they used the real-time bus information. Of this group, 94% indicated that the display of this information was useful, while 81% indicated that the bus timepoint information was useful.

Regarding the specifics of their use of real-time SWIFT bus-location information, 33% of the respondents indicated that they used this information to monitor more than one bus route at a time. 2.2 was the average number of buses that were reported to be monitored at the same time by this group. Note, however, that for SWIFT, only one bus could be displayed if timepoint information was simultaneously displayed— thus, use of SWIFT timepoints necessarily restricted the use of real-time SWIFT bus-location information to monitor more than one bus at a time. Nonetheless, 18% of those SWIFT users who displayed real-time bus positions reported that this information was helpful in making transfers more convenient. These findings suggest that real-time bus position information was useful for making transfer decisions (e.g., when to get off their current bus in order to transfer to a bus that will take them more directly to their destination) among those who monitor more that one bus at a time.

Other findings regarding the use of real-time SWIFT bus-location information indicated:

- 50% used the information to monitor the arrival of buses
- 50% said it caused them to take alternative transportation modes (which direction, bus to vehicle or vehicle to bus, was not specified)

- 38% used the information to help them decide what bus to take
- 36% said the information made them feel less anxious about waiting for a bus
- 31% said it helped reduce bus-wait times
- 18% (corroborating earlier-reported results) reported that it helped them make bus-transfer decisions
- 12% reported that it increased their bus ridership

Regarding the use of the other information that was presented on the SWIFT portable computers, in addition to the real-time, bus-position data, SWIFT participants indicated that 78% used the congestion, or speed-flow, information; 54% used the traffic incident information; 49% used the street-address-search feature; 46% reported that the SWIFT map display helped them find alternative routes of travel; 40% used the "Yellow Pages" feature which provided telephone and address information for local businesses and organizations; and only 3% reported using the general information message and paging features of the system.

The high-level of dependence on SWIFT congestion, or speed-flow, information by SWIFT portable-computer users suggests that this information is very useful for making transit-related decisions, such as deciding whether to take the bus, which bus to take or when to take the bus. The low-level of reported usage of the SWIFT general-information messages and paging service was due to the fact that these services were generally not available for the majority of the SWIFT portable-computer users throughout the field operational test due to technical difficulties.

Perceptions of Changes in Traffic Congestion, Air Quality, Energy Consumption, and Safety

Participants perceived a number of benefits as a result of widespread use of the SWIFT services, including avoiding congestion, making better use of time, planning better routes, reducing stress, and saving travel time. Focus group participants were hopeful that widespread use of SWIFT services would reduce congestion and commute times.

Perceptions of System Reliability

Users generally found the devices to be reliable. Seiko MessageWatch users reported the highest reliability rates followed by Delco in-vehicle navigation device users, and SWIFT portable computer users. In focus-group discussions, SWIFT portable computer users expressed a concern with the signal connection and the receipt of general-information messages. These perceptions were due to technical problems associated with the receipt of general-information messages by these devices.

Perceptions of System Availability

Participants generally perceived that the SWIFT system was available. High terrain and being inside buildings appeared to have the greatest impact on receipt of messages for portable computer users. Users of the Delco in-vehicle-navigation device reported problems in receiving messages while in parking garages. Users of the Seiko MessageWatch reported few problems with the receipt of messages.

Conclusions. The SWIFT FOT was a successful demonstration of HSDS technology for presenting ATIS data to travelers in a large, congested metropolitan area. Three types of traveler information were sent to three groups of SWIFT FOT participants with a reasonable degree of reliability.

SWIFT FOT participants generally viewed SWIFT as a beta—or proof of concept—test rather than a test of a finished product. Nonetheless, most indicated that they found the traveler information to be useful, incorporated it to make travel decisions and came to rely on it. Overall, the conclusions that can be drawn from the SWIFT FOT include the following:

- SWIFT was important for travel planning—the majority of users, regardless of device type, indicated that they found traffic incident and congestion information to be very important for making travel decisions.
- SWIFT was useful for travel planning—most participants, including those receiving the real-time bus-position information, indicated that they found the majority of the information presented by SWIFT to be useful for making travel decisions, such as what road/bus to take, what time to leave, etc.
- SWIFT had many desired features, but many suggestions for improvement were offered. Among those provided were to improve message timeliness, provide route-specific messages, improve accuracy, tell when an incident occurred and provide messages when the system goes down.
- SWIFT devices were perceived as useful, although improvements in portability were suggested for the portable computers, in particular.
- SWIFT participants indicated a willingness to pay of between $5.00 and $20.00 per month for a service that incorporated several improvements to timeliness, accuracy, reliability and convenience
- SWIFT users indicated that information provided by the system primarily helped them to "keep moving," "reduce my stress level" and "reduce my commute time." Others indicated that the information helped them change commute routes, change commute times and saved them time by assisting with the monitoring of bus arrivals.
- SWIFT was viewed as assisting, or improving the following: congestion, time utilization, route planning, stress levels and travel time.
- SWIFT was viewed as a reliable system—93% of Seiko MessageWatch users viewed the system as being available 75-100% of the time, while 79% of Delco-in-vehicle-navigation device and 44% of SWIFT portable-computer users made this attribution.
- SWIFT was viewed as being an available system, but one that was affected by buildings and terrain, particularly the SWIFT portable computers.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The United States (U. S.) Congress passed the Inter-modal Surface Transportation Efficiency Act (ISTEA) in 1991. The purpose of this legislation was to re-invigorate the country's transportation infrastructure by providing needed repairs to the highway system, encouraging the development of inter-modal transportation facilities and applying information technology (IT) solutions to transportation problems.

The Intelligent Transportation Systems (ITS) initiative grew out of ISTEA's interests to apply IT solutions to transportation problems. Specifically, the U. S. Department of Transportation (USDOT) developed the *National Program Plan for ITS* (1994) in order to guide the deployment of ITS around the country. The goals of the USDOT ITS program are to:

- Improve the safety of surface transportation
- Increase the capacity and operational efficiency of the surface transportation system
- Enhance personal mobility and the convenience and comfort of the surface transportation system
- Reduce the environmental and energy impacts of surface transportation
- Enhance the present and future productivity of individuals, organizations and the economy as a whole
- Create an environment in which ITS can flourish

Operational tests present opportunities to develop, deploy and evaluate specific implementations of ITS. According to the Federal Highway Administration (FHWA) document, *Generic ITS Operational Test Guidelines* (1993), prepared by The MITRE Corporation, an ITS Field Operational Test (FOT) is a "joint public/private venture, conducted in the real world under live transportation conditions..." that "...serve[s] as [a] transition between Research and Development (R&D) and the full-scale deployment of [ITS] technologies." Thus, FOTs represent a significant step in accelerating the deployment of ITS in North America.

Conducting FOTs results in feedback from the public regarding the viability and perceived usefulness of a specific ITS implementation. This information can be used by the public and private organizations involved to determine the best approach toward full-scale implementation after the FOT is completed. Also, lessons are learned during the conduct of an FOT that will enable the Federal, State and Local governments in partnership with industry and non-profit, academic institutions to bear, conceive, design, develop and deploy an ITS that provides the best possible services to the traveling public.

1.1. SWIFT Project

On September 8, 1993, the Federal Highway Administration (FHWA) published a request for ITS FOTs. The concept for the SWIFT project was submitted in response to this request on January 6, 1994 by the SWIFT Project Team. The SWIFT Project Team proposed to partner with the FHWA to perform an operational test of a wide-area ITS communications system in the

Seattle area. The proposed system incorporated a flexible FM sub-carrier High Speed Data System (HSDS) that had been developed and commercially deployed in the Seattle area by one of the SWIFT Project Team members. The HSDS would be used to transmit traveler information to three receiving devices provided by other SWIFT Project Team members. It was anticipated that the SWIFT Operational Test would provide valuable information regarding the viability of these devices for traveler information systems. SWIFT Project Team members included:

- Delco Electronics Corp., a subsidiary of General Motors Corporation (Delco)
- Etak, Inc. (Etak)
- Federal Highway Administration (FHWA)
- International Business Machines, Inc. (IBM)
- King County Department of Metropolitan Services (Metro Transit)
- Metro Traffic Control, Inc. (Metro Traffic Control)
- Seiko Communications Systems, Inc. (Seiko)
- Washington State Department of Transportation (WSDOT).

On April 6, 1994, the SWIFT proposal was accepted by the FHWA contingent upon the filing of a signed Memorandum of Understanding (MOU) by all SWIFT Project Team members and a Teaming Agreement between the Washington State Department of Transportation (WSDOT) and the FHWA. The SWIFT MOU was signed on October 18, 1998 and the SWIFT Teaming Agreement was completed on January 10, 1995. Following the fulfillment of these requirements by the SWIFT project team, construction of the SWIFT system was initiated.

In addition to guiding the signing of the SWIFT MOU and Teaming Agreements, WSDOT also negotiated separate contracts with the University of Washington (UW) and Science Applications International Corporation (SAIC) to participate in the SWIFT project. The University of Washington was retained to provide data gathering and fusion services for the project, while SAIC was retained as the independent evaluator. In this regard, SAIC signed their contract with WSDOT on September 13, 1994 and UW on November 17, 1994.

As part of the their contract with WSDOT, the University of Washington also developed and demonstrated a dynamic ride-share matching system called Seattle Smart Traveler (SST). SST used the UW Intranet to match ride requests with drivers. Participants registered and requested/offered rides using a web-like page, and riders would be notified of pending rides by email. The project also used 65 SWIFT Seiko MessageWatchs, or pagers, to let riders know where to call to set up a ride. These SST users also participated in SWIFT and received traffic incidents and general-information messages. A separate evaluation of SST was conducted by the Texas Transportation Institute and, thus, the SWIFT evaluation did not address the SST project.

1.2. SWIFT System Description

An overview of the SWIFT system is shown in Figure 1-1, while Table 1-1 lists the primary types of information that were delivered by SWIFT. Each SWIFT receiving device regularly scanned the FM airwaves to identify, retrieve and display the information/messages intended for it.

The SWIFT system was divided into five (5) data components:

- Generation— gathering of the information to be transmitted
- Processing— formatting of the information to be transmitted
- Transmission— broadcast of the information to travelers
- Reception— receipt of the transmitted information by SWIFT devices
- Interpretation— use of the transmitted information by operational test participants.

Each of these are described in the following sections.

Table 1-1. Information Delivered by SWIFT.

Device/Information Received	Traffic Incidents, Advisories, Scheduled Events and Road Closures	Route Guidance	Traveler-Service Information	Freeway Loop-Sensor Information	Bus Locations and Schedules	Time and Date, Personal Paging and General Information Messages
Seiko MessageWatch	Yes	--	--	--	--	Yes
Delco In-vehicle Navigation Device	Yes	Yes	Yes	--	--	Yes
SWIFT Portable Computer	Yes	--	Yes	Yes	Yes	Yes

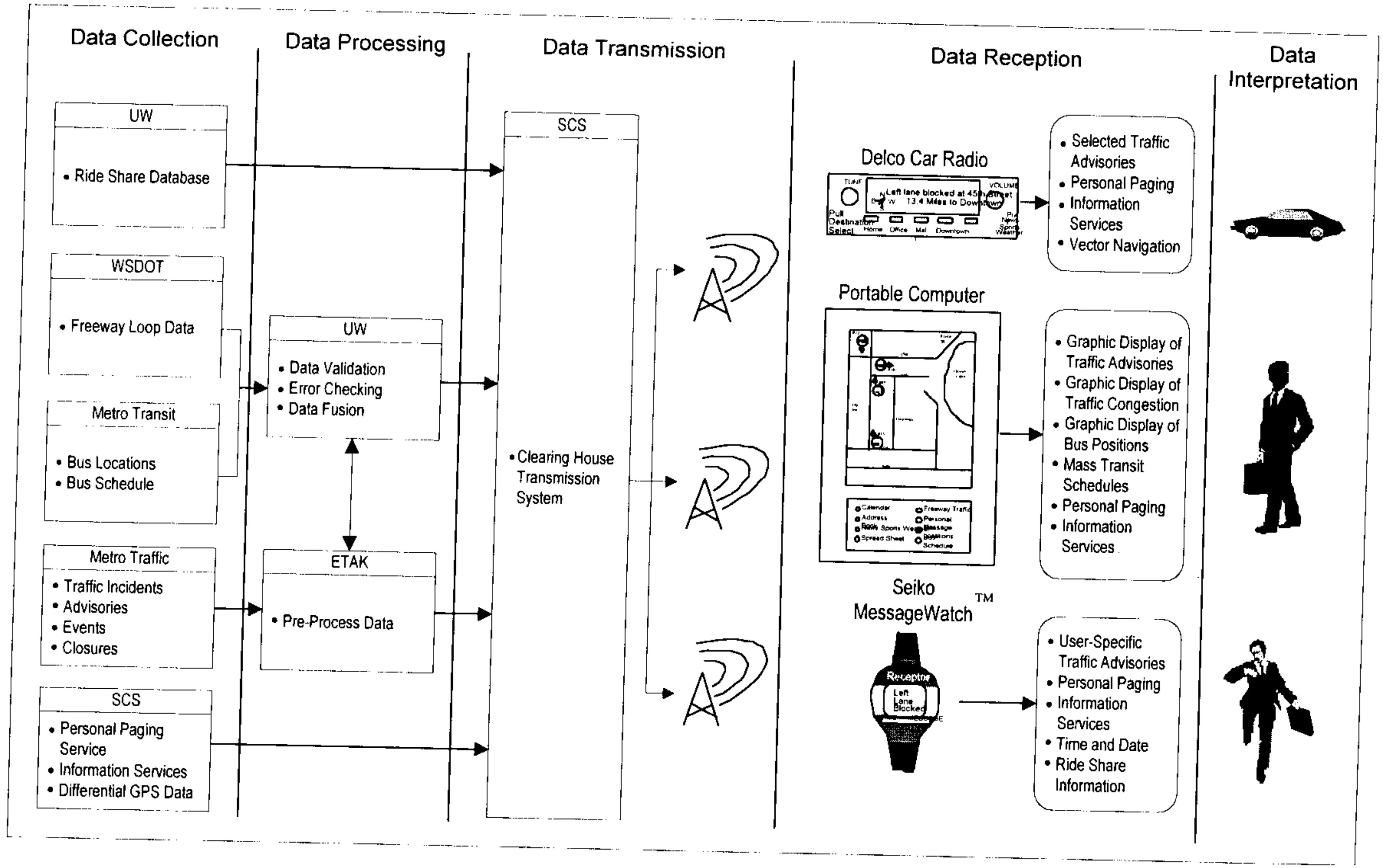

Figure 1-1. SWIFT System Description.

1.2.1. Generation

Table 1-2 provides a listing of the information that was provided to SWIFT FOT participants. This information was generated by Metro Traffic Control, Etak, Delco, WSDOT, Metro Transit and Seiko.

Table 1-2. SWIFT Data Generation.

Data Generator	Data Generated
Metro Traffic Control, Inc.	Traffic Incidents, Advisories, Scheduled Events and Closures
Delco and Etak	Route Guidance
Etak	Traveler-Service Information
WSDOT	Freeway Loop-Sensor Information
Metro Transit	Bus Locations and Schedules
Seiko Communications Systems, Inc.	Time and Date, Personal Paging and General Information Messages

Traffic Incidents, Advisories, Scheduled Events and Closures

This information was generated by Metro Traffic Control personnel who routinely compiled incident information for use in traffic reports delivered to several Seattle-area radio stations. Information, consistent with the International Traveler Information Interchange Standard (ITIS), was entered into a Traffic Work Station (TWS) developed by Etak, Inc. The TWS located the incident and the operator added descriptive information about the incident, such as "truck overturned" or "right lane closed." The TWS then formatted the message for transmission and forwarded it to Seiko.

Route Guidance

As part of the in-vehicle device they developed for the SWIFT project, Delco supplied a route-guidance system that assisted local drivers by providing a directional pointer to pre-selected destinations. This system incorporated a Global Positioning System (GPS) antenna that was placed on the roof of the SWIFT FOT participant's vehicles that participated in this portion of the test, and was tied into a Geographic Information System (GIS) that Etak supplied. Users would select destinations from an "Etak Guide" which contained the latter's geographic coordinates. Users could also enter latitude/longitude coordinates as destinations, save the current positions of their vehicles as destinations and select to receive estimated time of arrival (ETA) information based upon the current speed of their vehicles. The route guidance provided by the directional pointer was static— no turn-by-turn directions were provided, only an arrow pointing in the direction the driver needed to go to reach the destination.

Traveler-Service Information

As indicated, the in-vehicle device for SWIFT provided traveler-service information (i.e., Etak Guide) to its users. This same information was also presented as a "Yellow Pages" directory on the SWIFT portable computers. Users could select the name of local-area businesses or organization by category (e.g., service stations, restaurants, colleges and universities, tourist destinations, etc.) and receive a display of the appropriate address and telephone number in order to guide their travel. Portable computer users could also select to have the locations of their selections presented on the map of Seattle that accompanied the SWIFT application.

Freeway Loop-Sensor Information

Traffic congestion information was derived from the existing WSDOT freeway management system in Seattle. Vehicles were detected with a network of 2,200 standard traffic loops, and UW used the loop information to estimate speeds, which were then expressed as a percentage of the posted speed limit. The speed information was compared to freeway bus speeds to detect any errors. Congestion information was then packaged into a format that could be directly transmitted and sent to Seiko via the Internet.

Bus Locations and Schedules

Bus location and schedule information was provided by King County Metro Transit. Their Automatic Vehicle Location (AVL) system uses small roadside transmitters, wheel (distance) sensors and pattern matching to locate buses in the system. Each location was updated about once every minute and a half. Raw data from Metro Transit's system were sent to UW, where each coach location was converted into latitude and longitude. The UW then generated all of the information including the route and trip number into a format ready for transmission, which was sent to Seiko via the Internet. The SWIFT project included all the fixed routes that Metro Transit operates, or up to 900 buses during peak periods.

Time and Date, Personal Paging and General Information Messages

All SWIFT devices also received and displayed information services currently available to Seiko MessageWatch customers. These included time and date, weather reports, financial-market summaries, sports scores, ski reports and lotto numbers. All SWIFT devices could also function as a personal pager.

1.2.2. Processing

Data generated by WSDOT, Metro Transit, and UW were collated at UW, where it was validated, converted, corrected and fused. Once these activities had taken place, the data were processed into standardized data packets in order to facilitate ultimate transmission over the HSDS. Information provided by Metro Traffic Control was preprocessed on the TWS. All data from UW and Metro Traffic Control were transmitted to Seiko via the Internet.

1.2.3. *Transmission*

SWIFT data transmission involved sending the processed data to Seiko which formatted the data packets for transmission over the HSDS transmission network. Once formatted by Seiko, the data were transmitted over an FM subcarrier at a rate of 19,000 bytes per second (19 Kbps). In order to increase the certainty of reception by Seiko MessageWatches, double-level error correction and multiple transmissions were used. Otherwise, asynchronous (or broadcast) message sent to the Delco in-vehicle navigation device and the portable computers were sent only once.

Seiko High Speed Data System

The SWIFT project was based upon the HSDS that is currently used to deliver paging and information services to Seiko MessageWatch customers. The HSDS signal is added to standard FM broadcast transmissions in the form of digital data modulated at a frequency 66.5 khz higher than the standard, or "nominal," FM audio signal. No portion of an FM signal, audio or otherwise, is broadcast below the nominal frequency. FM radio signals are usually broadcast in three frequency groups between the nominal frequency and 55 khz above this frequency. Thus, the SWIFT HSDS signal was presented at a frequency that did not interfere with nominal, or standard FM audio, transmissions.

SWIFT HSDS receivers were "frequency agile," which means they could receive messages from any HSDS-equipped FM station. Seven Seattle-area radio stations transmitted the HSDS protocol to SWIFT devices. Consequently, information was sent from all stations in the area which nearly guaranteed reception of important paging messages.

SWIFT information was transmitted three times (once every 1.87 minutes) from each station for the Seiko MessageWatch. Otherwise, for the portable computers and Delco in-vehicle navigation device, congestion information was transmitted every 20 seconds, incident information every 30 seconds and bus information every 90 seconds. This feature of the Seiko HSDS provided information redundancy which further ensured that SWIFT FOT participants were receiving the most current information provided by their receiving device.

SWIFT Message Formats

All SWIFT information was encoded into a version of the International Traveler Information System (ITIS) message-formatting convention. The North American version of ITIS, which was developed by the Enterprise group, is based on message formats used by the European Radio Broadcast Data System (RBDS). The ITIS codes conserve bandwidth by sending incident and congestion information in a compact form. Some customization of the ITIS formats was necessary for SWIFT in order to adjust for HSDS packet size, which is longer than the RBDS packet. Message formats were also developed to send the SWIFT bus location and speed/congestion data, which are not available in the RBDS.

SWIFT traffic-incident information received by the Delco in-vehicle navigation device was integrated with Global Position System (GPS) location and time/date information received by the same device. The latter capability provided the incident-direction/distance information and the current time of day information presented by the Delco in-vehicle navigation device.

Information transmitted to the three receiving devices used in the SWIFT project is presented below:

- Seiko MessageWatch— incident type/direction, roadway affected and closest intersection. Example: A level 3 incident (i.e., accident) on Southbound I-5 is located near the Mercer intersection.
- Delco In-vehicle Navigation Device— incident type/direction, description, roadway/intersection affected, duration and vehicle-reference (in miles) description. Example: An accident blocking the two outside lanes of Northbound I-5, expected to last for the next 15 minutes, is located 16 miles to the Northwest.
- SWIFT Portable Computer— icon display/text description (including incident type, roadway affected, direction, closest intersection, backup and duration) of incidents, icon display of real-time bus position, timepoint schedule information, icon display of speed information (i.e., closed, 0-19, 20-34, 35-49, 50+ and no data) and speed icon location description. Example: Vehicles are traveling at 50% of normal speed at the Mercer speed sensor.

1.2.4. Reception

Three types of HSDS-capable receiver devices, each developed and manufactured by private entities through consultation with their SWIFT team members, provided SWIFT FOT participants with incident information, traffic speed/congestion information, bus information, informational messages (e.g., forecast weather, sports scores, stock-market information) and personal pages, depending upon the device. The devices were:

- Seiko MessageWatch
- Delco In-Vehicle Navigation Device
- SWIFT Portable Computer

Figures 1-2, 1-3 and 1-4 show examples of the three receiving devices used for SWIFT. Operational features of each of these devices are described in the following sections.

Seiko MessageWatch

These devices are commercially available and widely used in the Seattle area to deliver personal-paging services and "information service" messages. Current information-service messages include weather forecasts, financial market summaries, local sports scores and winning lotto numbers. SWIFT traffic messages were featured as an added information service.

SWIFT test participants who used the Seiko MessageWatch supplied information to the Evaluator about the usual routes, directions, days and times of the day they traveled. Traffic messages indicating the location and severity of traffic problems that the user might encounter were sent based on the resulting travel profile. Because the Seiko MessageWatch stored eight messages, only traffic problems that resulted in substantial delays were sent.

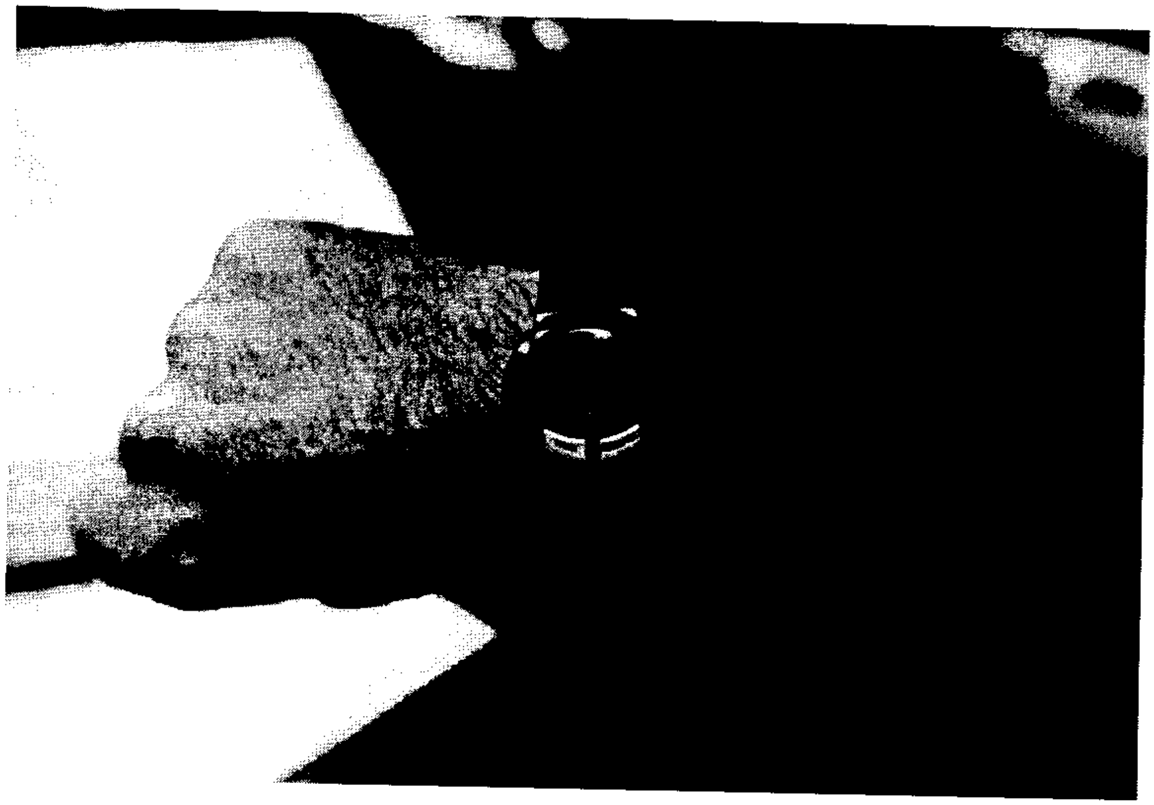

Figure 1-2. Seiko MessageWatch.

Delco In-Vehicle Navigation Device

This device incorporated a route-guidance component, GIS, GPS receiver and the speakers of a radio/compact disc player to present real-time traffic information to users. The whole package was placed into one of four vehicle types: 1995 or newer Buick Regals, Oldsmobile Cutlass Supremes and Saturns, and GMC Rally Vans.

The Delco device included the capability to select destinations from a "Yellow Pages" directory of local landmarks, hotels, restaurants, businesses and street corners selected by the user. The GPS provided the current location of the vehicle and a directional display associated with the route guidance system indicated the direction (relative to the vehicle) and distance to the selected destination. The stereo speakers were used to announce received messages.

Real-time traffic-incident information was transmitted over the Seiko HSDS. The HSDS receiver was built into the Delco in-vehicle navigation device filtered out any messages that were outside a pre-defined distance (e.g., 20 miles) from the current location of the vehicle. The navigation device also decoded upon demand the SWIFT traffic messages from text into a "voice" that provided incident details to the driver. Although messages were retransmitted every minute, only new or modified messages were announced to the driver.

Figure 1-3. Delco In-vehicle Navigation Device.

SWIFT Portable Computer

The SWIFT project primarily used IBM Thinkpad and Toshiba Satellite portable computers. Some Dauphin sub-notebook computers were distributed before they were discontinued due to negative user feedback. The Thinkpads were 486 machines, used Windows 3.1, had a built-in, "butterfly" keyboard and presented information on an active matrix, SVGA color display. The Satellites were Pentium 100 machines, used Windows 95 and also presented information on SVGA color displays.

A separate HSDS receiver unit was attached to the SWIFT portable computer's serial port. This unit had approximately the same footprint as the portable computer and was often attached to the portable computer via Velcro tape. Primary SWIFT information presented on the portable computer included real-time traffic incident, speed/congestion and bus-location information.

All of the traveler information for SWIFT portable computers was displayed using Etak Geographical Information System (GIS) software to show the location of each piece of data. The software allowed the user to select the type(s) of information (i.e., traffic incident, speed/congestion or transit-vehicle location) to be displayed on a map of Seattle. A "Yellow

Pages" directory was also installed and linked to the GIS software to show the location of a selected business or point of interest. SWIFT portable computers also offered transit schedule information from static database tables inside the computer.

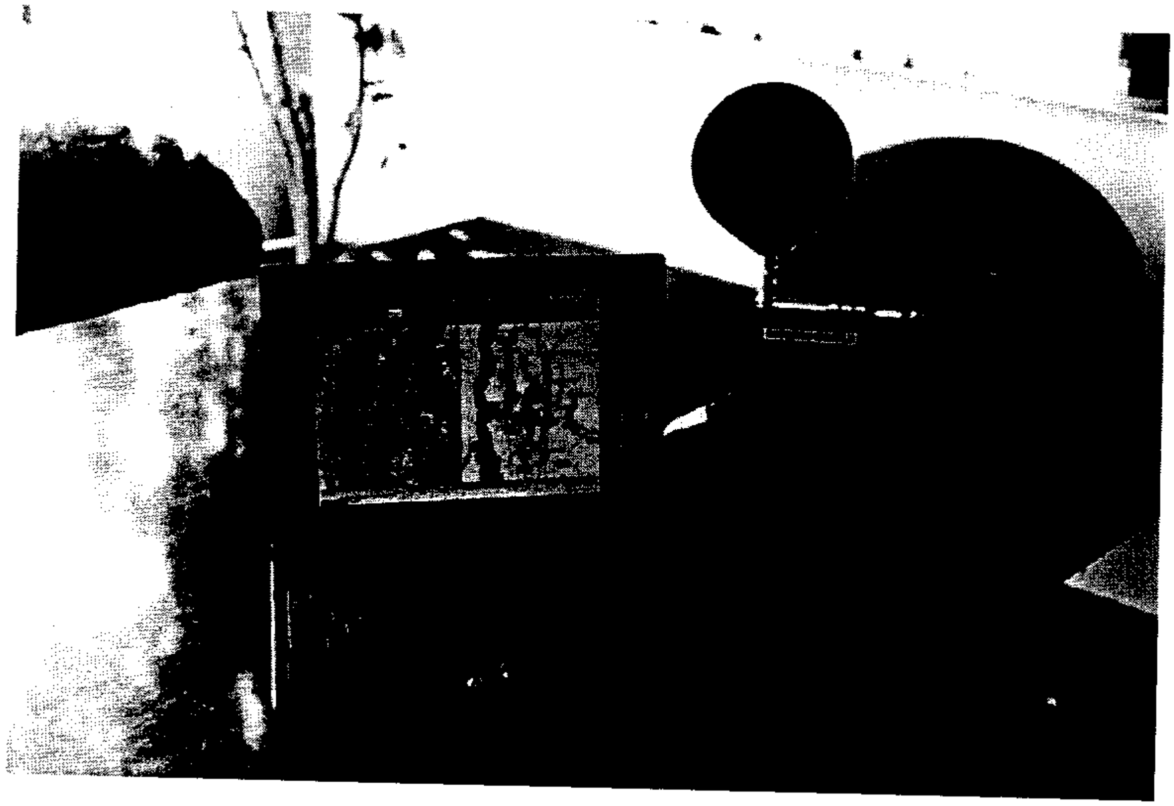

Figure 1-4. SWIFT Portable Computer and RRM.

1.2.5. Data Interpretation

The data interpretation portion of the SWIFT system involved hypothesized processes that affected how users were able to interact with the system. Among those user perceptions that were addressed were the following :

- Data Reception— whether SWIFT information was received
- Data Timeliness— whether SWIFT information was received in a timely fashion
- Data Reliability— whether SWIFT information was regularly received
- Data Display— whether SWIFT information was displayed appropriately
- Data Fidelity— whether SWIFT information was accurate
- Data Validity— whether SWIFT information affected travel behavior.

1.3. SWIFT Field Operational Test Evaluation

Once the SWIFT system was completed, an FOT was conducted with approximately 690 users who were recruited from the community in order to assess the system. With the majority of the SWIFT system completed by June 30, 1996, the SWIFT FOT evaluation was conducted from

July 1, 1996 through September 20, 1997. The goals of the SWIFT FOT evaluation, listed in order of priority, were to evaluate:

1. *Consumer Acceptance, Willingness to Pay and Potential Impact on the Transportation System* – determine user perceptions of the usefulness of the SWIFT receiving devices, how much consumers would be willing to pay for such devices and services and assess how SWIFT-induced changes in users' driving behavior might impact the Seattle transportation network if the SWIFT system was fully deployed.
2. *Effectiveness of the HSDS Transmission Network* – determine how well the SWIFT HSDS communications system functions.
3. *Performance of the System Architecture* – determine how well the various SWIFT components work singularly and together.
4. *Institutional Issues That Affected the Operational Test* – identify how institutional factors associated with the SWIFT public-private partnership affected the FOT, with emphasis on implications for deployment.
5. *Deployment Costs* – estimate how much money it would take to deploy and maintain a SWIFT-like system.

Five evaluation studies were conducted as part of the SWIFT FOT evaluation. These studies paralleled the five SWIFT FOT evaluation goals and were implemented at various times during the 15-month test. Table 1-3 provides a summary of SWIFT evaluation information.

As part of the conduct of the SWIFT FOT evaluation, the Evaluator was responsible for user recruitment. This involved the recruitment of approximately 1,200 individuals before selection of the 690 FOT participants was made. The final breakout of SWIFT participants is shown in Table 1-4.

Table 1-3. SWIFT Evaluation Information.

Study/ Activity	Study Leader	Test Plan Completion Date	Primary Data Collection Periods	Primary Data Collection Methods	Final Report Completion
Consumer Acceptance	Jeff Trombly	August 19, 1997	Spring, Summer and Fall, 1997	Question-naires, Telephone Surveys, Focus Groups	March 31, 1998
Communications	Jim Murphy	August 19, 1997	Fall, 1997	Field Tests	June 29, 1998
Architecture	Hesham Rakha	August 19, 1997	Spring, 1997	Data logging and Field Tests	March 31, 1998
Deployment Cost	Mark Jensen	August 19, 1997	Summer, 1997	Data Collection	March 31, 1998
Institutional Issues	Bruce Wetherby, Principal Investigator	August 19, 1997	Spring and Fall, 1997	Questionnaires and Semi-structured Interviews	March 31, 1998

Table 1-4. SWIFT Participant Breakout.

Device/Condition	Existing	New	Metro Transit Van Pool	SST	Total
Seiko MessageWatch	50	400	--	70	520
Delco In-vehicle Navigation Device	--	65	25	--	90
Portable Computer	--	80	--	--	80
Total	50	545	25	70	690

Selection criteria for each category of SWIFT user varied, primarily depending upon the assumed operational requirements for each device type. As a result, three types of Seiko MessageWatch users (i.e., existing [i.e., those who owned their own watches], new [i.e., those who were given a Seiko MessageWatch for the first time] and SST [i.e., those who participated in the SST program] and two types of Delco in-vehicle navigation device users (i.e., new [i.e., SOV commuters] and Metro Transit Van Pool [i.e., HOV commuters] were recruited. The majority of the eighty (80) SWIFT portable computer users were bus riders with mode-choice options.

The SWIFT FOT Evaluator was also responsible for the following activities:

- Device configuration/software installation
- Device distribution/installation scheduling
- Training/instruction on device usage
- Travel profile entry/maintenance
- SWIFT Help Desk
- User problem analysis/feedback to team members
- Device collection/de-installation
- SWIFT newsletter (writing, publication and mailing; WSDOT responsible for editing and breadboarding)

1.4. Purpose of SWIFT Consumer Acceptance Study

The purpose of the *SWIFT Consumer Acceptance Study* was to evaluate the how well the system was received by the users and how the system impacted their travel behavior. A third purpose was to assess system performance from a user's perspective. In particular, the *SWIFT Consumer Acceptance Study* was designed to evaluate fulfillment of Goal 1, "Consumer Acceptance and Willingness-to-Pay," and Goal 4, "Potential Impact on the Transportation System," as well as to collect and analyze information to support evaluation of Goal 3, "Performance of the System Architecture."

1.5. Objectives

The objectives of the *SWIFT Consumer Acceptance Study* were to assess the following:

Evaluation of Goal 1, "Consumer Acceptance and Willingness-to-Pay"

- Importance of traveler information in travel planning
- Usefulness of SWIFT traveler information in travel planning
- Minimum set of user services and device features required to provide viable product and services
- User perceptions of SWIFT device usefulness
- Willingness-to-pay for different services.

Evaluation of Goal 4, "Potential Impact on the Transportation System"

- User perceptions of changes in travel convenience and efficiency
- User perceptions of changes in traffic congestion, air quality, energy consumption, and safety.

Evaluation of Goal 3, "Performance of the System Architecture"

- SWIFT system reliability from a user perspective
- SWIFT system availability from a user perspective.

The *SWIFT Consumer Acceptance Study* focused on measurement and analysis of user perceptions toward SWIFT system usefulness and performance. No attempt was made to quantify the system-level impacts of SWIFT services on congestion, air quality, energy consumption, or safety in the Seattle region. Rather, the assessment of system-level transportation impacts was limited to examining subjective data (e.g., traveler's perceptions) collected from users and determination of whether these perceptions were consistent with a benefit.

2. METHODOLOGY

2.1. Study Duration

With the majority of the SWIFT system completed by June 30, 1996, the SWIFT FOT evaluation was conducted from July 1, 1996 through September 20, 1997.

2.2. Recruitment of Users

The general procedure for recruiting SWIFT users was to solicit the assistance of Employee Transportation Coordinators (ETCs) in Seattle-area companies/organizations of 100 or more employees. These individuals were asked to distribute SWIFT recruitment information to employees in their companies/organizations and to encourage sign-ups. The Evaluator guided the recruitment effort by providing information about the SWIFT project, either in hard copy or electronic format, to the ETCs. Individuals interested in participating in the SWIFT FOT evaluation were encouraged to contact the evaluator directly.

During recruitment, all potential users were required to complete a brief set of questions targeted at classifying candidates into an appropriate user group. Additional detailed information was collected after users had been selected and agreed to participate in the study. In addition, all potential candidates were required to complete a consent form.

Recruitment of SWIFT participants continued until the targeted number of users in each category had been reached. Due to production delays for two of the devices, the order of recruitment and "phased" distribution was Seiko MessageWatches first, Delco in-vehicle navigation devices second and SWIFT portable computers last. In any test that spans over a year, some participant attrition (i.e., drop out) was anticipated. Every effort was made to (1) encourage users to complete their participation in the SWIFT FOT and (2) recover as much data as practical from dropouts.

The final breakout of SWIFT participants is shown in Table 1-4. Over 1,200 individuals were screened before selection of the 690 test participants was made. Specific procedures for recruiting the users for each SWIFT end-user device are provided in the following sections.

2.2.1. *Seiko MessageWatch Users*

Two broad classes of Seiko MessageWatch users were recruited: *Existing Seiko MessageWatch* users and *New Seiko MessageWatch* users. *Existing Seiko MessageWatch* users were recruited in two ways:

- Users who signed up for SWIFT through their employers were screened as to whether they already owned a Seiko MessageWatch.
- Seiko contacted their existing customer base and solicited people willing to participate in the test *as Existing Seiko MessageWatch* users. The evaluator then contacted those who expressed an interest in participating.

New Seiko MessageWatch users were recruited from the general public through ETCs in the Seattle area who were solicited at monthly ETC coordination meetings. A list of targeted companies and organizations for SWIFT recruitment was developed through consultation with King County, Metro Transit who administers the ETC program in the Seattle area. ETCs in each of the identified companies were asked to distribute SWIFT informational brochures or electronic information to employees. Individuals who responded to these solicitations were screened based on their responses to questions in SWIFT recruitment brochures that were sent to all those who expressed an interest in the project. As necessary, follow-up telephone interviews were conducted by the Evaluator to assist with screening.

2.2.2. Delco In-vehicle Navigation Device

Delco in-vehicle-navigation device users were restricted to persons who owned, or operated, a late model (1995 or later) Saturn, Oldsmobile Cutlass Supreme or Buick Regal. In addition, devices were installed in vans operated as part of Metro Transit's vanpool project. This limitation was required because these vehicles have the "Double DIN" size openings that the units require. Also, limiting the types of vehicles reduced the amount of investigation required to connect the Delco unit to the vehicle wiring harness. Delco in-vehicle-navigation device users were recruited from among two sources:

- Commuters
- Metro Transit vanpoolers.

Users from the general public were recruited with the assistance of ETCs, as well as publicity derived from newspaper and television stories about the project. Also, selected local Saturn dealers were contacted to assist in the identification of potential users. Finally, Metro Transit vanpoolers were recruited by Metro Transit staff who contacted their customer base to solicit participation in the project.

2.2.3. SWIFT Portable Computer Users

SWIFT portable computer users were recruited with the assistance of local ETCs. Two broad classes of SWIFT portable computer users were recruited:

- Commuters
- Transit-choice users

Commuters were derived from those who reported that they frequently drove within the Seattle metropolitan area, either on the job or for travel between home and job or school. SWIFT *transit-choice users*, however, were individuals who said that they were frequent travelers on Metro Transit buses, although they may have used other travel modes occasionally.

2.3. SWIFT Device Deployment Schedule

The deployment of SWIFT devices is summarized in Table 2-1. This deployment commenced in a "phased" fashion on July 1, 1996 with the distribution of Seiko MessageWatch devices. Installation of Delco in-vehicle-navigation devices started on September 1, 1996, and distribution of SWIFT portable computers was initiated on January 1, 1997. Deployment of all SWIFT devices was completed by March 1, 1997.

Table 2-1. SWIFT Devices Deployed by Date.

Date	Seiko MessageWatches	Delco In-vehicle Devices	Portable Computers		
			Dauphin	IBM	Toshiba
July 1, 1996	100	0	0	0	0
September 1, 1996	450	15	0	0	0
November 1, 1996	520	65	0	0	0
January 1, 1997	520	90	25	0	35
March 1, 1997	520	90	25	20	35

2.4. Data Collection

The *SWIFT Consumer Acceptance Study* used the following data-collection methodologies for its evaluation:

- User Profiles
- Traveler Profiles
- Questionnaires
- Focus Groups
- Telephone Interviews
- Other

Each of these is described in the following sections.

2.4.1. User Profiles

SWIFT user-profile data was collected during user recruitment. These data were limited to items that were used to classify candidates into a particular user type category and included the following information:

- Name
- Home address
- Work City/School City
- Contact telephone number
- Whether the person owns or operates a 1995 or later model Saturn, Oldsmobile Cutlass Supreme, or Buick Regal
- Whether the person was a current Seiko MessageWatch subscriber
- Whether the person owns a personal computer

- Whether the person owns a laptop, or portable, computer
- Annual miles traveled in and around Seattle for personal and commuting and work-related travel
- Weekly frequency of travel by personal car/truck, company car/truck, car/vanpool, transit and other modes

These data were collected using a recruitment brochure. The information in the user profile was used for screening and participant selection and was also used in analysis of questionnaire and focus group findings. Once a subject agreed to participate in the test, a data element was added to the subject profile data that identified the SWIFT device being tested by that subject.

2.4.2. Traveler Profiles

As mentioned in a previous section of this report, traffic-incident messages were sent to users of all three SWIFT devices. In the case of the Seiko MessageWatch, however, only messages affecting specifically-requested roadway segments were provided to users. Requested routes were identified by having users complete a traveler profile. Listed on this form were all the 26 highway segments for which SWIFT provided traffic-incident information. These segments included freeways and major arterials within the Puget Sound region. Users completed a separate traveler profile for their commute to work, commute to home, and all other travel. On each form, users indicated the days of the week, hours of the day and direction of travel on each of the roadways for which they desired to receive messages. Traffic messages were sent for the highway segments selected during the times indicated. Throughout the SWIFT FOT, users of the Seiko MessageWatch updated their traveler profile by calling the Evaluator or completing a revised traveler-profile questionnaire.

2.4.3. Questionnaires

Questionnaires were administered to SWIFT users as shown in Table 2-2. Three questionnaires were distributed: one early, one during the middle and one towards the end of the FOT. Questionnaire items were prepared for each of the test objectives. The majority of the questions were presented as Likert-scale items. That is, an affirmatively worded statement such as "SWIFT traffic incident information is timely" was presented with a five-point scale with anchors provided for the ends of the scale. In the case of the above question the anchor for one was "strongly agree" and the anchor for five as "strongly disagree".

User profile and questionnaire data were merged into a relational database so that information from the profiles could be linked to user responses to questionnaire items. Written comments were subjected to content analysis. For the content analysis, an analyst reviewed the comments and then classified them into categories that would facilitate a concise and comprehensive summarization.

Table 2-2. Schedule for Distribution and Return Rates of Questionnaires.

Questionnaire Number	Device User Group	Date Distributed	Total Distributed	Total Returned	Return Rate (%)
1	Seiko MessageWatch	2/7/97	520	408	78.5%
1	Delco In-Vehicle Device	2/7/97	85	66	77.6%
1	Portable Computer	3/7/97	80	36	45.0%
2	Seiko MessageWatch	5/2/97	520	405	77.9%
2	Delco In-Vehicle Device	5/2/97	85	74	87.1%
2	Portable Computer	5/2/97	80	46	57.5%
3	Seiko MessageWatch	8/27/97	520	321	61.7%
3	Delco In-Vehicle Device	8/27/97	85	54	63.5%
3	Portable Computer	8/27/97	80	28	35.0%
Total = 9	--	--	1,438	2,355	Average = 61%

2.4.4. Focus Groups

Focus group meetings have proven to be a valuable tool for gathering market/product research data. The strength of focus group meetings in market/product research is based on three factors:

1. Grouping participants with common experiences in distinct focus group meetings
2. The participants' understanding that there are no right or wrong answers and that is only honest opinions (both positive and negative) about the product that are important to testers.
3. The focus group meeting design and process are scientific and can be replicated.

A total of 13 focus groups were conducted during the operational phase of the SWIFT FOT. The SWIFT focus-group schedule is presented in Table 2-3.

The primary purpose of the SWIFT focus groups was to assess user perceptions in more detail than was possible through questionnaires. Separate focus groups were conducted for each SWIFT device and user type, with participants being paid $50.00 each for their involvement. The Objective, Reflective, Interpretive and Decisional (ORID) design model was used to conduct the SWIFT focus-group meetings because this model lends itself to the derivation of concise, objective usage statements from individuals who have experience using a test product.

Table 2-3. SWIFT Focus Group Schedule.

Number	Device User Group	Date	Total Participants
1	Seiko MessageWatch Users	October 21, 1996	9
2	Seiko MessageWatch Users	October 22, 1996	7
3	Delco Users	November 21, 1996	9
4	Delco Users	November 21, 1996	9
5	Portable Computer Users	February 25, 1997	10
6	Portable Computer Users	March 12, 1997	9
7	Seiko MessageWatch Users	March 13, 1997	9
8	Delco Users	March 19, 1997	8
9	Portable Computer Users	April 4, 1997	7
10	Portable Computer Users	May 13, 1997	8
11	Seiko MessageWatch Users	August 27, 1997	8
12	Portable Computer Users	August 28, 1997	7
13	Delco Device Users	September 3, 1997	9

Specific focus group topics and issues that were addressed under each of these reference points were developed based on the following:

- SWIFT evaluation goals
- Characteristics and features of the SWIFT architecture and service delivery processes
- Characteristics and features of the three SWIFT receiving devices
- Information received from test participants during telephone interviews/questionnaires.

Table 2-4 presents the design for a typical focus group meeting conducted as part of the SWIFT Project.

Table 2-4. Focus Group Meeting Design.

Context: Through the SWIFT Project, operational test participants have been provided on-time, traffic information to enable them to choose routes that are less congested, ultimately improving traffic flow in and around Seattle. The *SWIFT Consumer Acceptance Study* element of the operational test has been designed to check perceptions about traffic information services and the receiving devices that have been used by the test participants.

Rational Objective: The purpose of the focus group meeting is to surface thoughts and feelings about the traffic information and to dialogue about its usefulness and value.

Experimental Objective: Participants should feel comfortable about participating in an open, honest exchange about ideas and perceptions.

OPENING	OBJECTIVES (Get Facts)	REFLECTIVE (Emotions, Associations, and Feelings)	INTERPRETIVE (Values and Meaning)	DECISIONAL (Future Resolve)	CLOSING
• Welcome • Meeting Objectives • Logistics • Role of Moderator • Role of Observers	• What is your name, occupation? • What is your commute pattern? • Why did you want to participant in SWIFT? • How many days per week do you use the SWIFT service? • How do you generally use the SWIFT service? • Are there any areas where you have trouble receiving messages? • How has the SWIFT information affected your commute?	• What was your general perception of the usefulness of the SWIFT system? • Are the messages legible and easy to understand? • Were the SWIFT services timely, reliable and accurate? • What are your views regarding the performance of your SWIFT device? • Has the service met your expectations?	• What other messages or information would you add? • What would you change about the service and why? • What would you change about your SWIFT device and why? • What would be the impact if SWIFT devices were widely available?	• What is the real value of this service for you and others? • How much would you be willing to pay each month for the service as it is? • How much would you be willing to pay if the suggested changes were made? • To what extent should public resources be used to support and/or distribute traffic information?	• Introduce observers • Note contributions of participants - why their participation was valuable and how the information will be used. • Thank participants • Discuss payment process • Adjourn
Registration, name tags, refreshments, tape recorder, presentation boards, handouts					Pay participants
20 minutes	25 minutes	25 minutes	20 minutes	20 minutes	5 minutes

2.4.5. Telephone Interviews

A total of six (6) telephone interviews were conducted with selected samples of SWIFT users at different times during the FOT. These interviews were conducted for various reasons, as shown in Table 2-5. Telephone contacts were also be made to encourage questionnaire returns among users who failed to return these instruments. Overall, the purpose of the SWIFT telephone interviews was to probe more deeply into selected responses and/or to obtain clarification of various issues identified by users.

2.4.6. Other Data Collection

In addition to the data collection efforts described above, users-perception data was obtained through the usability testing associated with the *SWIFT Architecture Study*. A total of 24 device users participated in these studies and were compensated $25.00 each. Finally, two "last chance" questionnaires were conducted when users turned in their devices upon completion of the FOT. These questionnaires were conducted for users of the Delco in-vehicle-navigation device and the SWIFT portable computers.

Table 2-5. SWIFT Telephone Interview Schedule.

Number	Device User Group	Purpose	Dates	Total		
				Contacts Made	Completed Responses	%
1	Seiko Message Watch	Confirm Receipt of Traffic Messages Other Comments	10/10/96 – 10/21/96	353	260	74%
2	Delco In-Vehicle	Confirm Receipt of Traffic Messages Other Comments	11/07/96 – 11/15/96	52	45	87%
3	Dauphin	Confirm Receipt of Traveler Information Confirm Receipt of General Informational Messages Other Comments	01/22/97 – 01/27/97	11	11	100%
4	Dauphin	Confirm Receipt of Software Upgrade #1/Installation Confirm Receipt of General Informational Messages Inquire as to use of SWIFT on other computers Other Comments	04/04/97 – 04/10/97	20	14	70%
5	Portable Computer	Confirm Receipt of Software Upgrade #2/Installation Asked if encountered any software upgrade problems	06/18/97 – 07/01/97	70	55	79%
6	Portable Computer	Survey impact of SWIFT Information on Transit Usage	09/11/97 – 09/20/97	55	35	67%

2.5. Data Analysis

Table 2-6 provides a summary of test objectives, hypotheses, measures of effectiveness, measures of performance, data sources, and methods of analysis for SWIFT Goal 1, "Evaluate Consumer Acceptance and Willingness to Pay," while Table 2-7 presents this information for Goal 4, "Evaluate the Potential for Impact on the Transportation System." Table 2-8 provides this information for Goal 3, "Evaluate the Performance of the System Architecture."

The fulfillment of each evaluation objective was assessed by constructing a variety of test measures, principally using psychometric scaling methods and questionnaire research statistics, and comparing these measures against test hypotheses. Measures of effectiveness and measures of performance were constructed from data collected from users through questionnaires, focus groups and telephone interviews.

Users were asked to record and/or discuss their perceptions toward various SWIFT devices and services and these data served as the basis for development of measures for hypothesis. Measures of consumer acceptance were constructed using psychometric scaling techniques including Likert scales, semantic differential and rank-order scales. Respondents were typically asked to rate a device attribute, feature, or experience on a five-point scale. Mean ratings were then developed for comparison purposes. It was not the intent of the Evaluator to examine the differences between means. Rather, in most instances, the interest was in whether respondents believed an item was important. A rating of 2.5 would be neutral – the mid-point between "not important at all" and "extremely important" in the case of an importance scale. A rating of less than 2.5 would indicate a negative perception while a rating greater than 2.5 would indicate a positive perception.

Table 2-6. Objectives, Hypotheses, Measures of Effectiveness, Measures of Performance, Data Sources and Method of Analysis for *SWIFT Consumer Acceptance Study* Evaluation of Consumer Acceptance and Willingness to Pay.

Objective	Hypothesis	Measure of Effectiveness	Measure of Performance	Data Source	Method of Analysis
1. Assess user perceptions regarding the importance of traveler information in travel planning	Traveler information is important in trip planning	SWIFT users report that traveler information is important	Traveler information is perceived as important	Surveys: •Questionnaires • Focus groups • Interviews	Analysis Technique: • Descriptive statistics • Analysis of Variance
2. Assess user perceptions of SWIFT traveler information usefulness in travel planning	Users report that SWIFT traveler information is useful in travel planning	SWIFT traveler information: • usefulness in .... • information .... • information .... • information	SWIFT information Perceived as: • Useful • Accurate • Understandable • Available (geographically)	Surveys: •Questionnaires • Focus groups • Interviews	Analysis Technique: • Descriptive statistics • Analysis of Variance
3. Identify minimum set of user services and desired device features required to provide viable products/services.	Travel information device features and functions important in travel planning.	Perceptions regarding importance of device features and functions	Perceptions regarding travel information device: • Input features • Display features • Device portability	Surveys: •Questionnaires • Focus groups • Interviews	Analysis Technique: • Descriptive statistics • Analysis of Variance
4. Assess user perceptions of SWIFT device usefulness	Users report that SWIFT devices are useful in travel planning	Perceptions regarding: • Device ease of use • Device safety of use • Device usability	SWIFT devices are perceived as: • Easy to use • Safe to use • Comfortable • Convenient to use	Surveys: •Questionnaires • Focus groups • Interviews	Analysis Technique: • Descriptive statistics • Analysis of Variance
5. Assess willingness-to-pay for different services	Users are willing to pay for SWIFT devices and services.	Perceptions regarding SWIFT users willingness-to-pay	• Amount willing to pay • Comparative value	Surveys: •Questionnaires • Focus groups • Interviews	Analysis Technique: • Descriptive statistics • Analysis of Variance

Table 2-7. Objectives, Hypotheses, Measures of Effectiveness, Measures of Performance, Data Sources, and Methods of Analysis for *SWIFT Consumer Acceptance Study* Evaluation of the Potential for Impact on the Transportation System.

Objective	Hypothesis	Measure of Effectiveness	Measure of Performance	Data Source	Method of Analysis
6. Assess user perception of change in travel convenience and efficiency.	Use of SWIFT devices results in perceived changes in travel conveniences and efficiency.	• Perceptions regarding: • Trip planning • Mobility • Mode choice • Route choice • Travel time • Travel distance • Travel stress	• Perceived influence of SWIFT on: • Trip Planning • Travel frequency • Mode Selection • Route Choice • Travel time • Travel distance • Travel stress	Surveys: •Questionnaires • Focus groups • Interviews	Analysis Technique • Descriptive statistics • Analysis of Variance
7. Assess perception of changes in traffic congestion, air quality, energy consumption, and safety.	Use of SWIFT system results in perceived reductions in traffic congestion, air pollution, energy consumption, and accidents	• Perceptions concerning changes in: • Traffic congestion • Air pollution • Energy consumption • Accidents	• Perceived influence on: • Traffic congestion • Air pollution • Energy consumption • Accidents	Surveys: • Questionnaires • Focus groups • Interviews	Analysis Technique • Descriptive statistics • Analysis of Variance

Table 2-8. Objectives, Hypotheses, Measures of Effectiveness, Measures of Performance, Data Sources, and Methods of Analysis for *SWIFT Consumer Acceptance Study Evaluation* of Performance of the System Architecture.

Objective	Hypothesis	Measure of Effectiveness	Measure of Performance	Data Source	Method of Analysis
8. Assess the SWIFT system reliability from a user perspective	SWIFT devices are free from mechanical or electrical malfunctions.	Perceptions regarding device failures	Perceptions regarding: • Device failure rates	Surveys: • Questionnaires • Focus groups • Interviews	• Descriptive statistics • Analysis of Variance
9. Assess the SWIFT system availability from a user perspective	SWIFT devices, when activated, can assess the system information	Perceptions regarding the availability of information	Perceptions regarding: • Information access failure rates	Surveys: • Questionnaires • Focus groups • Interviews	• Descriptive statistics • Analysis of Variance

2.6. Overview of Report

The following section of this report presents the results of the *SWIFT Consumer Acceptance Study*. Table 2-9 cross-references the findings of Section 3 with the evaluation objectives described above. Section 3.1 provides some additional, background, information regarding the household and travel characteristics of the SWIFT participants.

Table 2-9. SWIFT Evaluation Objective Cross-reference Matrix.

Evaluation Objective	Location in Section 3
1. Assess household and travel characteristics of SWIFT participants	3.1
2. Assess user perceptions regarding the importance of traveler information in travel planning	3.2
3. Assess user perceptions of SWIFT traveler information usefulness in travel planning	3.3
4. Identify minimum set of user services and desired device features required to provide viable products/services.	3.4
5. Assess user perceptions of SWIFT device usefulness	3.5
6. Assess willingness-to-pay for different services	3.6
7. Assess user perception of change in travel convenience and efficiency.	3.7
8. Assess perception of changes in traffic congestion, air quality, energy consumption, and safety.	3.8
9. Assess the SWIFT system reliability from a user perspective	3.9
10. Assess the SWIFT system availability from a user perspective	3.10

Section 4 of the report provides a discussion of the study results and Section 5 presents the study conclusions. Finally, the Appendix presents a list of operational "problems" that were encountered by participants during the SWIFT field operational test. Although the SWIFT test was successful in deploying and demonstrating the features and impacts of an ATIS fielded in a metropolitan environment, some "difficulties" or "glitches" were experienced by the end-users of the service. Thus, a list of the most salient of these technical problems is presented in order to provide the reader with a more complete understanding of the situational context within which SWIFT was evaluated and, in particular, to understand the meaning of the results that are presented in this report.

3. RESULTS

The results of the *SWIFT Consumer Acceptance Study* are organized according to the objectives listed in Section 1.5 and delineated in Section 2.5. Within each section, questionnaire, focus group and telephone interview results are reported separately. Before reviewing the results, the demographic and travel characteristics of device users are summarized.

3.1. Household and Travel Characteristics of SWIFT Participants

3.1.1. Household Characteristics

Device users were predominately male and members of households with a high rate of automobile ownership and access to technology. Approximately two-thirds of device users were male and over 80% of the households represented reported owing two or more personal vehicles (Figure 3-1). Furthermore, approximately 80% of users reported owning a Portable Computer (Figure 3-2) and having a subscription to Cable TV, the Internet or Cellular phone service (Figure 3-3).

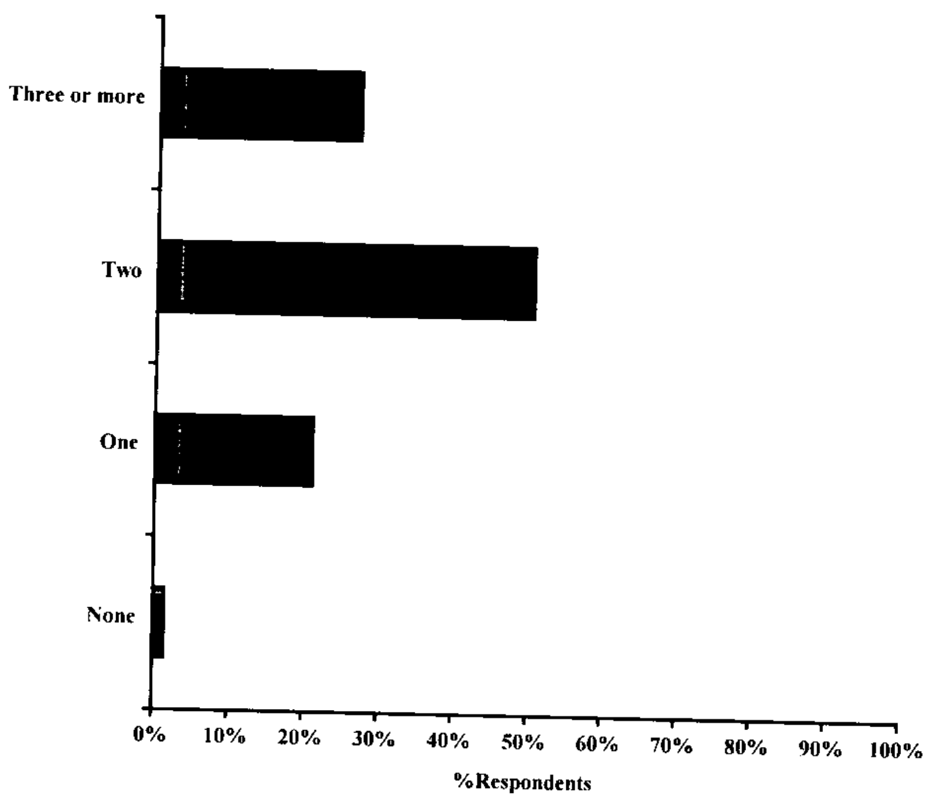

Figure 3-1. Personal Vehicle Ownership Among SWIFT Device Users.

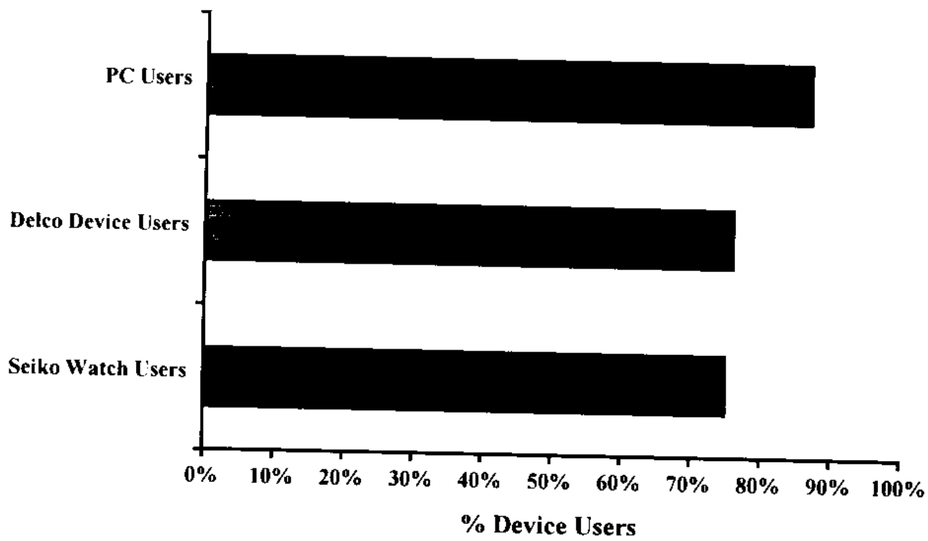

Figure 3-2. Proportion of SWIFT Device Users Who Own a Portable Computer.

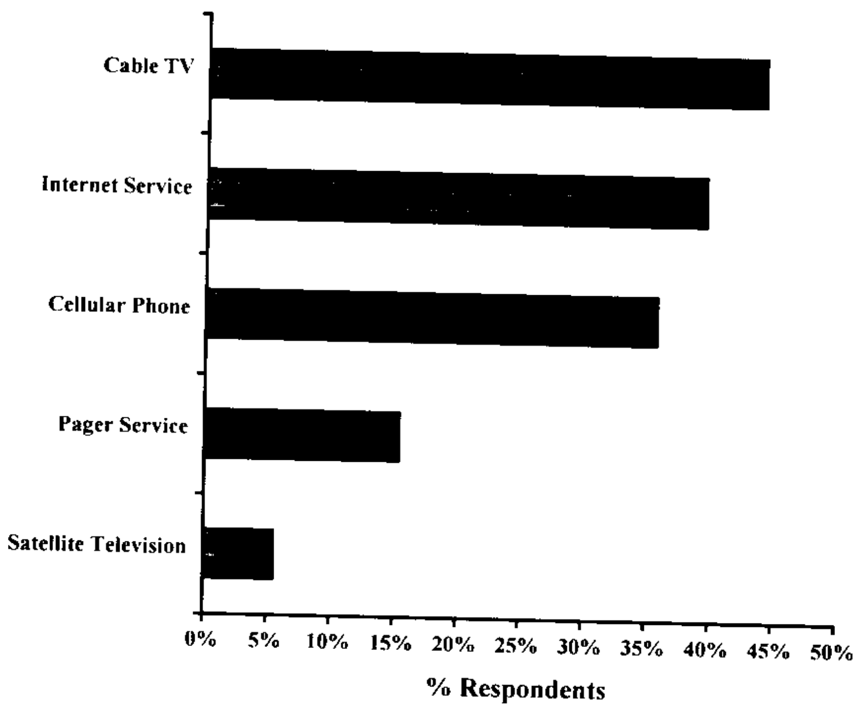

Figure 3-3. Proportion of SWIFT Device Users Subscribing to Selected Electronic Media.

3.1.2. Travel Characteristics

SWIFT participants were very mobile. The average number of personal miles, including journey to work, traveled each year in and around Seattle for all users was approximately 15,000 miles. The average number of work-related miles traveled by users was approximately 7,500 miles per year. SWIFT participants used a variety of modes for transportation to and from work. Nearly 53% of Seiko MessageWatch respondents classified themselves as exclusively drive-alone, automobile-mode commuters, while approximately 44% of the Delco in-vehicle-navigation device respondents and 19% of SWIFT portable computer users classified themselves into this category. If Metro Transit's 25 vanpoolers are excluded from Delco in-vehicle-navigation device users, then approximately 60% of remaining Delco users were exclusive drive-alone commuters. Nearly 57% of SWIFT portable computer respondents reported using a combination of modes including bus, vanpool and carpool to travel to work. Nearly one-third of Delco respondents classified themselves as primarily carpool or vanpool commuters.

Approximately two-thirds of SWIFT respondents reported traveling 30 or more minutes to work (Figure 3-4.). The variation in travel time to work among SWIFT participants was quite high, with well over half of the participants experiencing an 11-minute or more or variation in their average journey to work travel time (Figure 3-5). Respondents reported having a lower amount of flexibility in choosing times to leave home for work (Figure 3-6) than in leaving work for home (Figure 3-7). Over half of the participants reported that they had three or more routes to choose from when commuting to and from work (Figure 3-8).

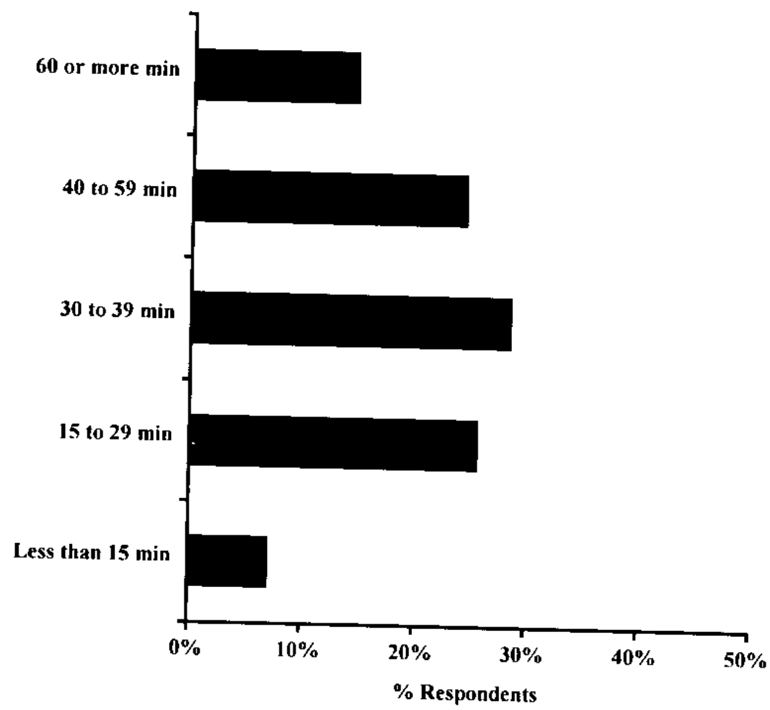

Figure 3-4. Average Journey Time to Work Among SWIFT Device Users.

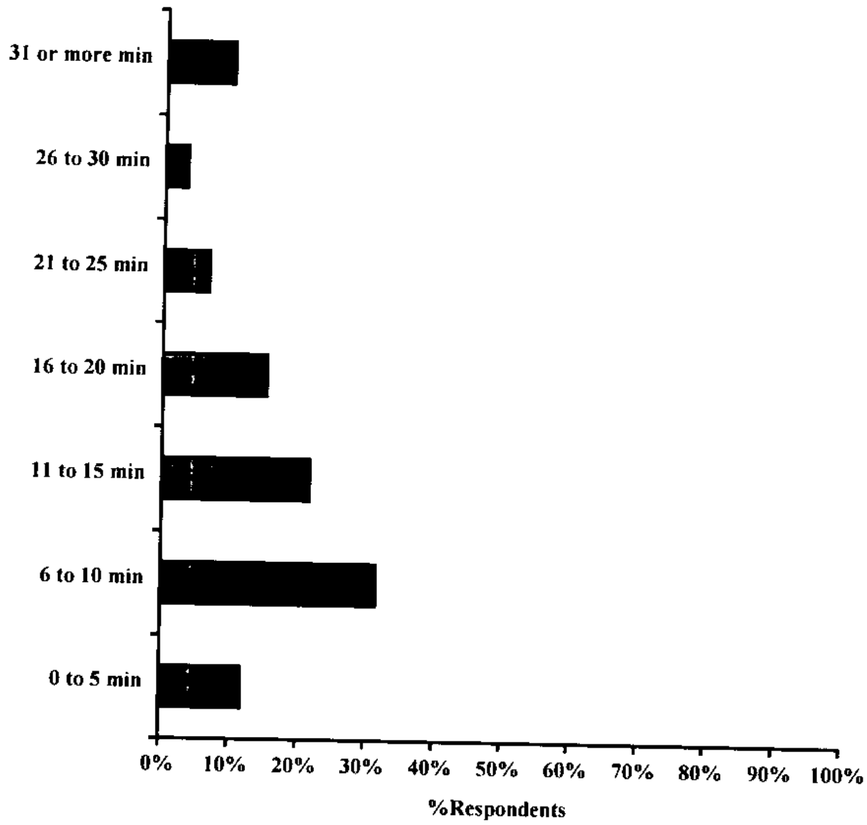

Figure 3-5. Variation in Average Journey Time to Work Among SWIFT Device Users.

The household and travel characteristics reported by questionnaire respondents suggests that the SWIFT Device users were largely auto oriented commuters - both drive alone and shared ride - who traveled more than 30 minutes to work. Users of the Seiko MessageWatch and Delco were more likely to be auto commuters than users of the SWIFT portable computer Device. The latter groups contained a higher proportion of shared ride and public transit users - as specified in the recruitment plan. The results also suggest that device users has several alternative commute routes available to them and had more flexibility in leaving work for home than in leaving home for work. The availability of alternative routes provides commuters with route choice options to respond to any reported incidents. The flexibility in leaving work for home suggests that users may postpone departure times to avoid any reported congestion or incidents. The results reported later in this report indicate that SWIFT users implemented both of these actions as a result of information provided by their SWIFT device.

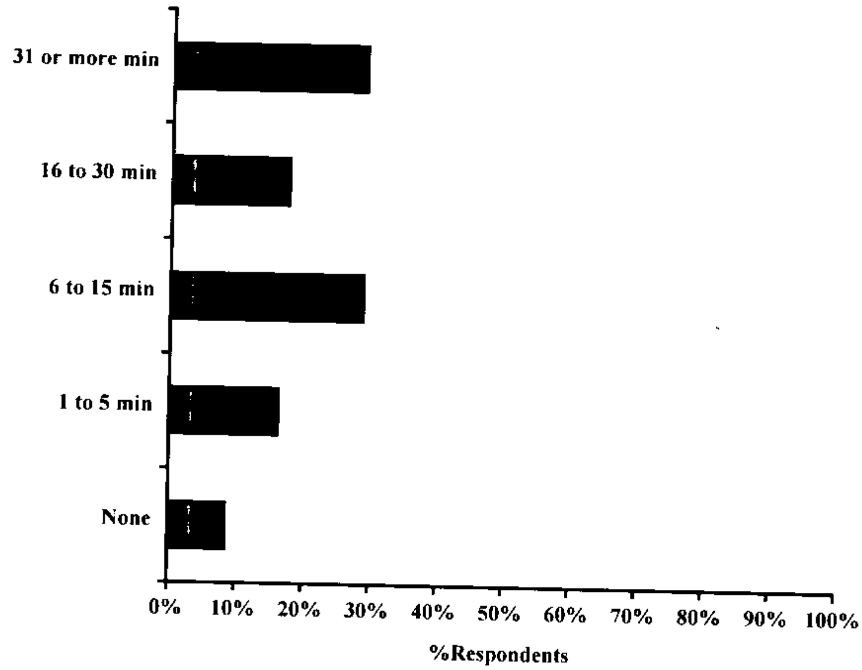

Figure 3-6. Flexibility in Time Leaving for Work Among SWIFT Device Users.

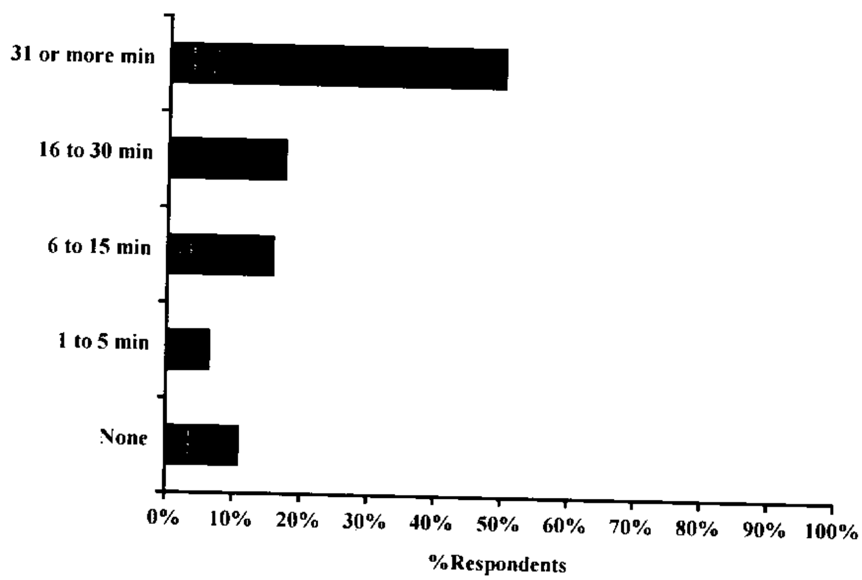

Figure 3-7. Flexibility in Time Leaving for Home Among SWIFT Device Users.

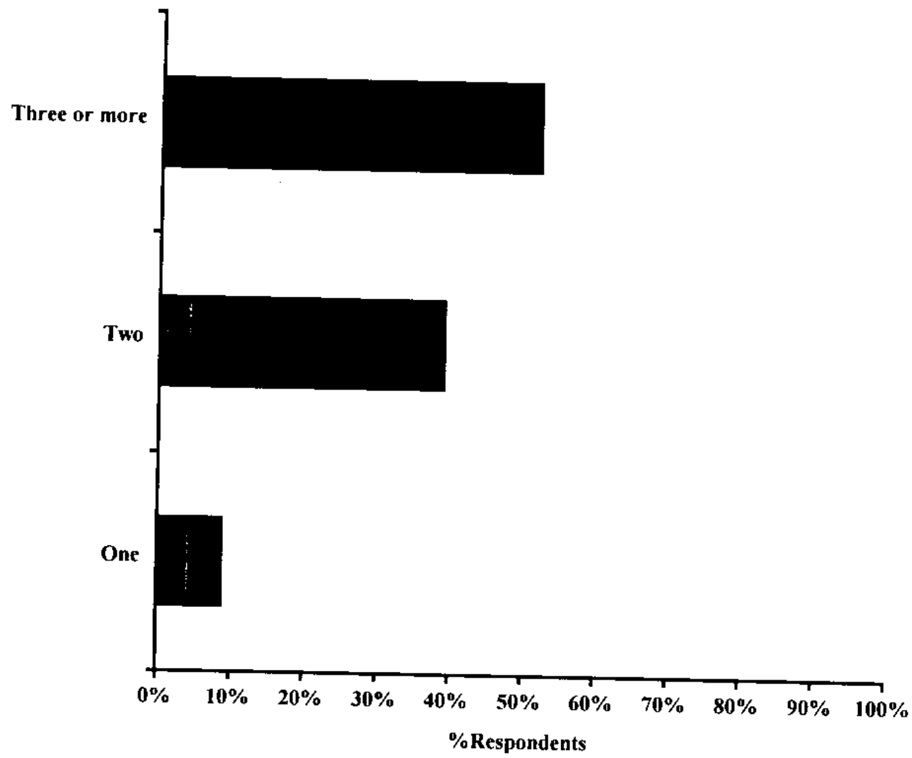

Figure 3-8. Number of Alternative Commute Routes Among SWIFT Device Users.

3.2. Importance of Traveler Information in Travel Planning

This section discusses the importance of traveler information for travel planning among SWIFT users. SWIFT devices and services provided users with varying levels of information, depending on the device. SWIFT users were provided with traffic-incident information, personal paging and informational messages. Delco in-vehicle-navigation device users were also provided with vector- navigation services for route planning and guidance. In addition, SWIFT portable computer users were provided with a graphic display of traffic conditions on a Seattle-area map, real-time bus position information and transit schedules that were loaded onto the portable computer's hard drive. In order to establish the perceived importance of the information provided by SWIFT services and devices, users were asked to evaluate the importance of receiving the this information.

3.2.1. Questionnaire Items

Importance of Travel Related Information

Figure 3-9 provides a summary of the importance that device users placed upon the receipt of travel-related information. For the entire SWIFT user group, the information items rated the highest in importance included traffic incident and congestion-related information. Items rated lowest in importance included real-time bus position and transit-schedule information.

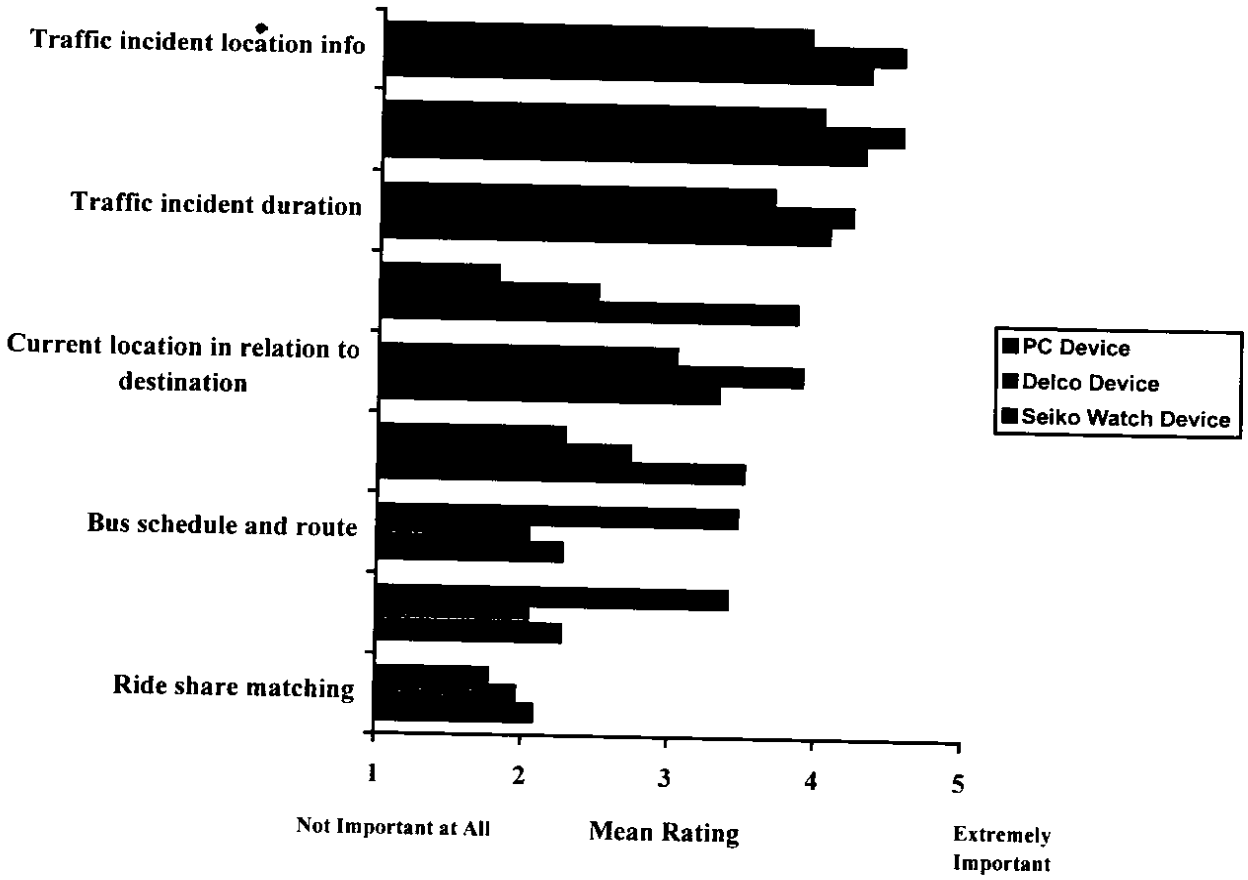

Figure 3-9. Importance of Receiving SWIFT Travel Information.

Results indicated that Seiko MessageWatch users placed a great deal of importance on the receipt of traffic incident and congestion-related information. Real-time bus and transit-schedule information did not seem to be very important to these users as reflected by the lower importance ratings. This can be attributed by the fact that the Seiko MessageWatch users also were not presented with this information. Finally, Seiko MessageWatch users tended to be somewhat neutral toward the importance of receiving general information and personal-paging messages.

Results for Delco in-vehicle-navigation device users were very similar to those observed for the Seiko MessageWatch users, except that the Delco users appeared to place slightly more importance on the receipt of traffic incident and congestion-related information and slightly less importance on the receipt of real-time bus position and transit schedule information. This can be attributed by the fact that Delco users also did not have a need to receive this information.

SWIFT portable computer users placed a high amount of importance on the receipt of traffic incident and congestion information and much less importance on general information message and personal-paging capabilities. As expected, because of the high transit usage among this group, the SWIFT portable computer users rated the importance of receiving bus-related information higher than the other user groups. Due to technical problems, however, the SWIFT portable computer users were not receiving pages or general-information messages and the results reflect this perception.

Importance of General Information Messages

Figure 3-10 summarizes of the importance that SWIFT users placed upon the receipt of general-information messages. Respondents placed a higher degree of importance on the receipt of weather, sports and news-related information than on financial and environmental-related information, the latter of which respondents generally considered unimportant to receive.

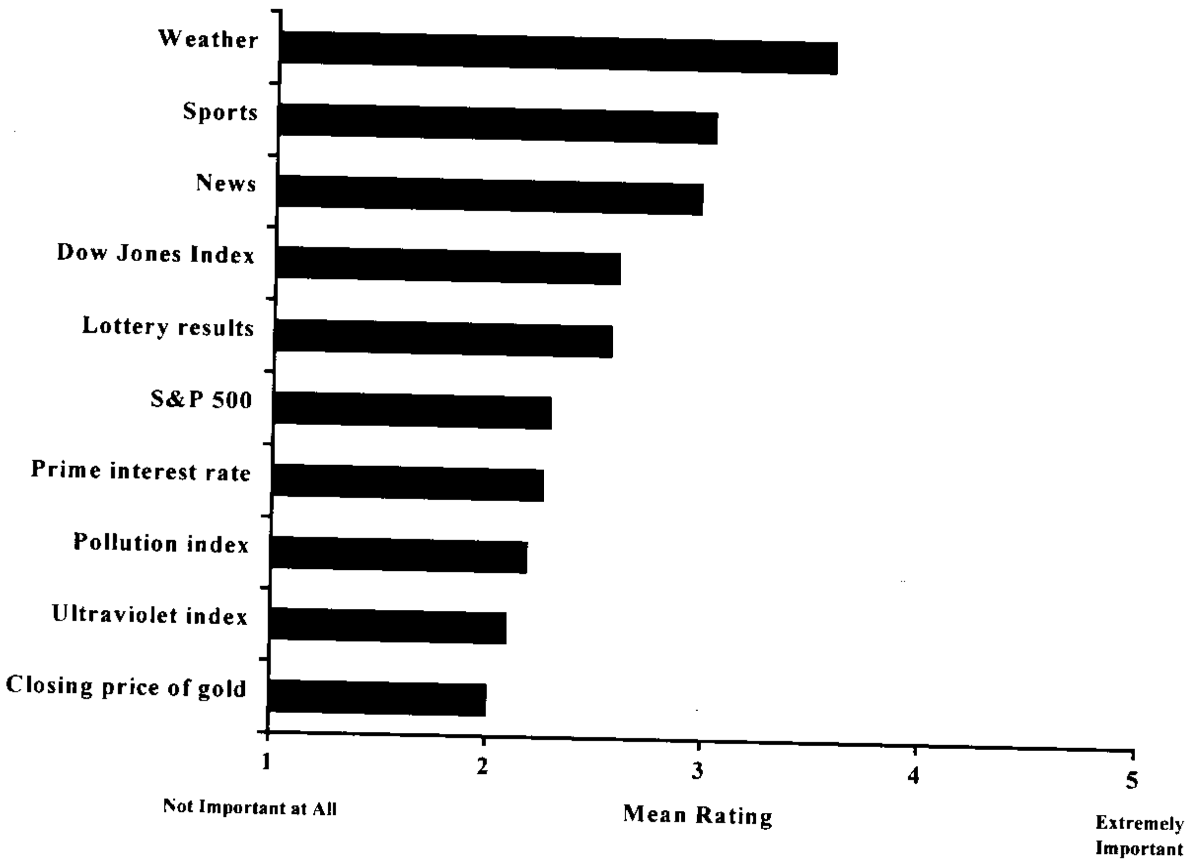

Figure 3-10. Importance of Receiving SWIFT General-Information Messages.

Satisfaction with Amount of Information Received

SWIFT users were asked to estimate whether they received too little, too much or just the right amount of traffic, transit and general-information messages. Approximately two-thirds of Seiko MessageWatch and SWIFT portable computer users believed that they received the right amount of traffic messages during peak commute, while a lesser proportion (40%) of the Delco in-vehicle-navigation device users believed that they received the right amount of traffic messages.

Results for the receipt of general-information messages indicated that approximately three-fourths (75.3%) of the Seiko MessageWatch users believed that they received the right amount of general-information messages, while slightly over one-half (53.9%) of Delco in-vehicle navigation device users and slightly under one-half (45.8%) of SWIFT portable computer users believed that they received the right amount of general-information messages.

3.2.2. Questionnaire Comments

User comments regarding the importance of receiving travel information included remarks suggesting the importance of receiving travel time along alternative routes as well as estimated duration of incident or congestion. Furthermore, SWIFT portable computer users suggested that it was important to receive information concerning the Estimated Time of Arrival (ETA) for buses. Users also commented on the importance of receiving ski-related information as well as information on special events in the region.

3.2.3. Focus Group and Telephone Interview Findings

Focus group participants were asked to identify messages or information that should be added to the SWIFT service. Participants suggested that incident-clearance time and alternative-route information be provided. In particular, Seiko MessageWatch telephone-interview respondents suggested that information on average speed and alternative routes be broadcast to all users, while Delco in-vehicle-navigation device users suggested that a map display be provided to graphically highlight this information.

3.3. Usefulness of SWIFT Traveler Information in Travel Planning

In general, all information services provided by the SWIFT system were designed to provide users with information that was useful in travel planning. Usefulness was evaluated by examining user perceptions of message characteristics (e.g., accuracy, reliability, timeliness and ease of understanding) as well as perceptions concerning the importance of improvements to messages.

3.3.1. Questionnaire Items

Initial Satisfaction with Message Usefulness

In the first SWIFT user questionnaire, respondents were asked to provide an initial assessment of satisfaction with travel messages provided by the SWIFT system. Figure 3-11 contains a summary of user perceptions regarding initial satisfaction with SWIFT travel messages. In general, users were satisfied with the number of messages received as well as the accuracy, clarity and timeliness of messages. Users were also generally satisfied with the geographic coverage included in messages as well as the number of roadways included. Minor differences between users of various devices were observed. In general, users of the Seiko MessageWatch appeared to be more satisfied than users of the other devices across all items. SWIFT portable computer users appeared to be less satisfied with the geographic and roadway coverage included in messages than users of other devices. Delco in-vehicle-navigation device users appeared to be more satisfied with message clarity than other device users.

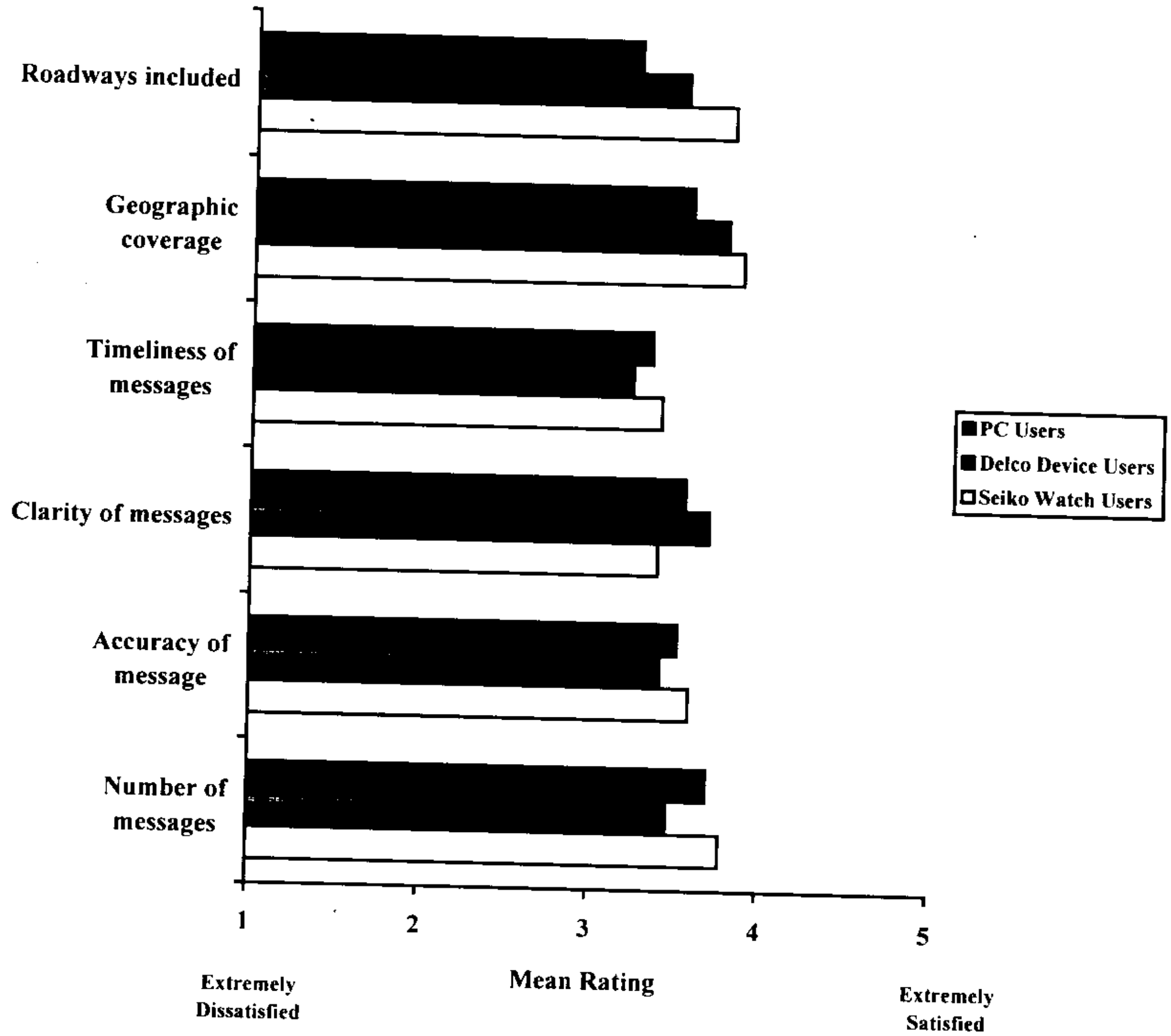

Figure 3-11. Satisfaction with SWIFT Travel Information - 1st User Survey

<u>Perceptions Concerning SWIFT Information</u>

In the second SWIFT user questionnaire, respondents provided a detailed evaluation of their perceptions concerning the accuracy, reliability, timeliness, ease of understanding and usefulness of information provided by SWIFT.

Seiko MessageWatch Users. Figure 3-12 presents a summary of the mean ratings of information accuracy, reliability, timeliness, ease of understanding, and usefulness provided by Seiko

MessageWatch users. In general, respondents rated personal paging and general-information messages very high across all these dimensions. Incident-related messages were generally not rated as high along these dimensions by respondents. The ease of understanding and timeliness of incident information was rated the lowest of all characteristics among Seiko MessageWatch users while the usefulness, reliability and accuracy were rated highest. Incident type information was generally rated lower than either incident direction or incident location information.

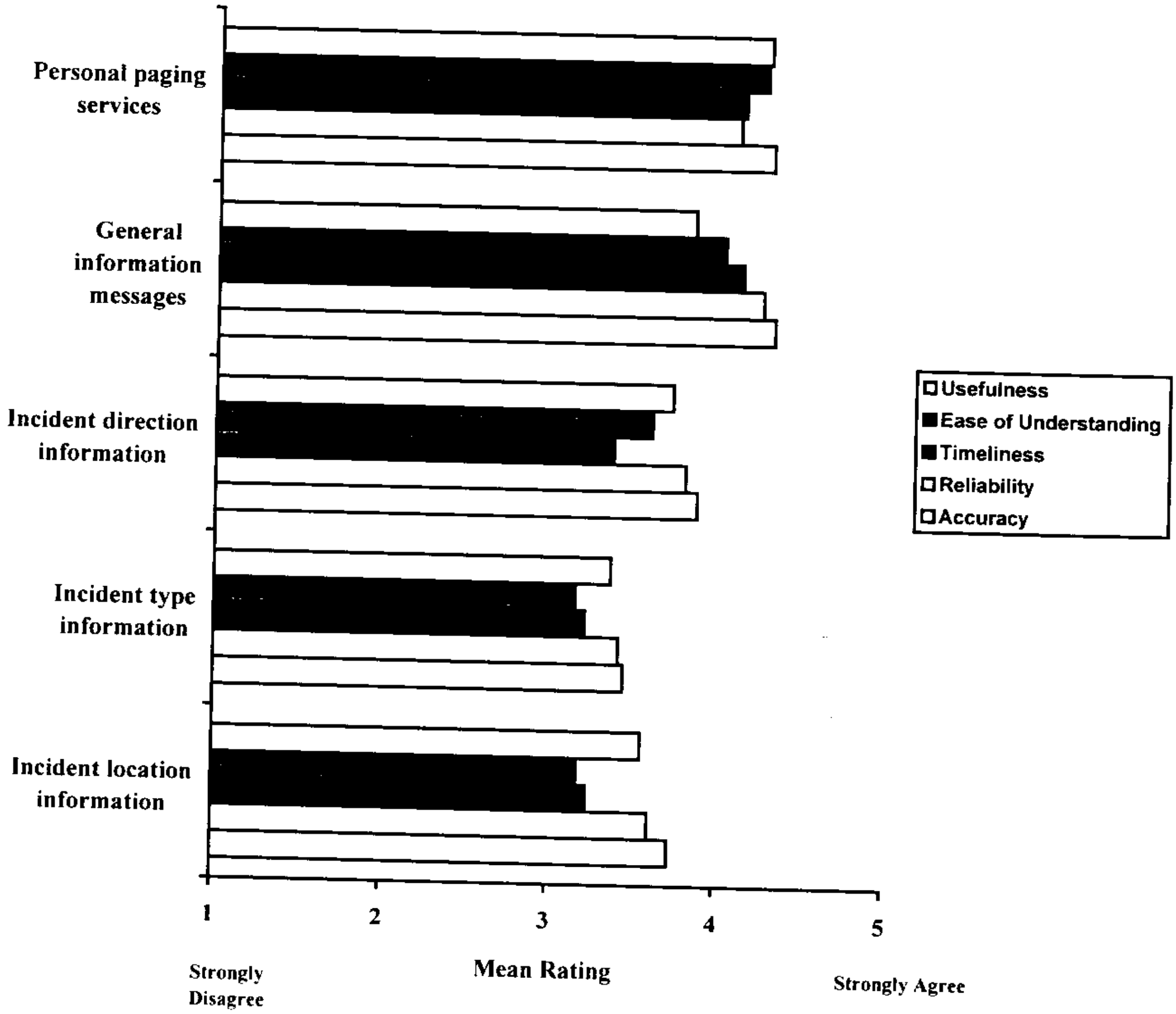

Figure 3-12. Seiko MessageWatch Users - Mean Agreement with the Assertion that Messages were "Accurate," "Reliable," "Timely," "Easy to Understand" and "Useful."

Delco In-vehicle-Navigation Device Users. Figure 3-13 contains a summary of the mean ratings provided by users of the Delco in-vehicle navigation device for message accuracy, reliability, timeliness, ease of understanding and usefulness. Results indicated that respondents rated personal paging lower than other information sources. This was a reflection of the technical problems that were experienced by users. Respondents generally found the information easy to understand but less useful. The timeliness of incident information was rated lowest among all incident-related items.

SWIFT Portable Computer Users. Figure 3-14 summarizes the mean ratings provided by SWIFT portable computer users. In general, personal paging and general-information messages were rated low because the services were not consistently available to users as a result of technical problems in message delivery. Focus group findings indicated that SWIFT portable computer users were confused on how to read and understand incident-direction information. Incident duration information was also rated low along all message attributes. Other incident-related information was generally rated quite high, as was traffic congestion and bus schedule/time point information. Bus position information was found to be easy to understand and useful by respondents. However, this information was rated low both in terms of reliability and accuracy.

Ease of Understanding of Aspects of Incident Messages

Respondents were asked about their ability to understand the following aspects of incident related information provided by the SWIFT system: how to use the information to their benefit, time of day when message applied, incident duration, location of incident, direction of travel affected, extent of expected delay and nature of congestion. Figure 3-15 summarizes the mean ratings provided by users in response to this question.

Respondents for all device user groups generally understood how to use the information to their benefit, the location of the incident and the direction of travel affected by the incident. Respondents using the Delco in-vehicle-navigation device appeared to have more difficulty understanding the time of day when the message applied than other user group respondents. Seiko MessageWatch respondents reported more difficulty in understanding the extent of expected delay and the nature of congestion than other respondents. Respondents using the SWIFT portable computer reported fewer problems in understanding aspects of incident messages than other respondent groups. The SWIFT portable computer group was provided with a map- based display that was unavailable to other user groups that may explain why the SWIFT portable computer group had less difficulty in understanding incident-related messages.

Importance of Improvements to Messages

Device users were asked to evaluate the importance of a list of selected improvements to the information provided by the SWIFT system.

Seiko MessageWatch Users. Figure 3-16 contains a summary of the mean ratings provided by Seiko MessageWatch users for selected improvements to SWIFT messages. In general, respondents rated all improvements as desirable. In particular, respondents expressed a desire to see improvements in the timeliness and accuracy of messages, as well as the presentation of route- specific messages.

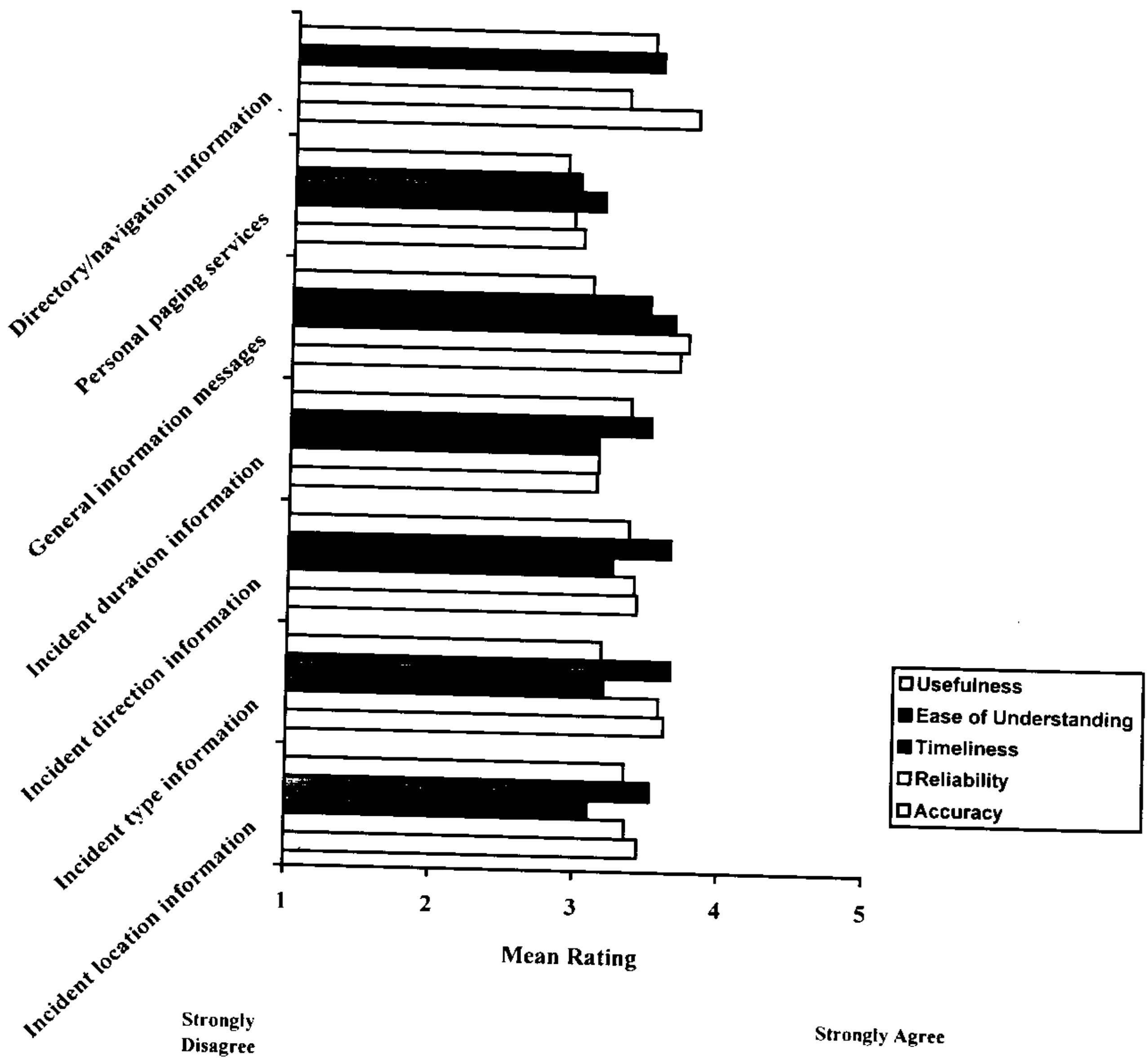

Figure 3-13. Delco Device Users - Mean Agreement with the Assertion that Messages were "Accurate," "Reliable," "Timely," "Easy to Understand" and "Useful."

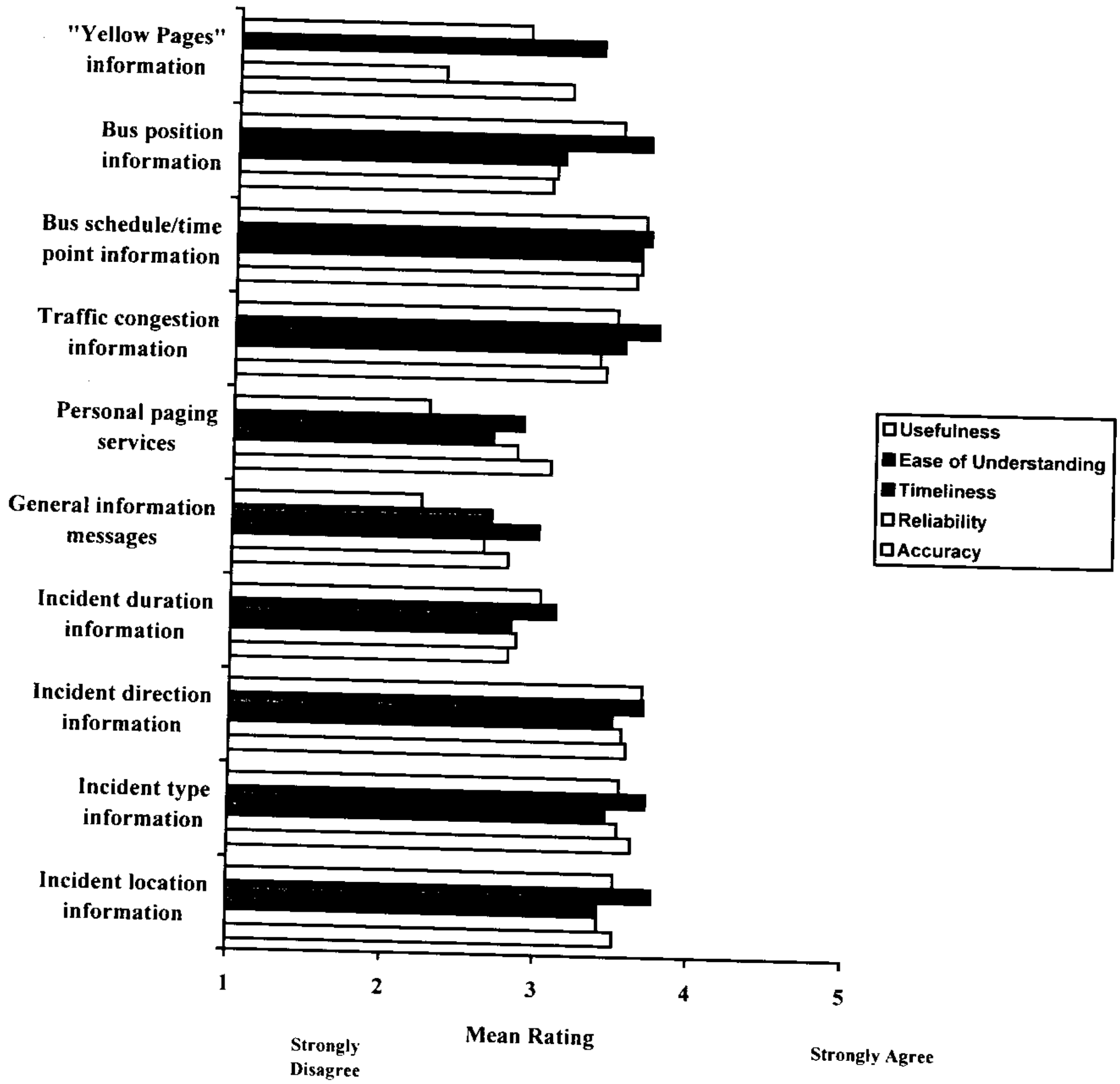

Figure 3-14. SWIFT portable computer Device Users - Mean Agreement with the Assertion that Messages were "Accurate," "Reliable," "Timely," "Easy to Understand" and "Useful."

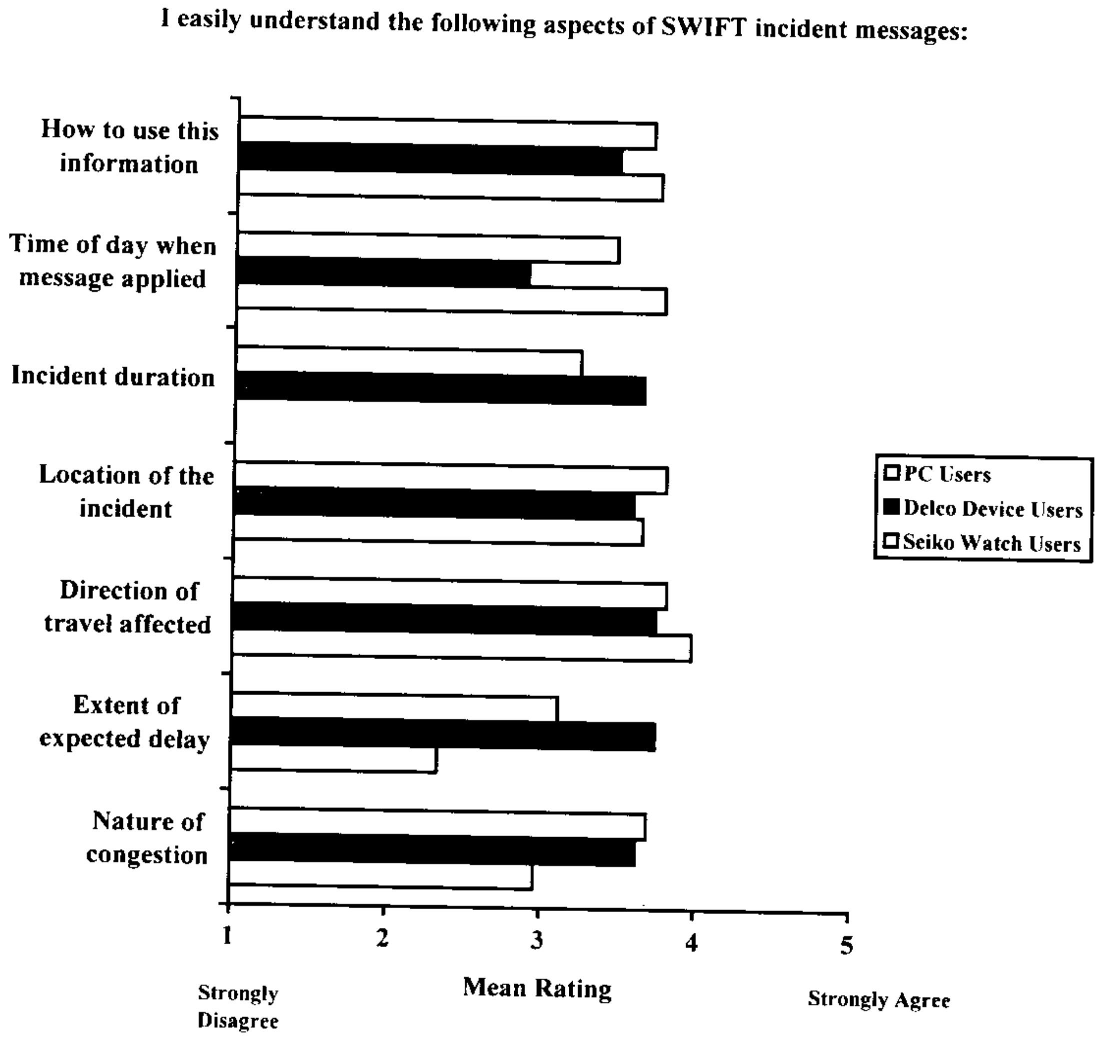

Figure 3-15. Ease of Understanding for Aspects of SWIFT Incident Messages.

Delco In-vehicle-Navigation Device Users. As shown in Figure 3-17, Delco in-vehicle-navigation device users appeared to support a wide range of improvements, with a desire to receive route-specific messages and a map-based display rated highest among the selected improvements.

SWIFT Portable Computer Users. Figure 3-18 provides a summary of the improvements suggested for the SWIFT portable computer. Respondents indicated a desire for a number of improvement to traffic messages, including expanding coverage of messages, improved accuracy/timeliness of messages and improved bus location/schedule information.

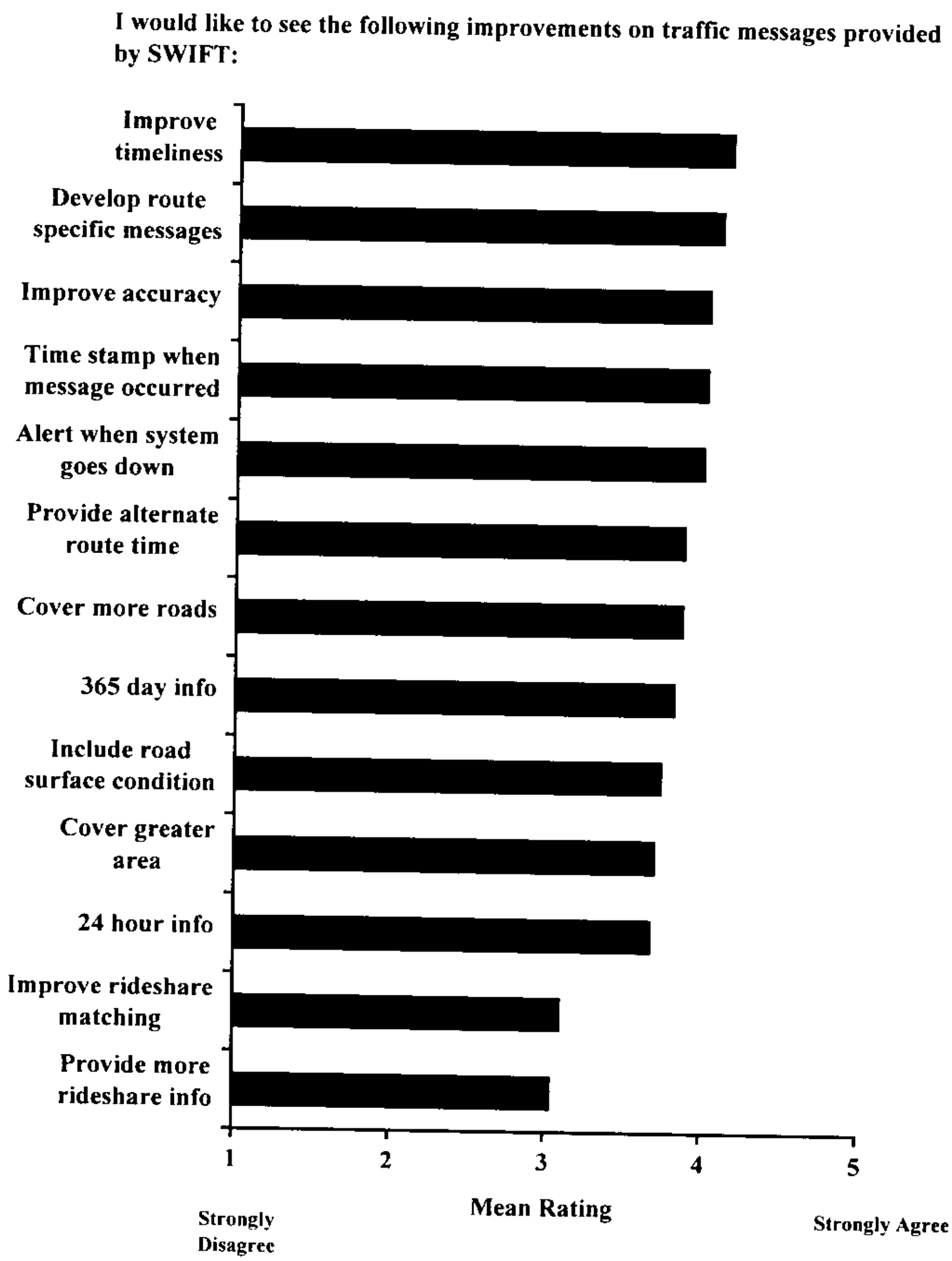

Figure 3-16. Importance of Improvements to SWIFT Traffic Messages Provided by Seiko MessageWatch.

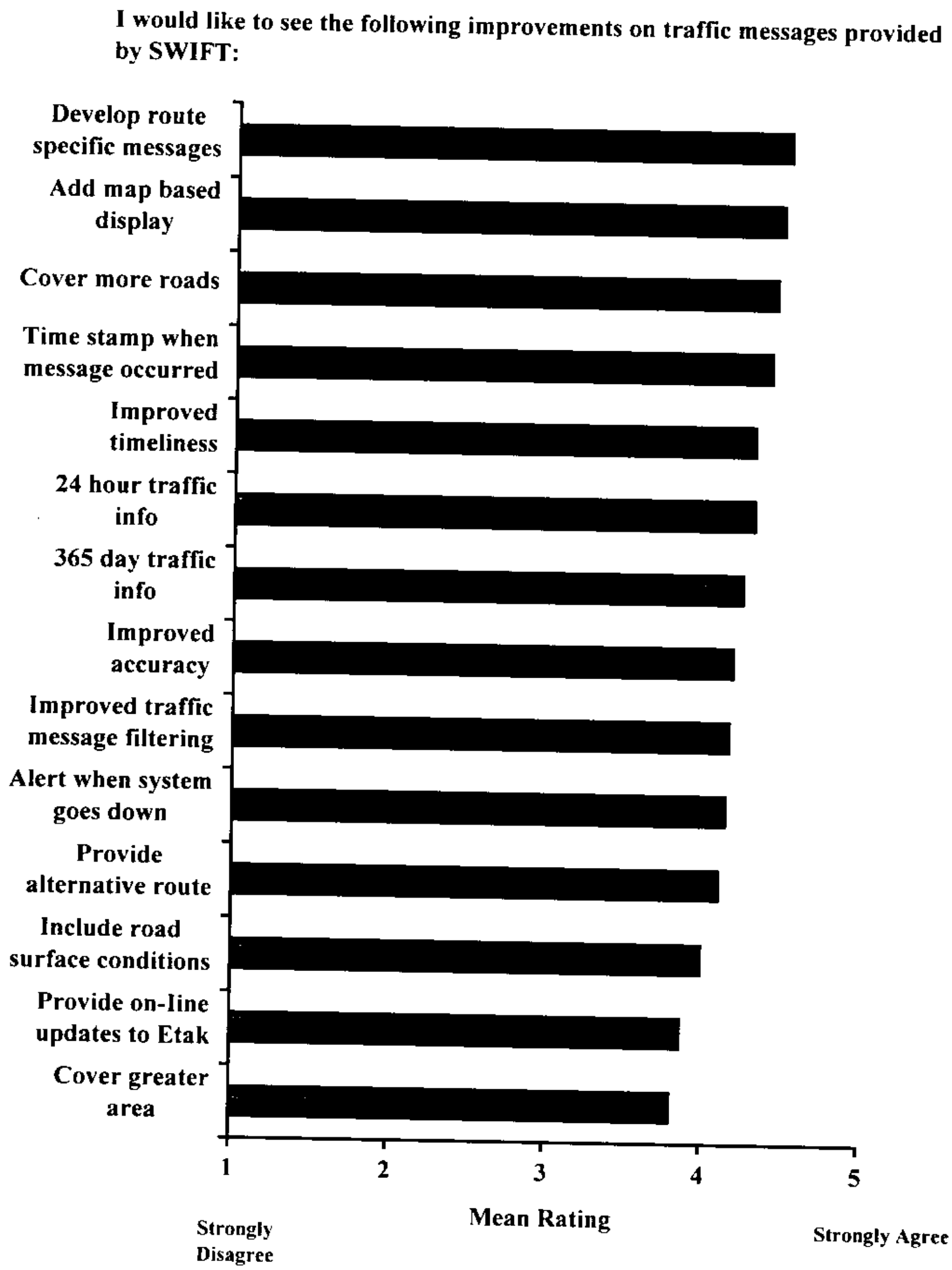

Figure 3-17. Importance of Improvements to SWIFT Traffic Messages Provided by Delco In-vehicle-Navigation Device.

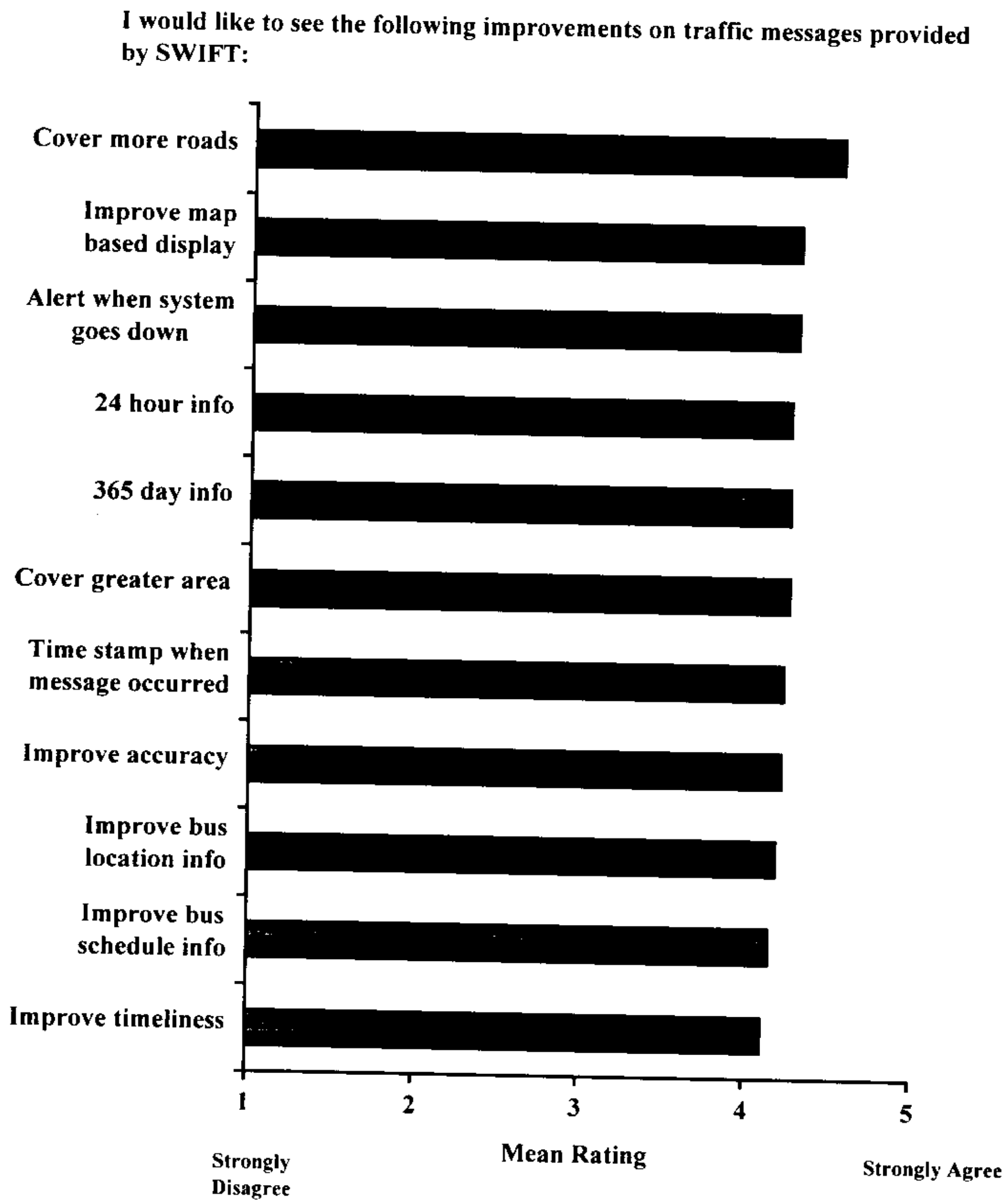

Figure 3-18. Importance of Improvements to SWIFT Traffic Messages Provided by SWIFT Portable Computers.

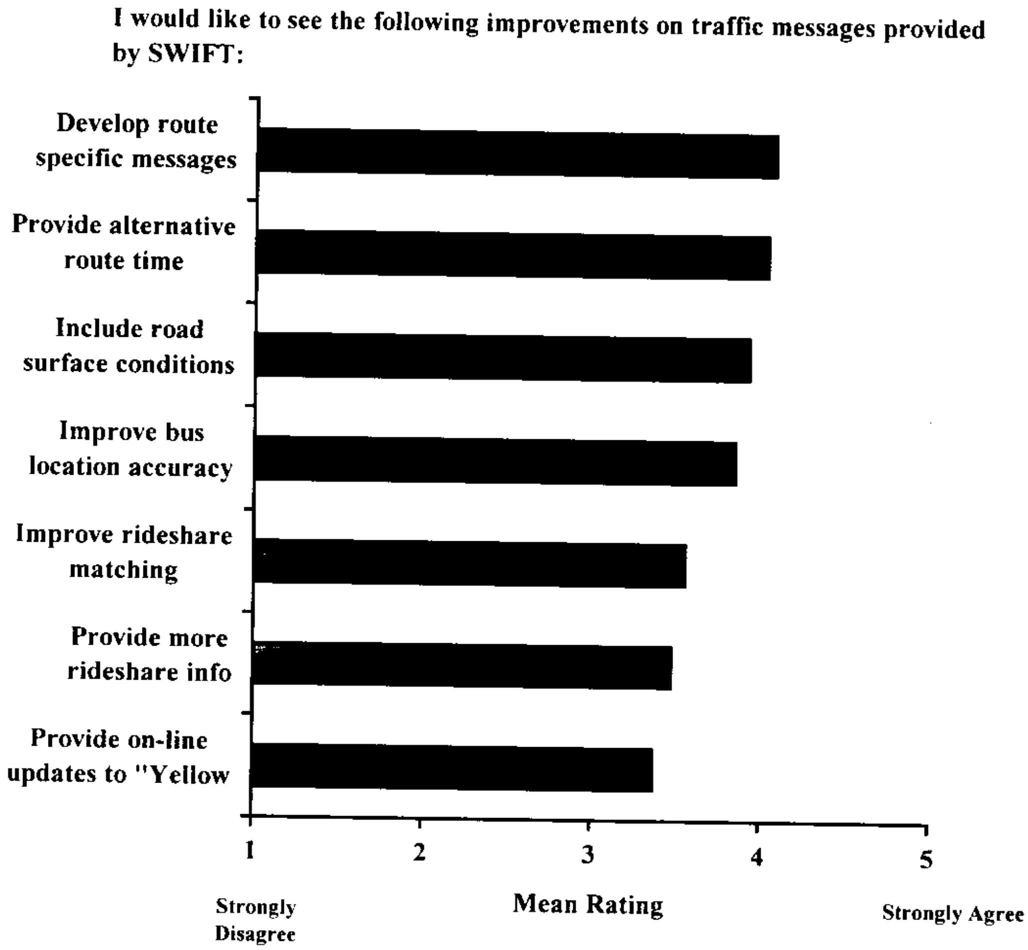

Figure 3-18 (Continued). Importance of Improvements to SWIFT Traffic Messages Provided by SWIFT Portable Computers.

3.3.2. Questionnaire Comments

Respondents reported a desire to see improvement to the timeliness and accuracy of messages. Improvements to message content included expanding to include construction-related information, as well as special events that may affect traffic congestion.

3.3.3. Focus Group and Telephone Interview Findings

Seiko MessageWatch participants expressed a concern with the timeliness of messages and expressed a desire for the addition of congestion related information, speed information and a route planning service. Delco in-vehicle-navigation device participants expressed concerns about the accuracy of the SWIFT directional information and also expressed a need to provide congestion-related information. The inaccuracy perceived by Delco in-vehicle-navigation device users is explained, in part, by the initial technical problems that resulted in the transposing of direction display by the device. SWIFT portable computer participants expressed a concern with the reliability of the signal connection and an expansion of the transit-related data to other transit operators in the region. Telephone interview respondents commented that the Etak Guide used by the Delco in-vehicle-navigation device appeared to be limited in coverage and required frequent updating.

3.4. Minimum Set of User Services and Device Features Required to Provide Viable Products and Services

In order to assess user perceptions concerning the desirability of various user service and device features, respondents were asked to evaluate their level of satisfaction with the physical and operational characteristics of SWIFT devices, the frequency of problems encountered and the importance of selected improvements.

3.4.1. Questionnaire Results

Delco In-Vehicle Device

Satisfaction with Physical Characteristics of Delco In-vehicle-Navigation Device. Figure 3-19 summarizes user satisfaction with the physical characteristics of the Delco in-vehicle-navigation device. The results indicate that Delco users were most satisfied with the device color, size, and styling and least satisfied with the message display size, illumination of buttons and message display background lighting.

Satisfaction with Operating Characteristics of Delco In-vehicle-Navigation Device. Figure 3-20 presents a summary of the level of satisfaction among Delco in-vehicle-navigation device users regarding various operating characteristics of the device. Results indicated a low degree of satisfaction with the personal-paging, message filtering and voice "announcement" features of the device. Regarding the latter, each traffic message that was received, even if it was received in a group with others, was individually announced. Thus, SWIFT users needed to adapt to "traffic, traffic, traffic," etc. being repeated on numerous occasions. Otherwise, users were somewhat neutral in the level of satisfaction for other features of the device, with the Etak Guide rated as highest in satisfaction. Perceptions regarding the personal-paging service reflected technical problems that were encountered after a later software upgrade.

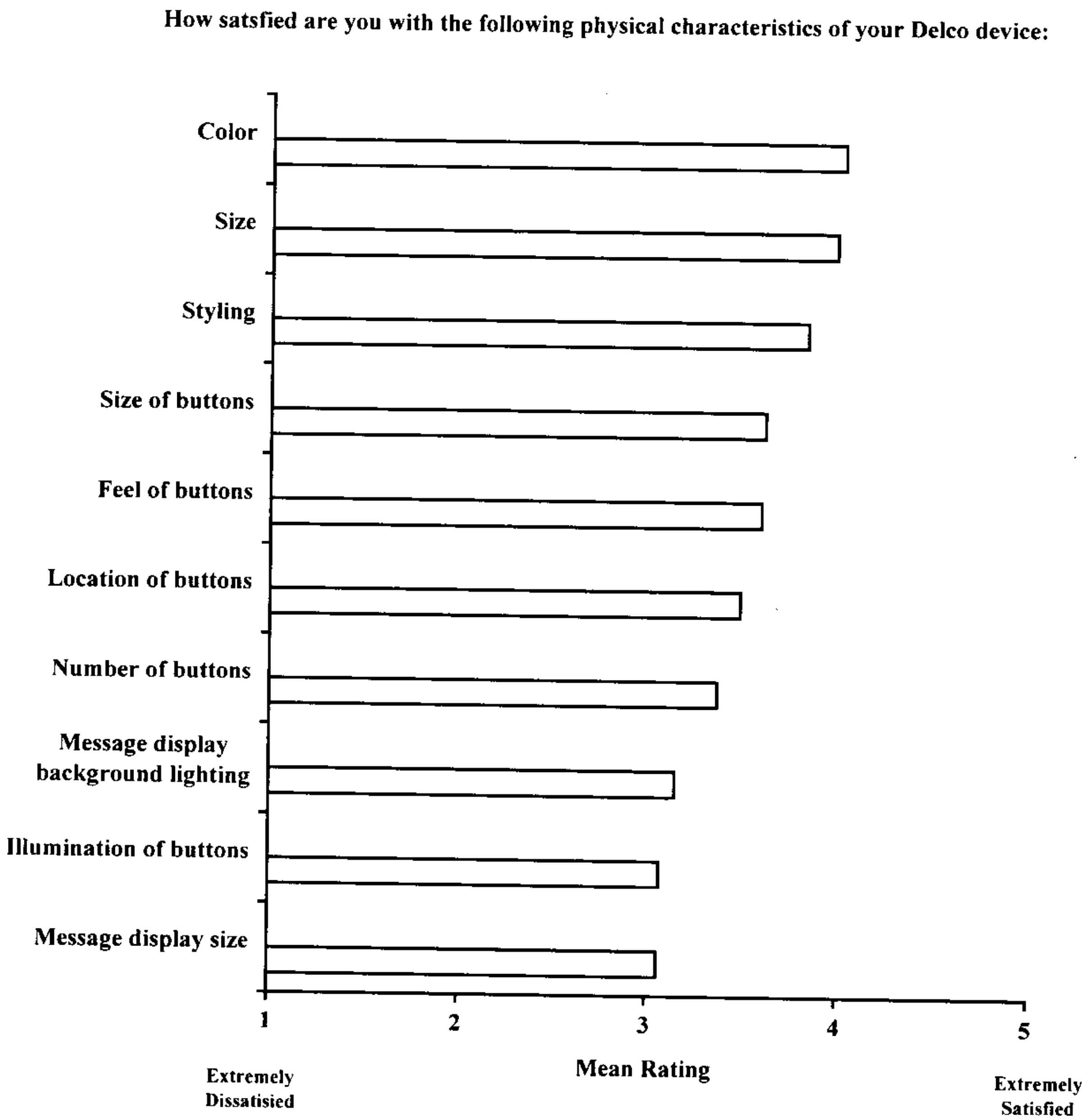

Figure 3-19. Satisfaction with Physical Characteristics of Delco In-Vehicle-Navigation Device.

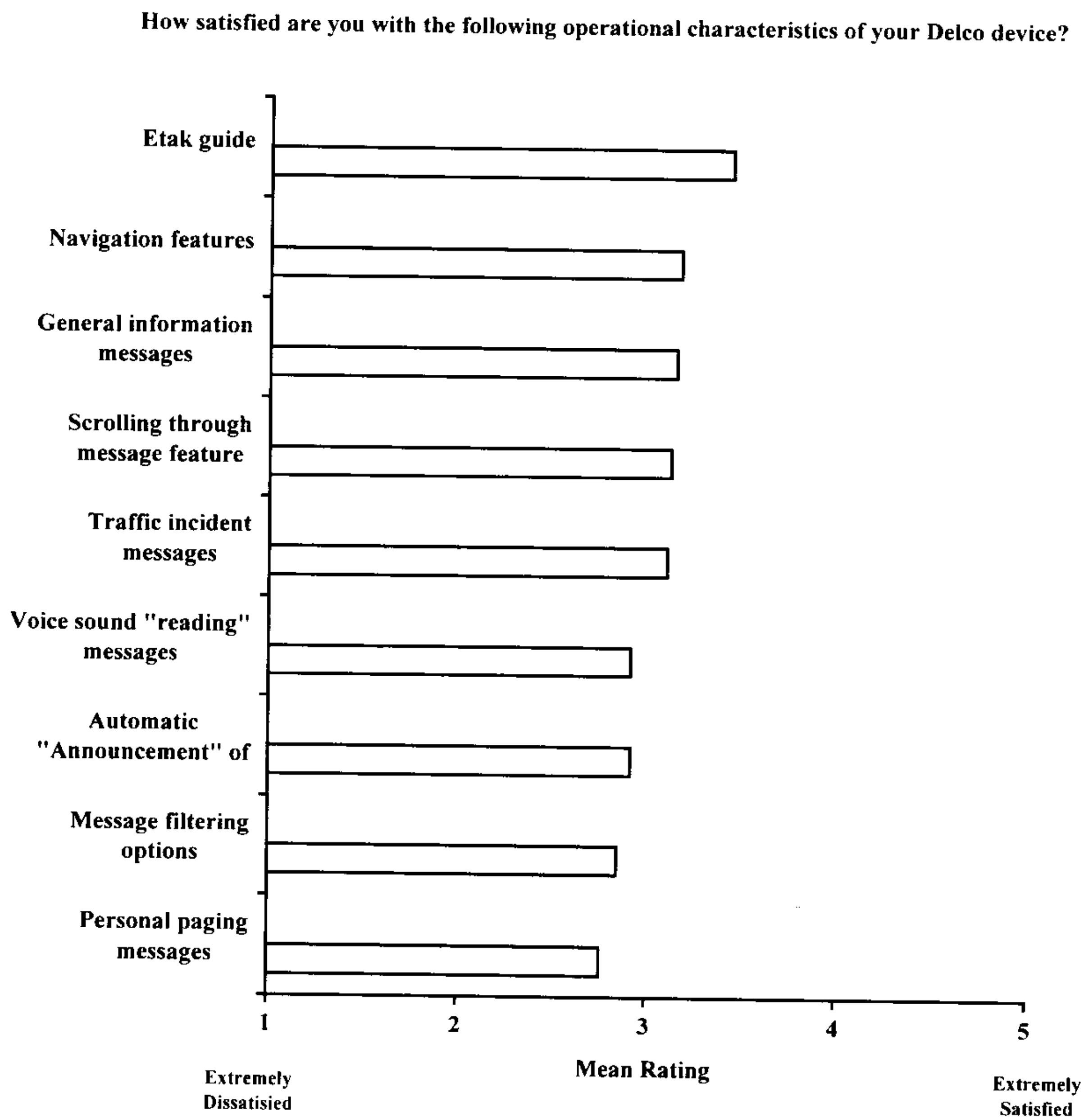

Figure 3-20. Satisfaction with Operational Characteristics of Delco In-vehicle-Navigation Device.

Satisfaction with "Announcement" Feature. Figure 3-21 summarizes user perceptions regarding aspects of the voice "announcement" of messages by the Delco in-vehicle-navigation device. The results suggest that device users agree that the "announcement" feature was both desirable and safe and does not distract from driving. Nonetheless, as previously indicated, the repeated announcement of new traffic messages was annoying to many users.

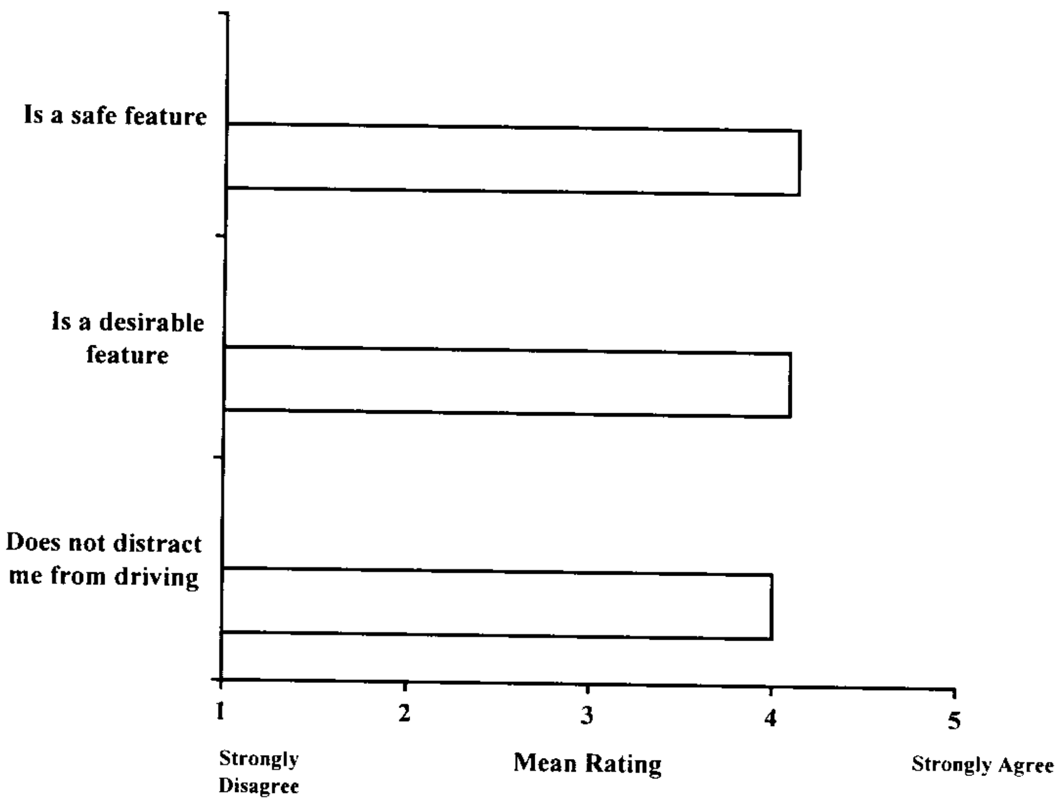

Figure 3-21. Satisfaction with "Announcement" feature of Delco In-vehicle-Navigation Device.

Frequency of Problems Encountered. Figure 3-22 summarizes the frequency of problems encountered by Delco in-vehicle-navigation device users. Users were asked to indicate the frequency of times they encountered on a five point scale with a value of one (1) indicating "very frequently" and five (5) indicating "never." The results indicate that the frequency of problems encountered was very low and that the most frequently encountered problems were associated with the message filtering feature and reading the display in direct sunlight.

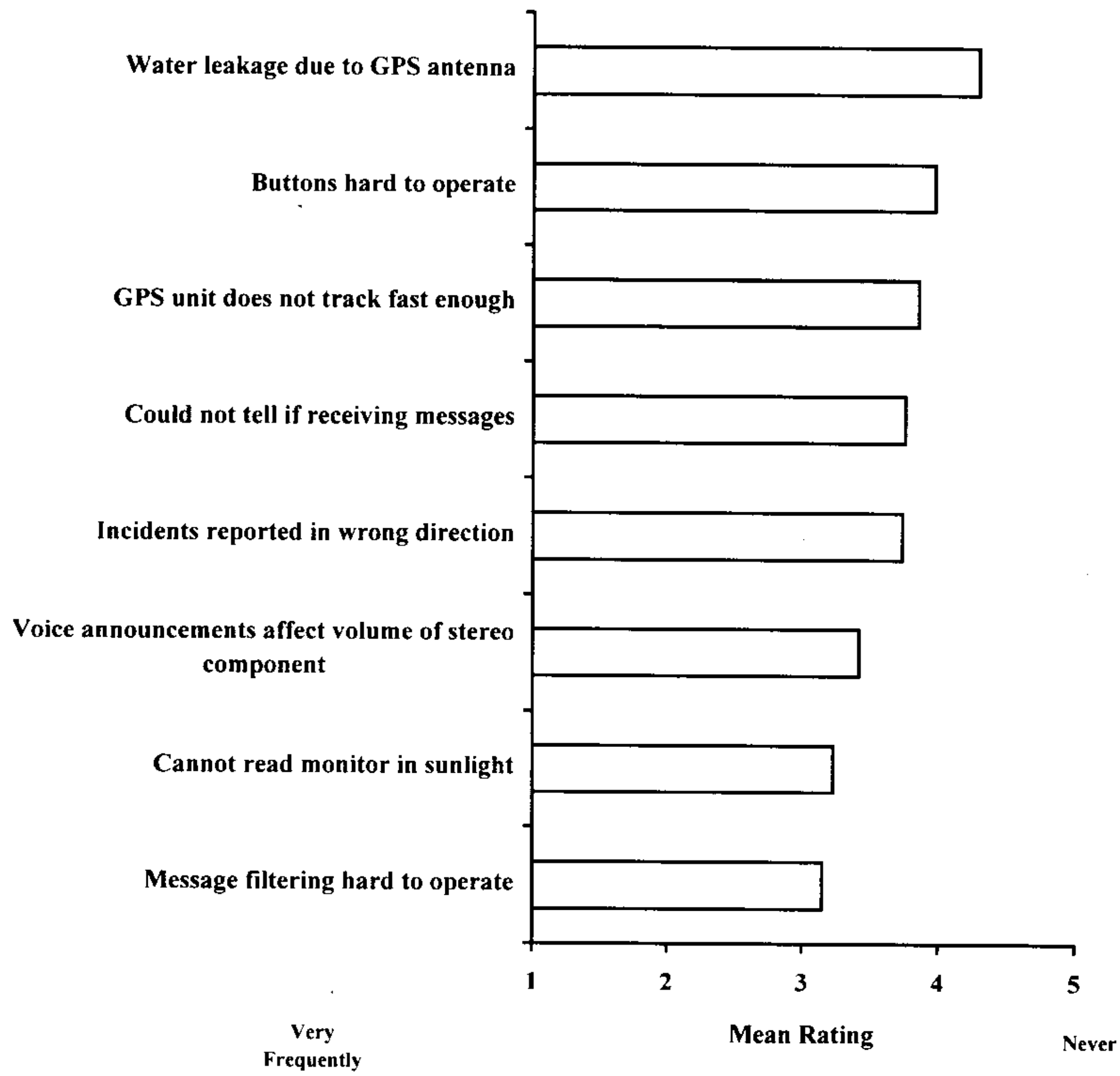

Figure 3-22. Frequency of Problems Encountered with Delco In-vehicle Navigation Device.

Importance of Improvements to Delco In-vehicle-Navigation Device. Figure 3-23 summarizes the importance that users placed on various improvements to the Delco device. The results indicate that users placed a high degree of importance on receiving congestion-related information, alternative-route information, route-specific information, and a graphic map display.

Lesser importance was placed on providing only a single "traffic" message when the car was started and providing travel time under perfect conditions.

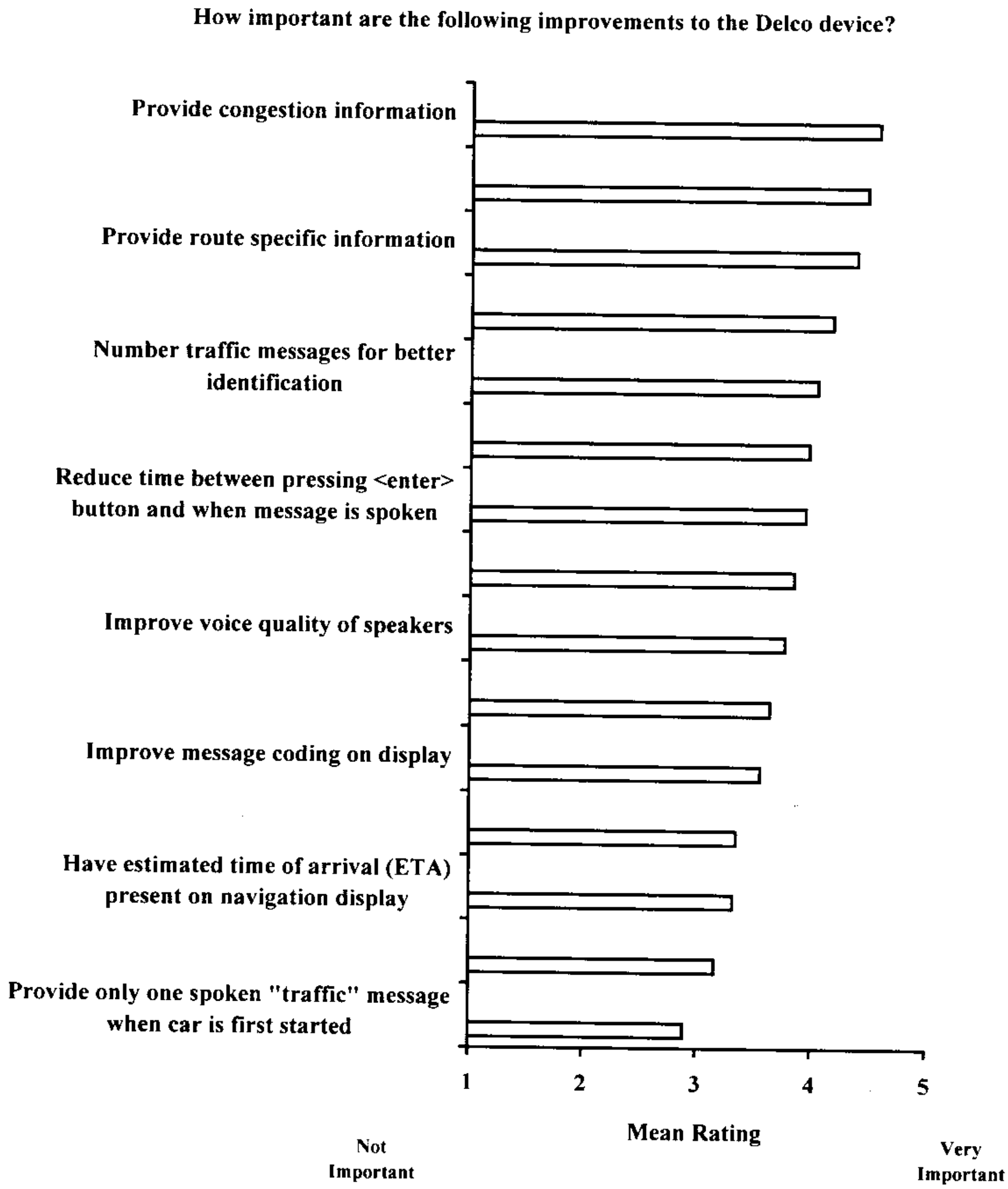

Figure 3-23. Importance of Improvements to Delco In-vehicle-Navigation Device.

SWIFT Portable Computer Device

Satisfaction with Physical Characteristics of SWIFT Portable Computers. Figure 3-24 summarizes user satisfaction with the physical characteristics of the SWIFT portable computers. In general, Dauphin users reported a lower level of satisfaction than either the IBM or Toshiba user groups for all the physical characteristics.

IBM users appeared to be most satisfied with the screen size, color and styling of the device and least satisfied with the weight and size of the device. Toshiba users followed a similar pattern. Users of the Toshiba device were most satisfied with the device color, styling, and size of the device and least satisfies with the weight of the device. In addition, Toshiba users appeared to be less satisfied with the mouse operation than IBM Thinkpad users.

Satisfaction with Operating Characteristics of SWIFT Portable Computers. Figure 3-25 summarizes the level of device user satisfaction with the operating characteristics of the SWIFT portable computers. In general, users of all devices appeared to report dissatisfaction with the communications connection and a high level of satisfaction with the use of icons. Users of the Dauphin reported a low-level of satisfaction for the congestion legend because this information was presented in black and white and not color, while Toshiba and IBM users reported a disinterest in the message status format, which frequently required users to "re-connect" their computers to the RRM.

Frequency of Problems Encountered with SWIFT Portable Computers. The results are presented in Figure 3-26. Users generally reported infrequent encounters with "General Protection Default" errors. Among Dauphin users, the most frequently encountered problems included environment/news feature not working, slow speed operation, loss of signal or weak signal. Among IBM Thinkpad users, the most frequently encountered problems included loss of signal, difficulty connecting with the Remote Radio Receiving Module (RRM) and bus information off-line. Toshiba users reported the most frequent problems with environment/news feature not working, loss of signal and difficulty connecting with the RRM.

Frequency of Problems Encountered with RRM. Figure 3-27 summarizes the frequency of problems encountered by SWIFT portable computer users with the RRM. In particular, users reported that the RRM was frequently cumbersome use and carry with their computers. In addition, users of the Toshiba device reported that the RRM failed to connect with the computer more frequently than the users of other devices.

Recommended Improvements to SWIFT Portable Computers. This was an open-ended question. Respondents generally agreed that the device must be made smaller and more portable as the current size of the RRM makes it difficult to be a truly portable device.

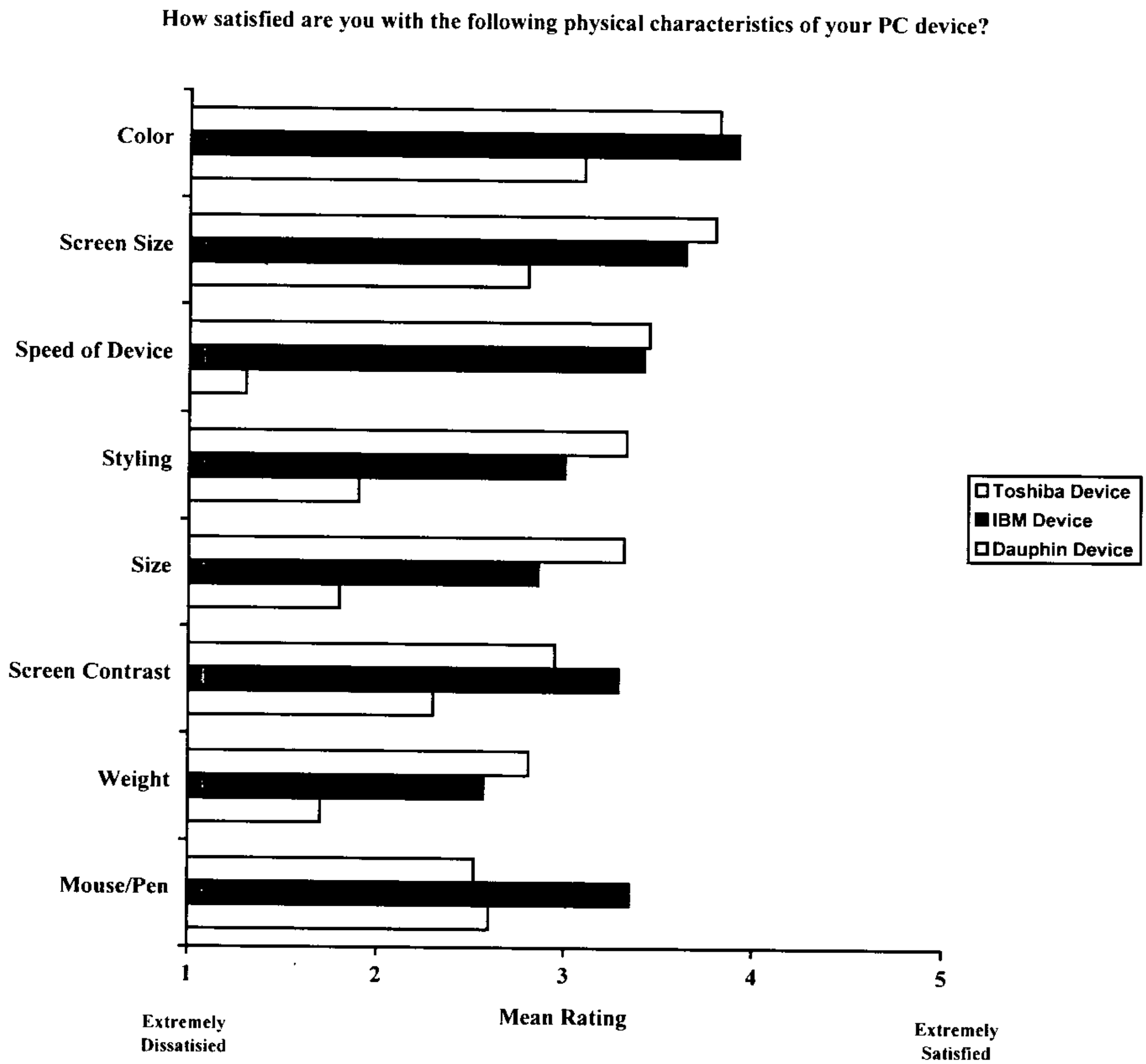

Figure 3-24. Satisfaction with Physical Characteristics of SWIFT Portable Computers.

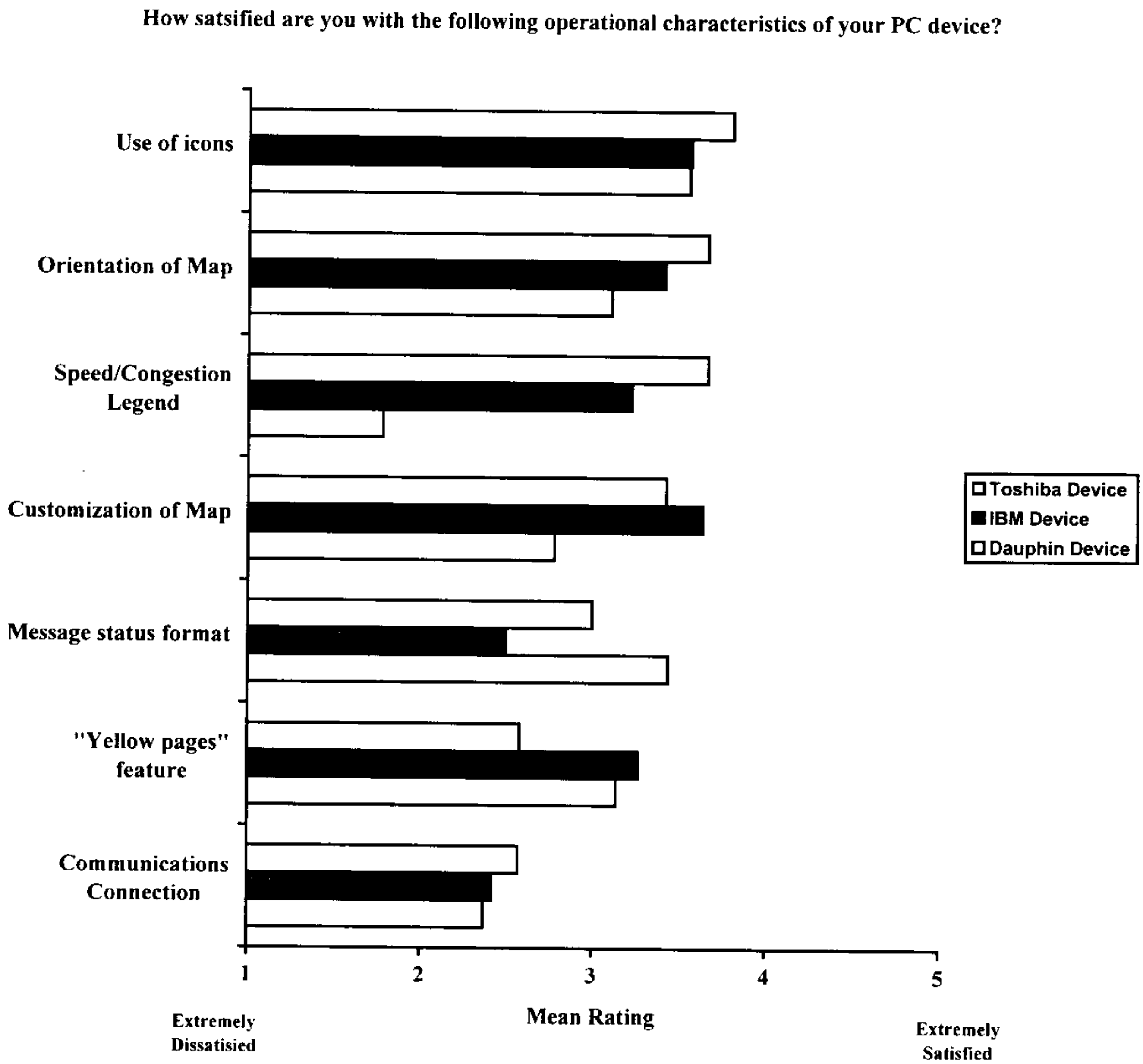

Figure 3-25. Satisfaction with Operational Characteristics of SWIFT Portable Computers.

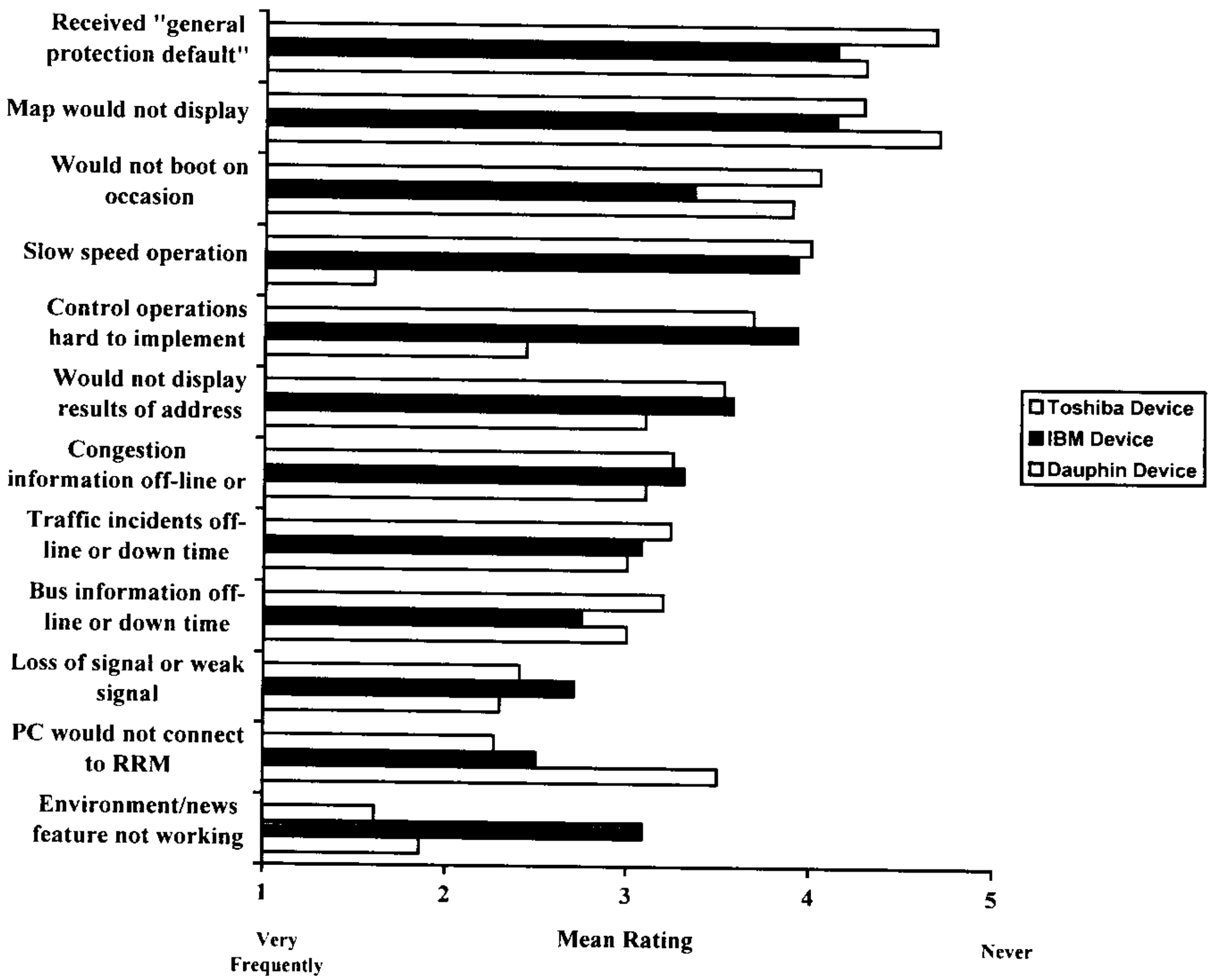

Figure 3-26. Frequency of Problems Encountered with SWIFT Portable Computers.

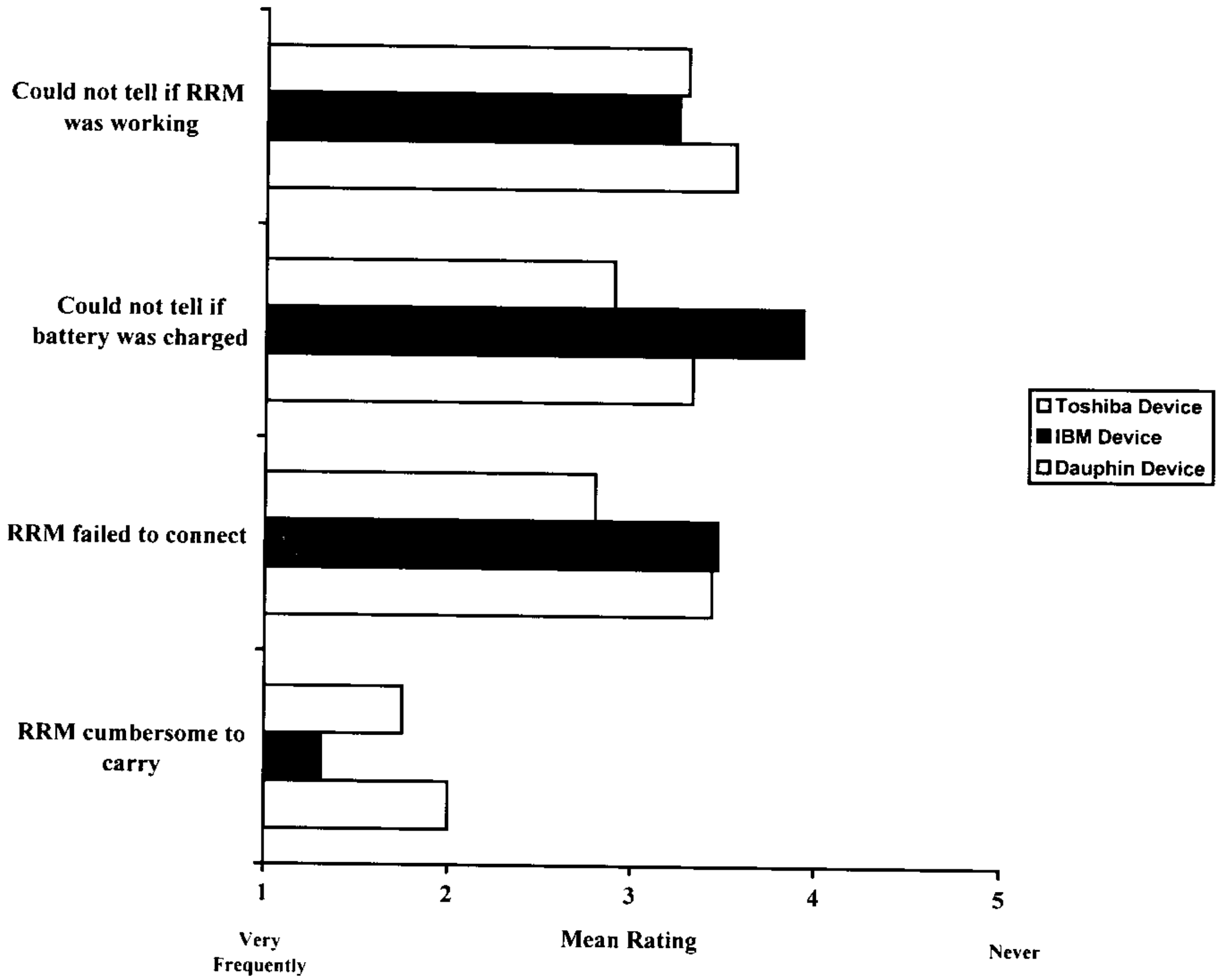

Figure 3-27. Frequency of Problems Encountered with Radio Receiving Module (RRM).

Seiko MessageWatch Users

Satisfaction with Physical Characteristics of Seiko MessageWatches. Figure 3-28 summarizes user perceptions concerning the physical characteristics of the Seiko MessageWatch. In general, users were satisfied with the physical characteristics of the device, including the number and location of buttons as well as the message display size. Users were less satisfied with the styling and message display background lighting.

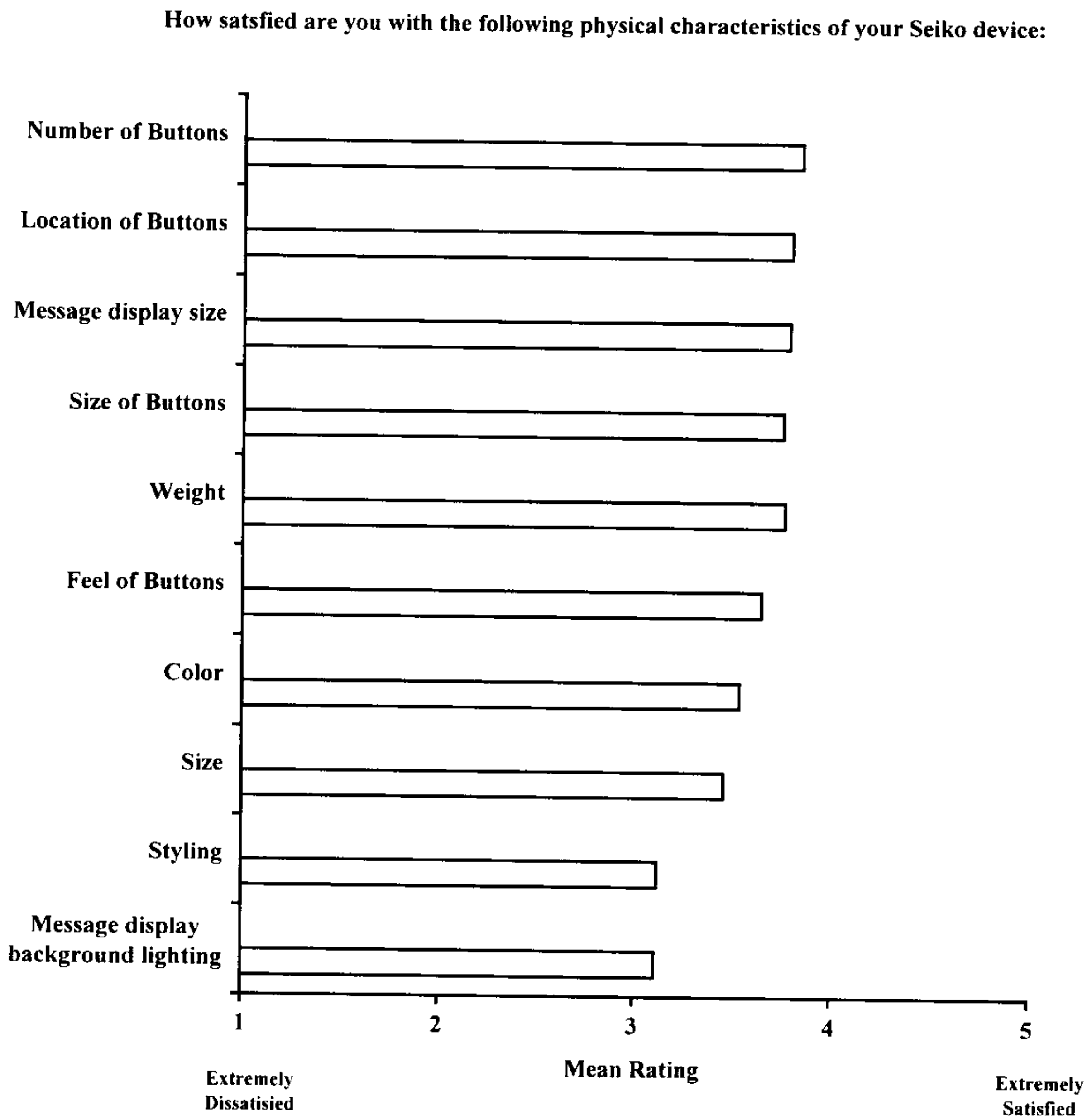

Figure 3-28. Satisfaction with Physical Characteristics of Seiko MessageWatch.

Satisfaction with Operating Characteristics of Seiko MessageWatches. Figure 3-29 summarizes user perceptions regarding the operating characteristics of the Seiko MessageWatch. In general, users were satisfied with the operating characteristics of the watch, including the automatic storage of messages. Users reported the lowest level of satisfaction with the features that continuously displayed the most recently received message and did not enable them to receive massage notifications in any other way than through an audible "beep."

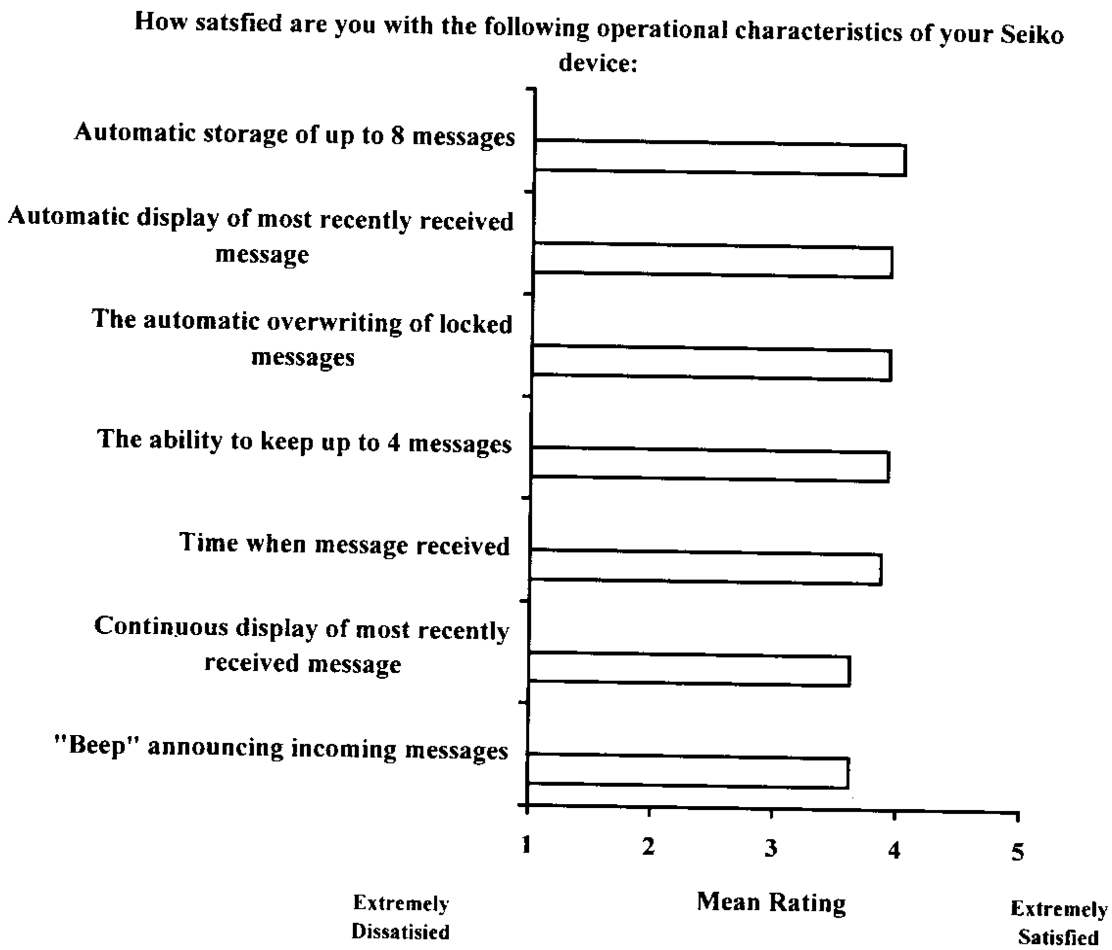

Figure 3-29. Satisfaction with Operational Characteristics of Seiko MessageWatch.

Frequency of Problems Encountered with Seiko MessageWatches. Figure 3-30 summarizes the frequency of problems experienced by Seiko MessageWatch users. The most frequently encountered problem reported was that messages were cryptic or hard to read. However, the frequency of this problem was relatively low.

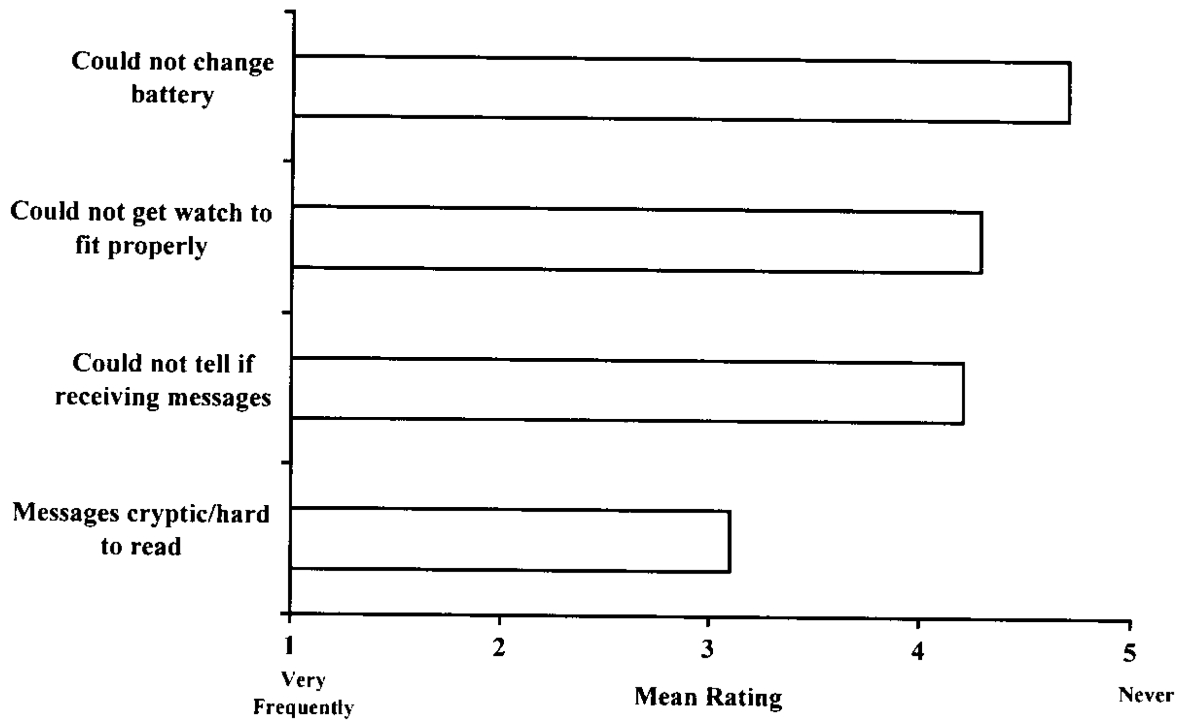

Figure 3-30. Frequency of Problems Encountered with Seiko MessageWatch.

Importance of Improvements to Seiko MessageWatch. Figure 3-31 summarizes the importance of various suggested improvements to the Seiko MessageWatch. Among the most important suggested improvements were the creation of an alphanumeric display capability, provide a different band type and provide more message-storage capability.

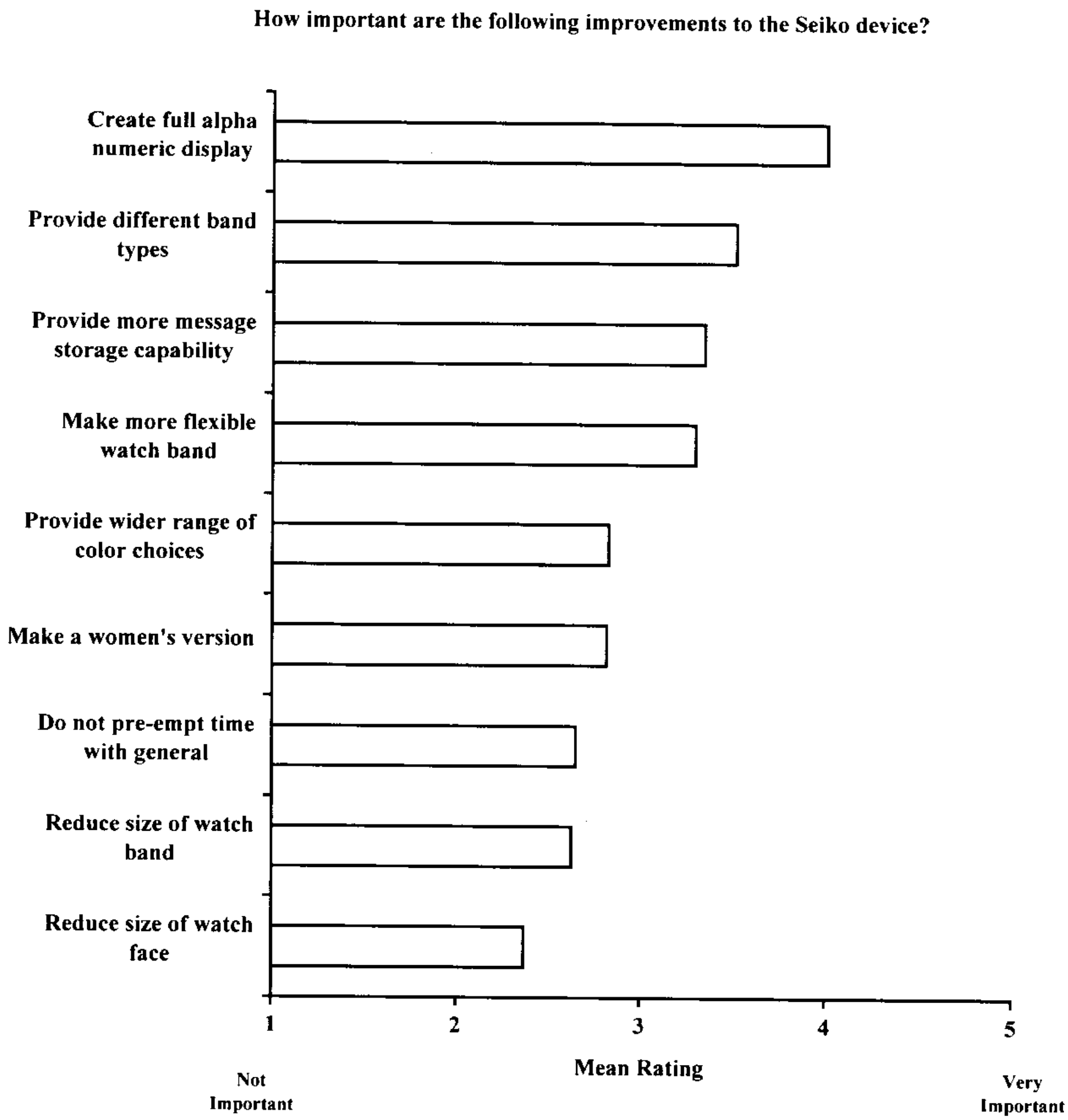

Figure 3-31. Importance of Improvements to Seiko MessageWatch.

Use of Travel Profile. Users of the Seiko MessageWatch were asked several questions regarding the use of the SWIFT travel profile to provide information on route segments for which they desired to receive information. The results indicated the following:

- A majority of users found that it would be useful to have information on routes not included in their most current travel profile;
- A majority of users found that they often found themselves wanting information for a road segment that was available but they did not request;
- Nearly 90% of the users found the existing forms easy to use;
- Among the most highly preferred methods to improve the profile forms included providing on-line enter/change capability (53%) and provide ability to reset for specific days (50%)
- A majority of users (69%) found themselves traveling at times different from those specified in their most current travel profile
- The use of a web page to update travel profiles was forwarded as the most effective method to change the travel profile

Desire to Receive Traffic Information on SWIFT Devices in Other Cities. SWIFT users were asked indicate their desire to receive SWIFT information on their devices in other cities. In general, all device users did not have a high level of desire to receive SWIFT information in other cities. Approximately one-third of the Seiko MessageWatch users reported that they "Often" or "Frequently" would like to receive information in other cities, while about 30% of Delco in-vehicle-navigation device users reported a similar level of desire. Only about 10% of SWIFT portable computer users would "Frequently" or "Often" desire to receive information in other cities.

Interference of Messages. New messages received by the Seiko MessageWatch typically overwrote existing messages on the display panel. Users were asked to evaluate the level of interference in message receipt caused by this feature. In general, users appeared to be satisfied with this feature of the device.

3.4.2. Questionnaire Comments

Seiko MessageWatch respondents reported a desire for a more flexible watch band, improved background message lighting and the replacement of the "beep" with a vibration that notifies the users of a message. Several respondents also reported a desire for improved alphanumeric display capabilities.

3.4.3. Focus Group and Telephone Interviews Findings

Focus group and telephone interview participants provided comments concerning various device features and improvements. In addition to those previously mentioned, participants in the focus groups and telephone interviews desired to see improvements to the voice quality of the Delco in-vehicle-navigation device, and a desire to see improvement to the size and portability of the RRM device.

3.5. User Perceptions of SWIFT Device Usefulness

SWIFT users were asked to summarize their perceptions concerning the usefulness of their SWIFT devices in meeting their travel needs. In order to provide an appreciation of the usefulness of their devices, respondents were asked to provide information concerning their frequency of consulting the device along with perceptions concerning device usefulness.

3.5.1. Questionnaire Items

Frequency of Consulting SWIFT Device

As part of the third questionnaire, device users were asked to identify the weekly frequency with which they consulted their device. Figure 3-32 provides a summary of the results for the three device types. Nearly all respondents representing users of the Delco in-vehicle-navigation device and Seiko MessageWatch reported consulting traffic information at least once a week. Approximately 70% of the respondents representing users of the SWIFT portable computer reported consulting traffic information once a week. Over 60% of respondents reported using transit location and schedule information at least once a week, while fewer than half of the respondents reported using address finding or "Yellow Pages" features at least once a week.

Timing of Consulting SWIFT Device

As part of the first and second questionnaires, device users were asked to indicate when they consulted device features and information. The results are summarized in Figure 3-33 and were fairly consistent across questionnaires. Most respondents reported consulting information immediately before leaving on a trip. Over one-fourth reported that they consult information while en-route. The results suggest that information provided immediately before travel will have the most relevance to travelers.

Methods Used to Obtain Travel Information Before Leaving

Device users were asked to identify methods they used to obtain traffic information before leaving on a trip as part of all three questionnaires. The results are presented in Figures 3-34.

In general, respondents reported a preference for radio reports followed by SWIFT travel information. Nonetheless, these results indicate that the SWIFT system was very heavily used by FOT participants as soon as it was made available.

Methods Used to Obtain Travel Information While En-Route

Device users were asked to identify methods they used to obtain traffic information while en-route as part of the first and third questionnaires. The results are presented in Figure 3-35. Most respondents reported the use of commercial radio followed by the SWIFT device and actually encountering the incident.

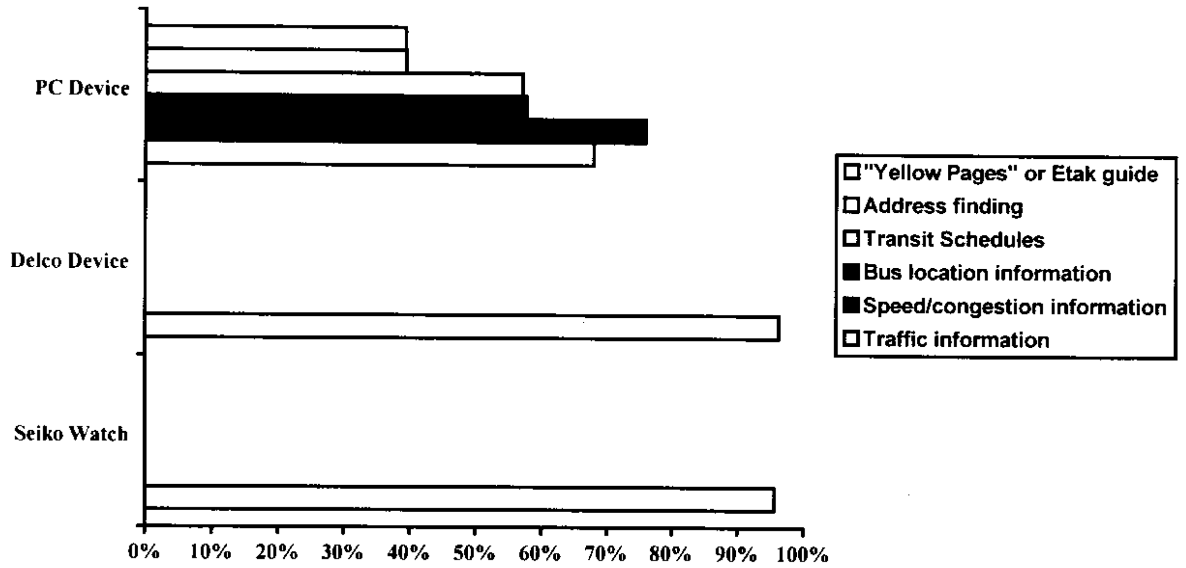

Figure 3-32. Percentage of SWIFT Respondents Who Reported Consulting Information Provided by Their Device One or More Times Per Week.

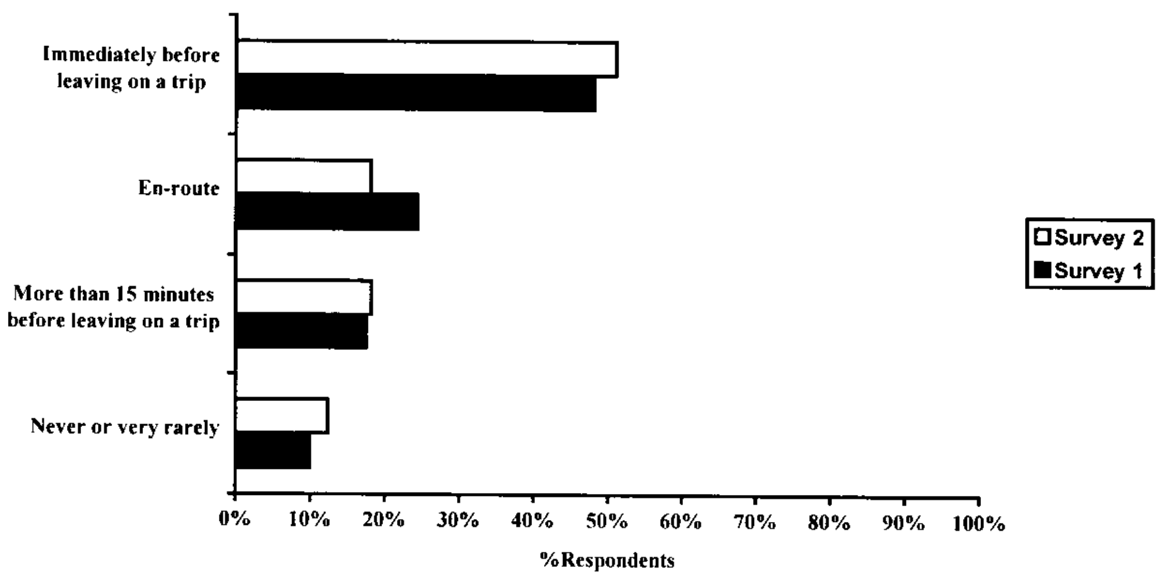

Figure 3-33. Timing of Consulting Travel Information Provided by SWIFT.

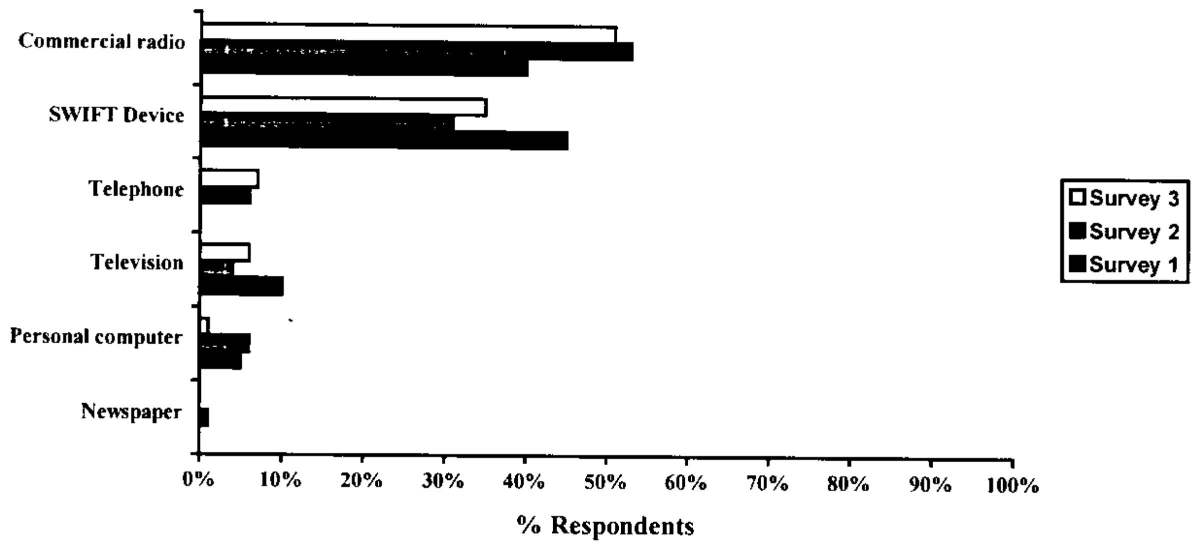

Figure 3-34. Methods Used by SWIFT Users to Obtain Traffic Information Before Leaving on a Trip.

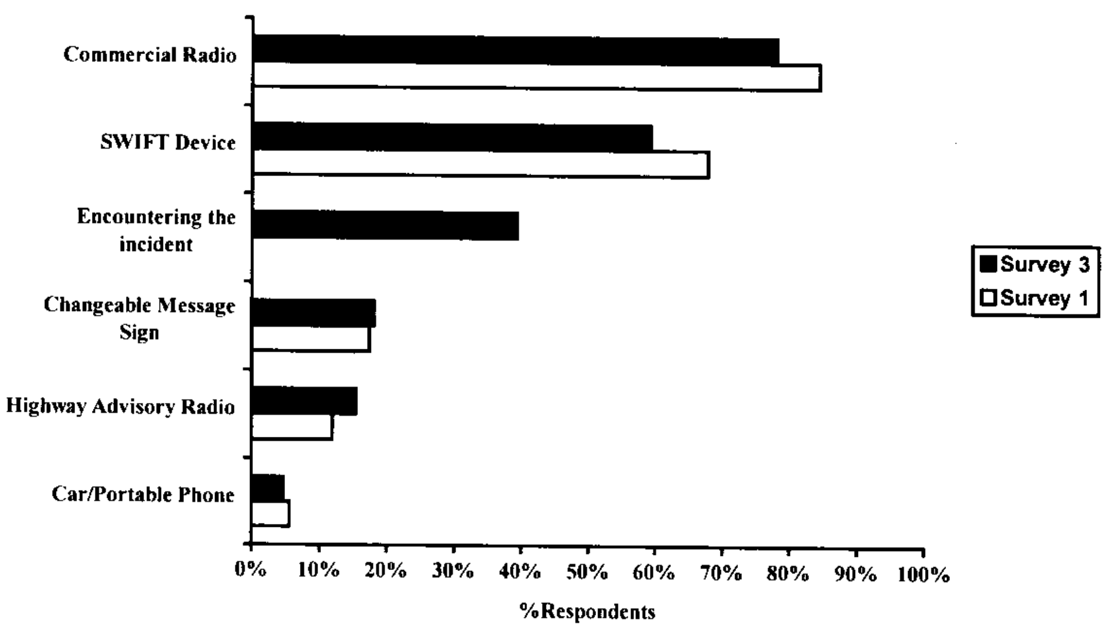

Figure 3-35. Methods Used by SWIFT Users to Obtain Traffic Information While En-Route.

Characteristics of SWIFT Devices

Users of the SWIFT devices were asked to assess several characteristics including ease of use, safety, comfort and convenience as part of the third questionnaire. The results are presented in Figure 3-36. SWIFT portable-computer users generally provided lower ratings for device convenience, comfort and ease of use than other device users. Overall, users of the Seiko MessageWatch rated all features higher than any other device user group. Users of the Delco in-vehicle-navigation device rated safety of use quite high, however, this rating was lower than for other device user groups.

Satisfaction with Device Usefulness

Device users were asked to rate the overall usefulness of their device on all three SWIFT user questionnaires. The results are summarized in Figure 3-37. Seiko MessageWatch users were generally very satisfied with the usefulness of their device and showed an increased level of satisfaction over the course of the SWIFT FOT. Over three-fourths of the respondents to the third questionnaire were either "extremely satisfied" or "satisfied" with the usefulness of the device. Users of the Delco in-vehicle navigation devices were somewhat less satisfied than users of the Seiko MessageWatch. Approximately 40% of respondents in the third questionnaire were either "extremely satisfied" or "satisfied." However, nearly 30% were either "dissatisfied" or "extremely dissatisfied." Users of the SWIFT portable computers were less satisfied with the usefulness of their device than users of other devices. Nearly 50% of the respondents to the last questionnaire were either "dissatisfied" or "extremely dissatisfied."

3.5.2. Questionnaire Comments

Many respondents reported using a variety of approaches (e.g., SWIFT, radio) in combination with each other to obtain traffic information before leaving on a trip or while en-route.

3.5.3. Focus Group and Telephone Interview Findings

Focus group participants generally reported using SWIFT immediately prior to leaving on a trip. Most reported that the SWIFT information was useful for travel planning purposes and was consulted on a fairly frequent basis.

Other results indicated that Seiko MessageWatch users generally agreed that the device was easy, safe, comfortable and convenient to use, while users of the Delco in-vehicle-navigation device reported that their device was relatively less convenient to use than Seiko MessageWatch users. SWIFT portable computer users the same thing.

3.6. Willingness-to-Pay for Different Services

SWIFT participants were asked to provide information regarding their willingness-to-pay for SWIFT devices and services.

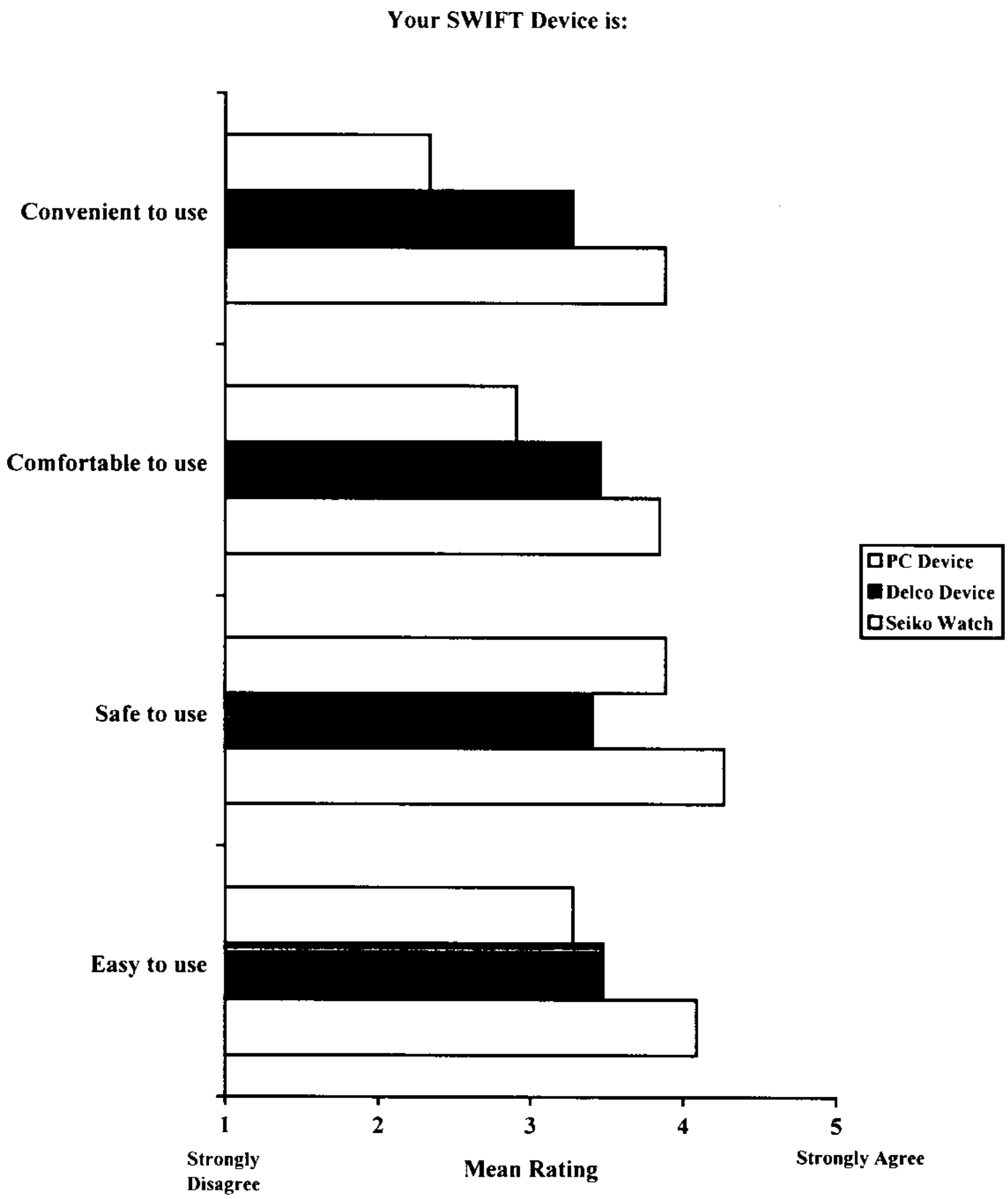

Figure 3-36. Rating of SWIFT Device Characteristics.

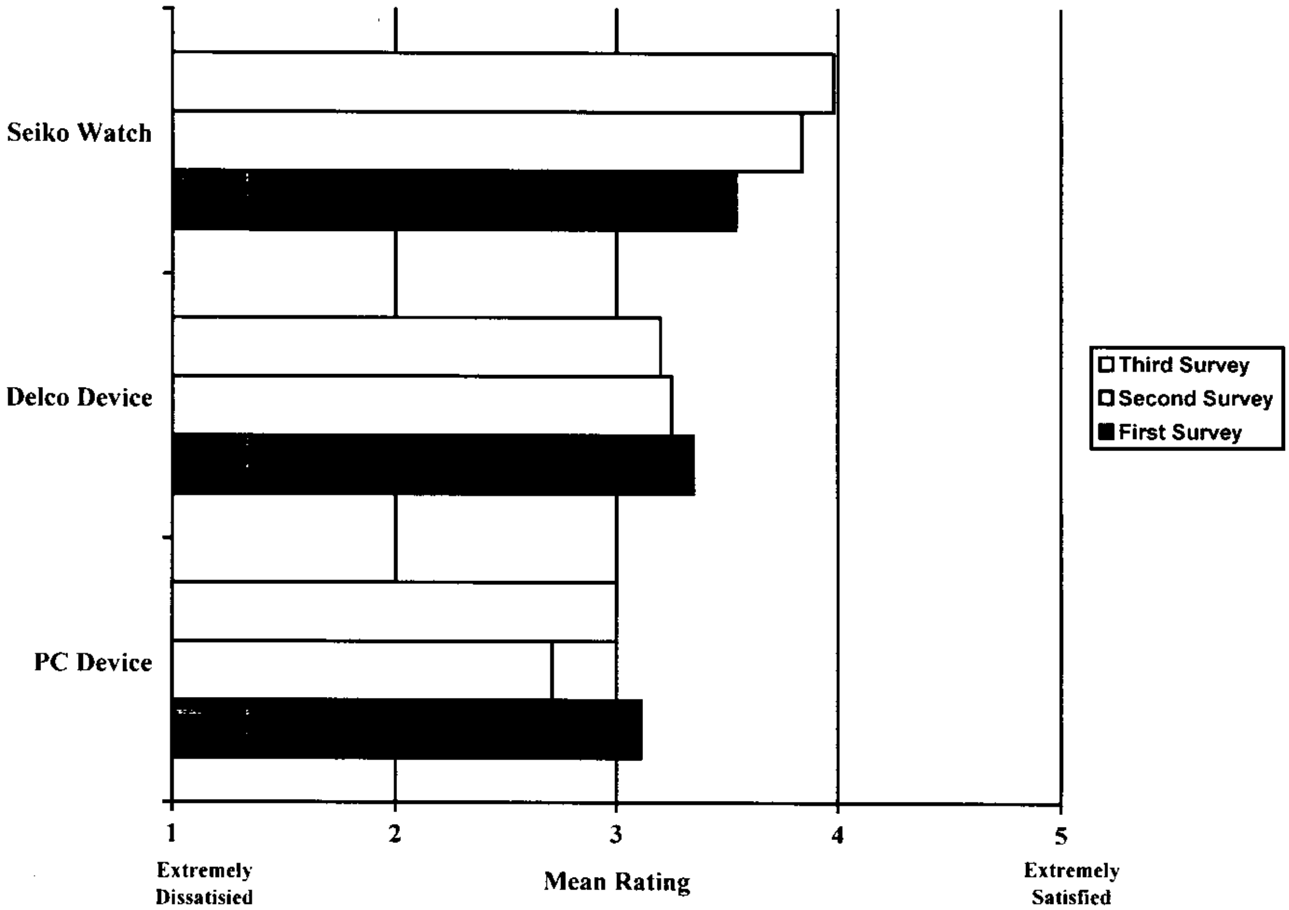

Figure 3-37. Satisfaction with Usefulness of SWIFT Devices.

3.6.1. Questionnaire Items

Respondents Willing to Consider Purchasing SWIFT Device

As part of the second questionnaire, device users were asked to indicate whether they would be willing to consider purchasing SWIFT devices or services. Figure 3-38 summarizes the results. Users of the Seiko MessageWatch and Delco in-vehicle-navigation device appeared to be more willing to consider purchase than users of the SWIFT portable computer.

Amount Respondents are Willing to Pay

Also as part of the second questionnaire, device users were asked to indicate how much per month they would be willing to pay to receive the SWIFT travel information. Figure 3-39 summarizes the results. Approximately 20% of respondents were not willing to pay any amount to receive the services, while two thirds (i.e., approximately 67%) of users of all devices were willing to pay in the range of $5 to $10 per month. Seiko MessageWatch respondents reported a willingness-to-pay approximately $ 6.00 per month while users of the Delco in-vehicle-navigation device and SWIFT portable computer reported a willingness to pay around $ 8.00 per month. Combined, all device users reported a willingness-to-pay of approximately $ 6.50 per month.

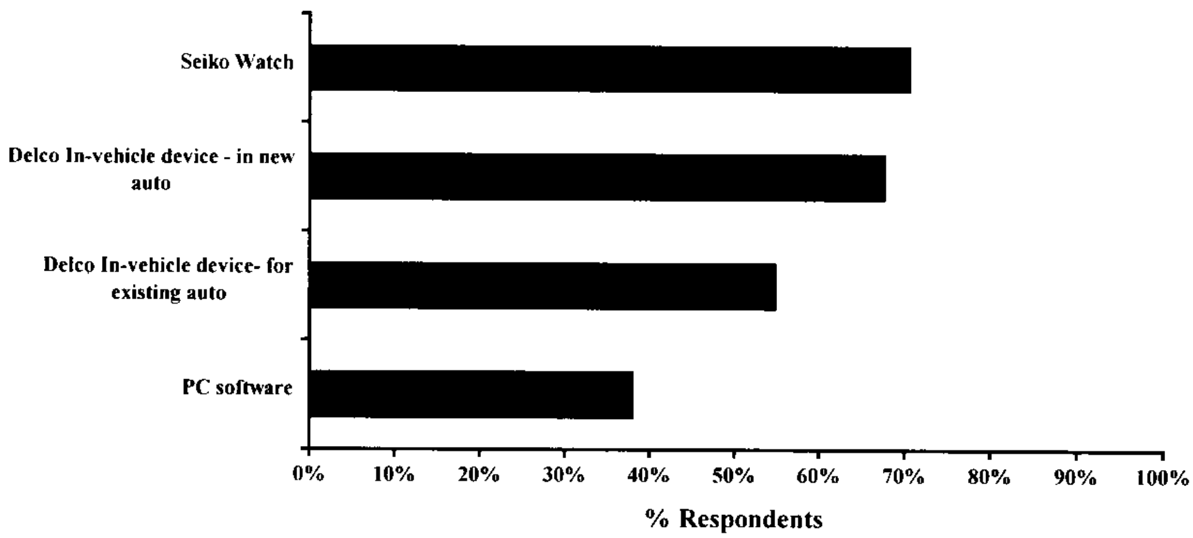

Figure 3-38. Percentage of Respondents Willing to Consider Purchasing SWIFT Device.

Respondent Willingness to Subscribe if Current Services Retained

As part of the third questionnaire, respondents were asked to evaluate their willingness to subscribe to SWIFT services. Figure 3-40 summarizes the results of this question. Approximately 50% of all users would either "probably not subscribe" or "definitely not subscribe" if the current services were retained. Approximately 30% of Seiko MessageWatch users would "definitely subscribe" or "probably subscribe," while only about 15% of other device users would "definitely" or "probably" subscribe.

Approximately 88% of respondents cited cost of service as a factor that would influence their decision to continue use of the SWIFT service. About two-thirds of respondents cited improved device features and messages as factors influencing continued use. Finally, about half indicated that easier to understand messages would influence their decision to continue use and approximately 44% cited a desire to have more routes covered.

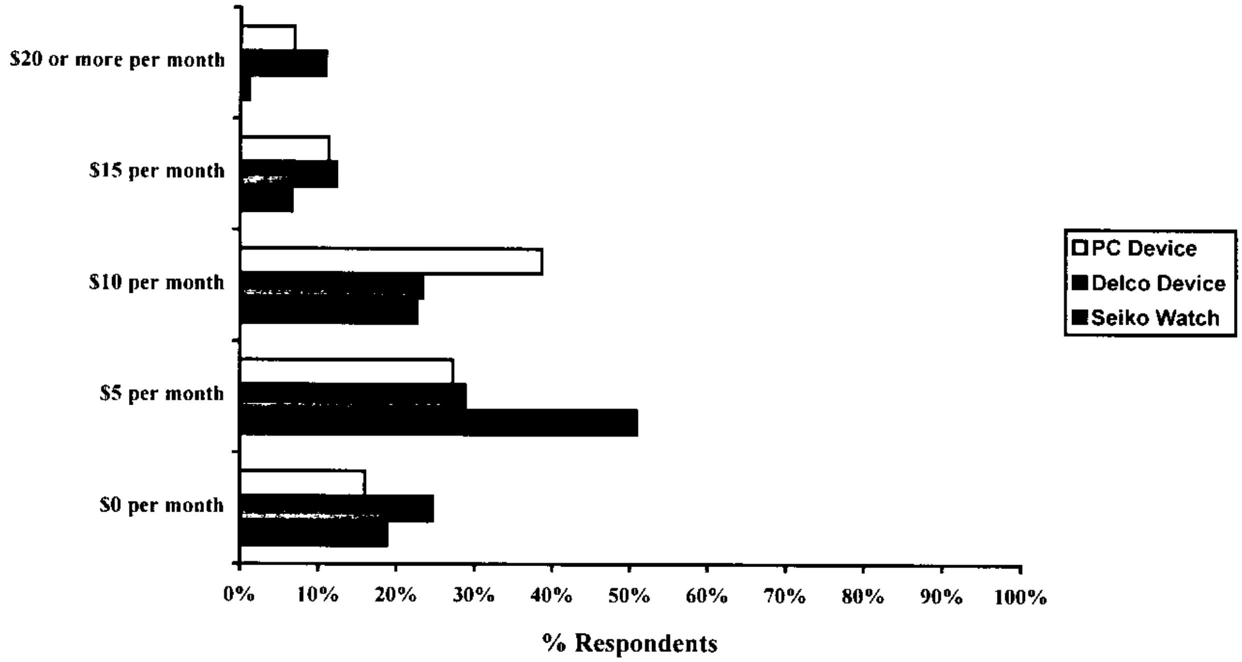

Figure 3-39. Amount Willing to Pay Per Month for SWIFT Travel Information.

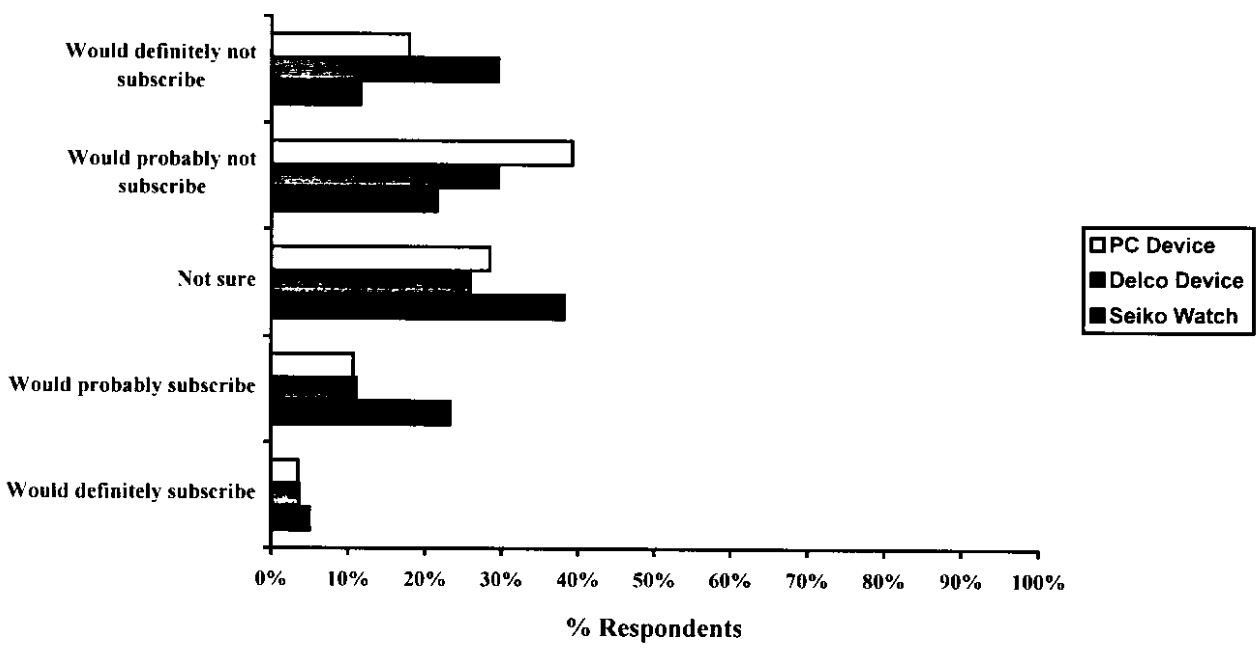

Figure 3-40. Willingness to Subscribe if Current Services Retained.

Scaled Value of SWIFT Information

In the third questionnaire, SWIFT participants were asked to consider the value of 15 related items. Among these items was SWIFT traffic information. The fifteen items were:

- 4 hours of parking in downtown Seattle
- Alphanumeric personal paging service
- Bus location information
- Cellular phone service (with 30 minutes of calls)
- Daily newspaper
- Online service (e.g., MSN, America Online)
- Premium cable TV channel (assume you have basic service)
- Satellite television service
- Stock quotes on a pager
- SWIFT traffic messages
- Telephone voice mail (or answering machine)
- Traffic information on the radio
- Transit schedule information
- Weather information by telephone
- Wireless email on a notebook computer.

The items were presented in pairs, and respondents were asked to select the most valuable item in each pair. Except when stated otherwise, they were to assume services were for one month, and all quantities were one each. Each respondent was asked to compare 15 pairs of items across all participants, 103 of 105 possible pairings of the items were presented, with each item appearing as the first or second member of a pair equally often. The responses were converted into a dominance matrix that represents each item in a row and a column, with the cells in the matrix representing the proportion of times the row item was selected over the column item. Thurstone's scaling procedure was then applied. The procedure requires the assumption that the paired comparisons were based on judgments against a single criterion dimension (value). Furthermore, the procedure requires the assumption that, in sampling, the probability of an item being selected over another item being selected will fluctuate over time, but that over many samples, a mean probability of selection of an item over another will arise, and the variability about that mean will distribute normally.

The results of the scaling procedure are shown along the left side of Figure 3-41, where the items are placed on a scale from 0 to 100, with items placed along the scale according to the respondent's collective value choices. On the right side of the figure items are scaled against

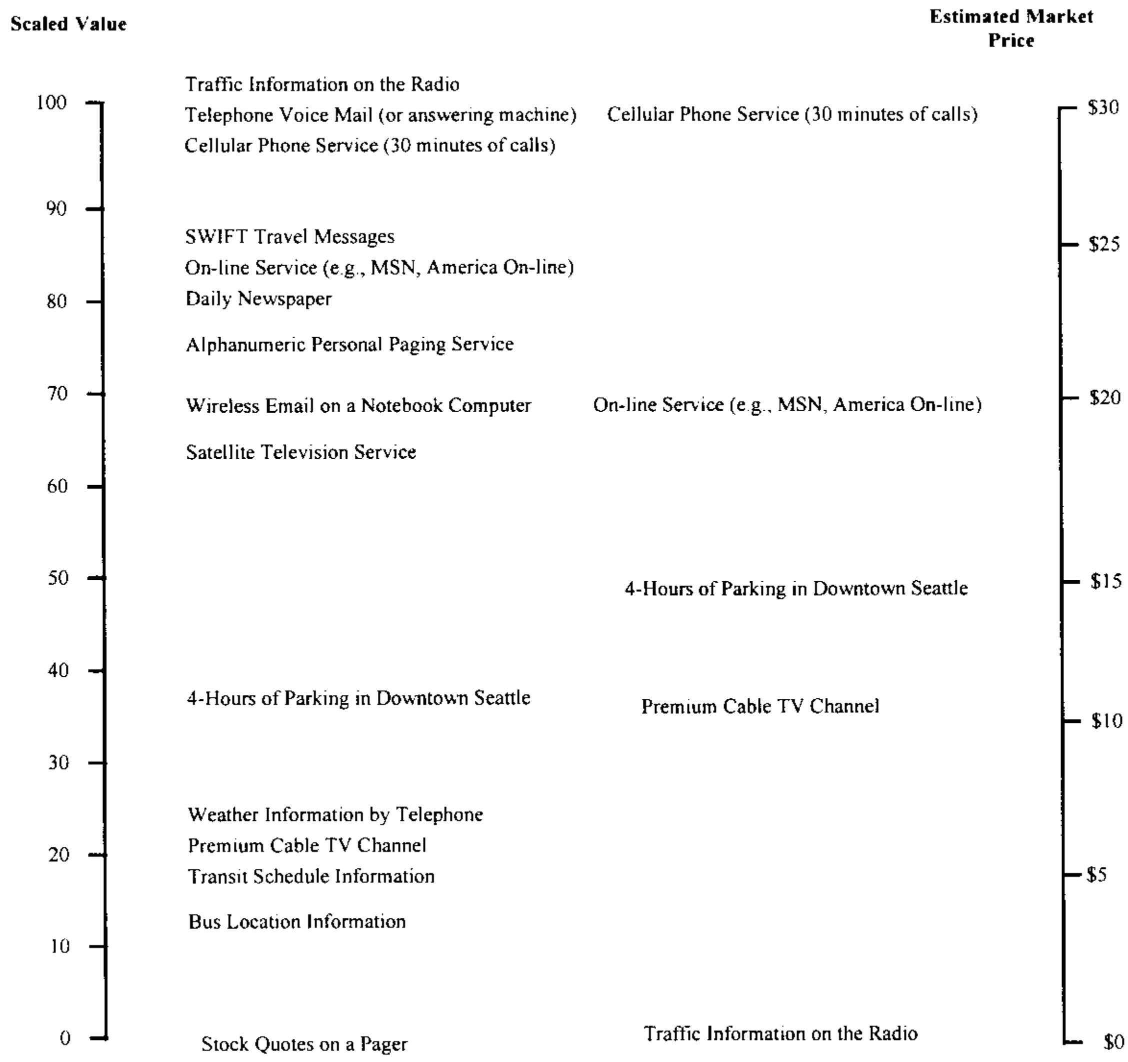

Figure 3-41. Participants' Scaled Value for Items in Questionnaire.

estimated market prices for the items in the Seattle region. As can be seen, the most expensive items appear at the top of the value scale, and, as expected, items provided free to SWIFT Device Users appear at the bottom of the scale. The finding that items on the scale are roughly ordered according to values one might expect users to place on them suggests that the scaling procedure was successful. Note that some items, such as traffic information on the radio, have a much greater value to the respondents than their estimated market price. This was in line with the request that respondents rate the value, not the cost of the items. SWIFT travel information was valued about equally with a daily newspaper and on-line services. Based on this perceived value, it appears that participants might be willing to pay as much as $20 per month for a SWIFT-like system. Because respondents rated relative value, and not willingness-to-pay, care should be taken in interpreting this result. For instance, traffic information on the radio, which is distributed free of charge to the consumer, was the most highly-valued item. Given that consumers now receive the radio information free, it is likely that they would show some resistance to paying $20 per month for SWIFT travel information, even if they perceive that to be its true value.

3.6.2. Questionnaire Comments

Respondents provided comments concerning factors that may influence their continued use of SWIFT devices and services. Respondents suggested a need to increase the coverage area, make the device more convenient and comfortable to use and improve the performance.

3.6.3. Focus Group and Telephone Interview Findings

Focus group participants were asked how much they would be willing to pay for the SWIFT services both as they experienced it, and if the improvements they requested were made. The average cost users of the Seiko MessageWatch reported they would pay for SWIFT services without any improvements was $2.85 per month. The average cost these users said they would be willing-to-pay if improvement were made was $ 7.03. Users of the Delco in-vehicle navigation device reported an average willingness-to-pay of $2.70 per month without improvements and $12.85 per month if improvements were made. Users of the SWIFT portable computer stated that they would be willing-to-pay an average of $6.22 per month without improvements and $12.08 per month if suggested improvements were made to the service.

Focus group participants suggested that they would be more willing to consider purchasing SWIFT services if they were bundled as part of other information services such as a monthly on-line account. Many suggested that packaging of services in this manner would provide them with a greater overall value and thus increase the likelihood that they would subscribe to a SWIFT information service.

3.7. User Perception of Change in Travel Convenience and Efficiency

SWIFT users were asked to provide their perceptions concerning the impact of SWIFT devices and services on their travel convenience and efficiency.

3.7.1. Questionnaire Items

Impact of Travel Messages on Commuting

Users where asked in the third questionnaire to rate their perceptions concerning the usefulness of SWIFT travel messages for improving commuting travel convenience and efficiency. Figure 3-42 presents a summary of the results. A significant number of respondents agreed with the assertion that SWIFT travel messages helped them "keep moving", reduce stress, and reduce commute time. Users also generally agreed with the assertion that SWIFT travel messages improved on- time performance and allowed users to manage their time more effectively by leaving earlier or later. Users were more neutral toward the impact of travel messages on reducing commute length, and generally did not agree that travel messages resulted in a change in means of travel.

These results were generally consistent across device user groups with some exceptions. Specifically, users of the SWIFT portable computer were more likely to agree that SWIFT travel messages allowed them to make decisions about means of travel. This was consistent with the fact that SWIFT portable computer users, as a group, were more likely to be transit choice users than other device users groups.

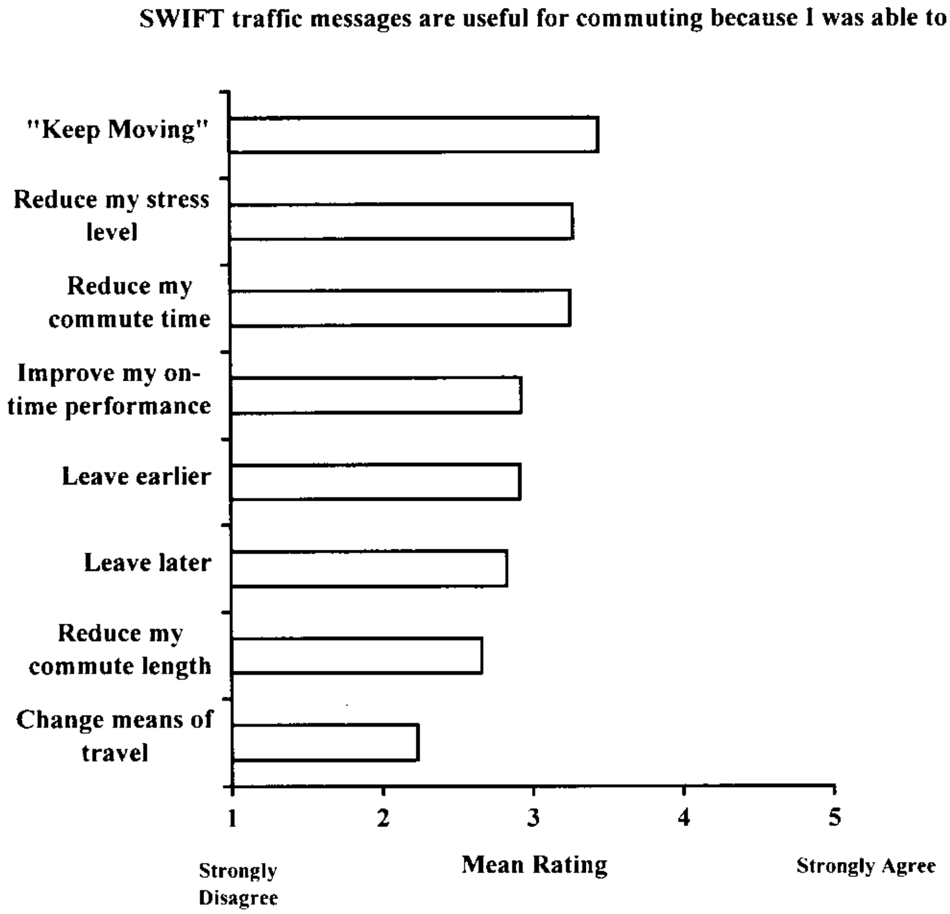

Figure 3-42. Usefulness of SWIFT Travel Messages.

Impact of Bus Position/Schedule Information

SWIFT portable computer users were asked to assess the usefulness of bus position/schedule information on travel convenience and efficiency. Figure 3-43 presents a summary of the results. In general, SWIFT portable computer users agreed with the assertion that use of the bus position/schedule information reduced stress, enabled users to stay inside while waiting for the bus, assisted in bus transfer, encouraged bus use, allowed users to arrive on time and allowed users to leave sooner.

Using the bus position/schedule information provided by SWIFT:

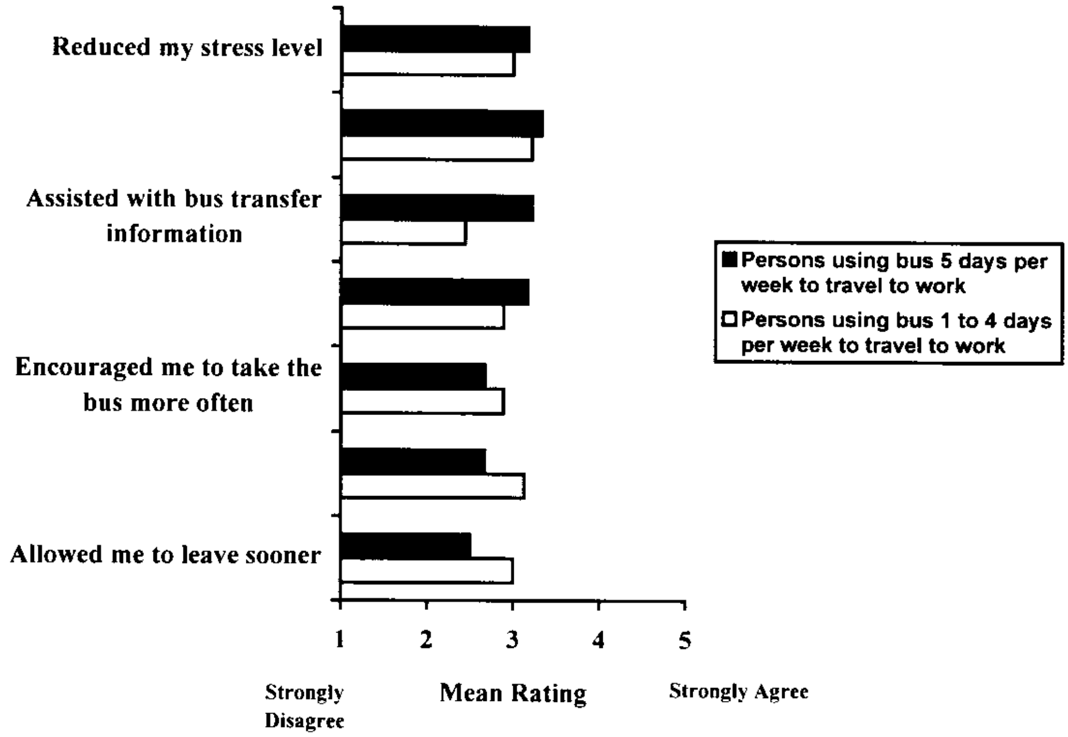

Figure 3-43. Impact of Bus Position/Schedule Information.

Actions Implemented as a Result of Receiving SWIFT Travel Messages

In the third SWIFT questionnaire, respondents were asked to identify the frequency with which they implemented an action affecting their commute travel as a result of receiving SWIFT travel messages. The results presented in Figure 3-44 indicate that a significant majority of respondents changed their commute route one or more times per week as a result of a travel message received from the SWIFT system. Another large percentage changed their commute times at least once a week as result of receiving SWIFT travel messages. Approximately one-fifth combined trips or changed travel done as part of work and less than 10% changed commute mode or canceled their trip.

These results were fairly consistent across device user groups, with some exceptions. Delco in-vehicle-navigation device users were less likely to change commute start time and mode than other users, while SWIFT portable computer users were more likely to change commute start time and mode then other device users. Among all users groups, changing commute routes was the most frequent response to information provided by the SWIFT system.

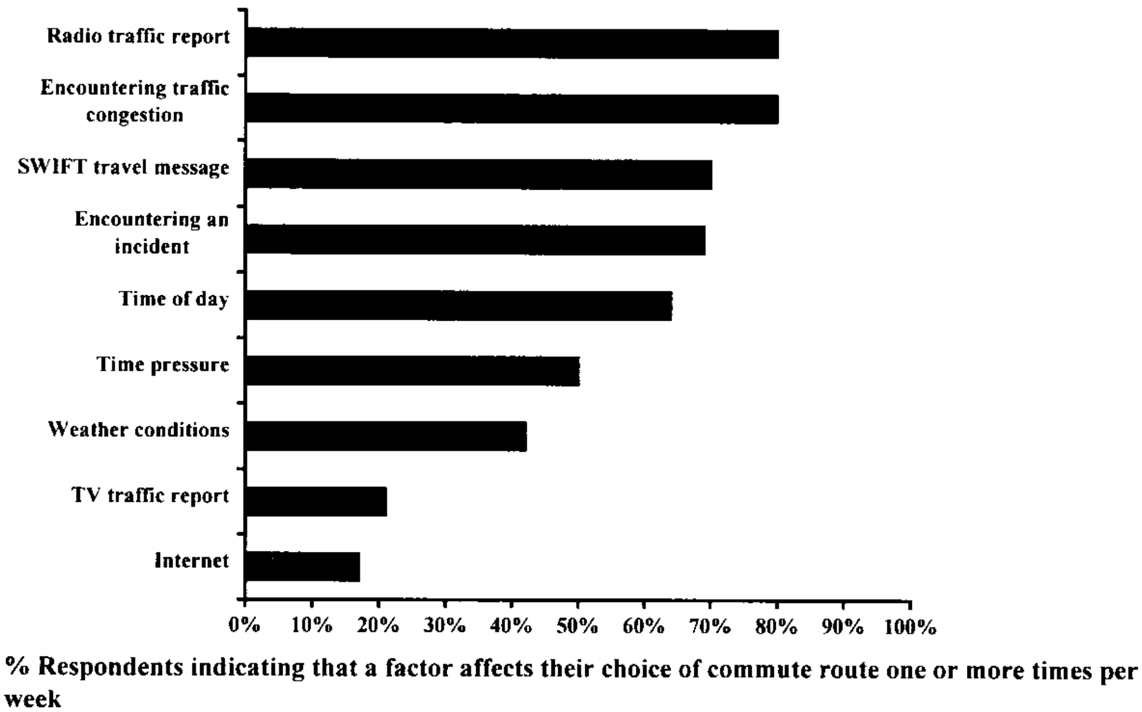

Figure 3-44. Factors Affecting Respondent's Choice of Commuting Route One or More Times per Week.

Factors Affecting Choice of Commuting Route

In the third questionnaire, SWIFT participants were asked to identify the frequency with which they changed their commuting route as a result of various factors including the receipt of travel messages on their SWIFT device. The results presented in Figure 3-45 indicate that the route choice of a significant majority of respondents were affected by the receipt of radio traffic reports followed by actually encountering the incident and SWIFT travel messages. Actually encountering an incident and time of day also affect the route choice decisions of a majority of respondents. Traffic information on the Internet was cited as a factor affecting commuting route choice by less than one-fifth of the respondents.

3.7.2. Questionnaire Comments

SWIFT portable computer users commented that the bus position and schedule information allowed them to stay out of the weather while waiting for a bus thus making travel more comfortable. Other respondents commented that the bus position and schedule information helped them plan alternative routes if a bus was missed.

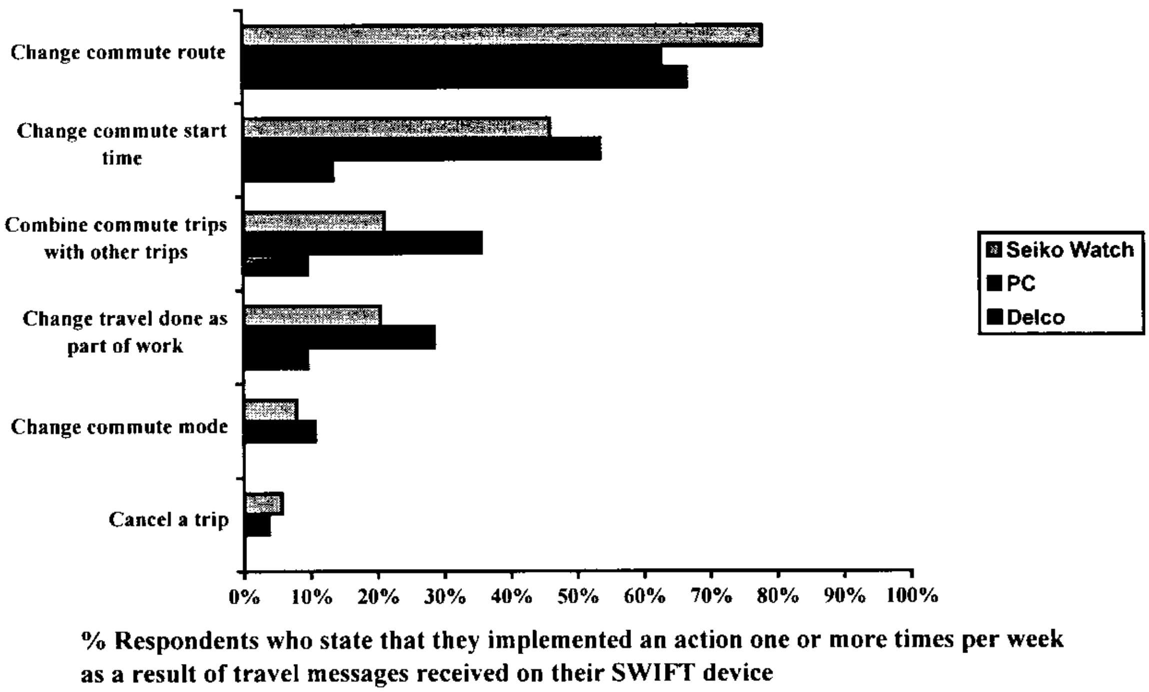

Figure 3-45. Actions Implemented by Respondents One or More Times per Week As a Result of Travel Messages Received on Their SWIFT Device.

3.7.3. Focus Group and Telephone Interview Findings

The majority of participants said that the used the SWIFT system either to decide which routes to take or for alternative route information. Some participants also commented that they used the SWIFT system for work related travel, to check for traffic incidents before leaving, to decide weather to leave earlier or later, to assist with the commute and as a cross-reference against other information sources such as commercial radio. Users of the SWIFT portable computer also commented that they used the SWIFT system to check for bus schedule and transfer information and to decide which buses to take.

Portable computer users were surveyed twice near the end of the SWIFT FOT regarding their use of real-time transit information. In these two surveys, one a telephone interview and the second a written questionnaire that was completed upon device return, 54% of the surveyed SWIFT portable computer users, on average, indicated that they used the real-time bus information. Of this group, 94% indicated that the display of this information was useful, while 81% indicated that the bus timepoint information was useful.

Regarding the specifics of their use of real-time SWIFT bus-location information, 33% of the respondents indicated that they used this information to monitor more than one bus route at a time. 2.2 was the average number of buses that were reported to be monitored at the same time by this group. Note, however, that for SWIFT, only one bus could be displayed if timepoint information was simultaneously displayed— thus, use of SWIFT timepoints necessarily restricted the use of real-time SWIFT bus-location information to monitor more than one bus at a time. Nonetheless, 18% of those SWIFT users who displayed real-time bus positions reported that this information was helpful in making transfers more convenient. These findings suggest that real-time bus position information was useful for making transfer decisions (e.g., when to get off their current bus in order to transfer to a bus that will take them more directly to their destination) among those who monitor more that one bus at a time.

Other findings regarding the use of real-time SWIFT bus-location information indicated:

- 50% used the information to monitor the arrival of buses
- 50% said it caused them to take alternative transportation modes
- 38% used the information to help them decide what bus to take
- 36% said the information made them feel less anxious about waiting for a bus
- 31% said it helped reduce bus-wait times
- 18% reported that it helped them make bus-transfer decisions
- 12% reported that it increased their bus ridership

Regarding the use of the other information that was presented on the SWIFT portable computers in addition to the real-time, bus-position data, SWIFT participants indicated that 78% used the congestion, or speed-flow, information; 54% used the traffic incident information; 49% used the street-address-search feature; 46% reported that the SWIFT map display helped them find alternative routes of travel; 40% used the "Yellow Pages" feature which provided telephone and address information for local businesses and organizations and only 3% reported using the general information message and paging features of the system.

The high-level of dependence on SWIFT congestion, or speed-flow, information by SWIFT portable computer users suggests that this information was very useful for making transit-related decisions, such as deciding whether to take the bus, which bus to take or when to take the bus. The low-level of reported usage of the SWIFT general-information messages and paging service was due to the fact that these services were generally not available for the majority of the SWIFT portable-computer users throughout the field operational test due to technical difficulties.

3.8. User Perception of Changes in Traffic Congestion, Air Quality, Energy Consumption, and Safety

SWIFT users were asked to consider the possible impact of more widespread use of their devices on traffic congestion, air quality, energy consumption and safety.

3.8.1. Questionnaire Items

Respondents were asked to rate their agreement with the assertion that SWIFT travel messages were useful in helping them achieve the benefits presented in Figure 3-46. When enacted collectively by a number of travelers, the benefits listed in this figure contribute toward the achievement of societal goals of reducing traffic congestion, improving air quality, reducing energy consumption and increasing safety.

In general, users of the SWIFT devices perceived a number of benefits associated with device use. These included avoiding congestion, making better use of time, planning better routes, reducing stress and saving travel time. In addition, users agreed that travel messages provided by a device generally helped them arrive on time, decide when to travel, save fuel and get more work done. On average, respondents tended to disagree with the assertion that SWIFT travel messages helped them to decide to take the HOV, ride the bus more often, reduce travel distance, decide when to carpool/vanpool, make more sales calls and make more business calls.

3.8.2. Questionnaire Comments

Respondents offered a number of comments concerning the impact of device use on traffic congestion, air quality, energy consumption and safety. Several respondents suggested that the limited number of alternative routes available to commuters in the Seattle area restricted the impact of SWIFT device use. Others commented that this situation encouraged the use of transportation alternatives other than the single-occupant automobile.

3.8.3. Focus Group and Telephone Interview Findings

Participants using the Seiko MessageWatch and Delco in-vehicle-navigation device stated that if the SWIFT service was generally available to the public, the impact would be a reduction in traffic congestion and commute times as a result of travelers choosing alternative routes. In addition, some users believed that using SWIFT devices while driving would be distracting and therefore possibly unsafe to use. In addition, participants using the SWIFT portable computer believed that transit, carpool and vanpool usage would increase through use of SWIFT traveler information. SWIFT portable computer users also felt that if the device were generally available to the public that more people would stagger their work hours and experience less stress while driving. Furthermore, SWIFT portable computer users suggested that fewer accidents would occur and people would improve their ability to make alternative-route choices.

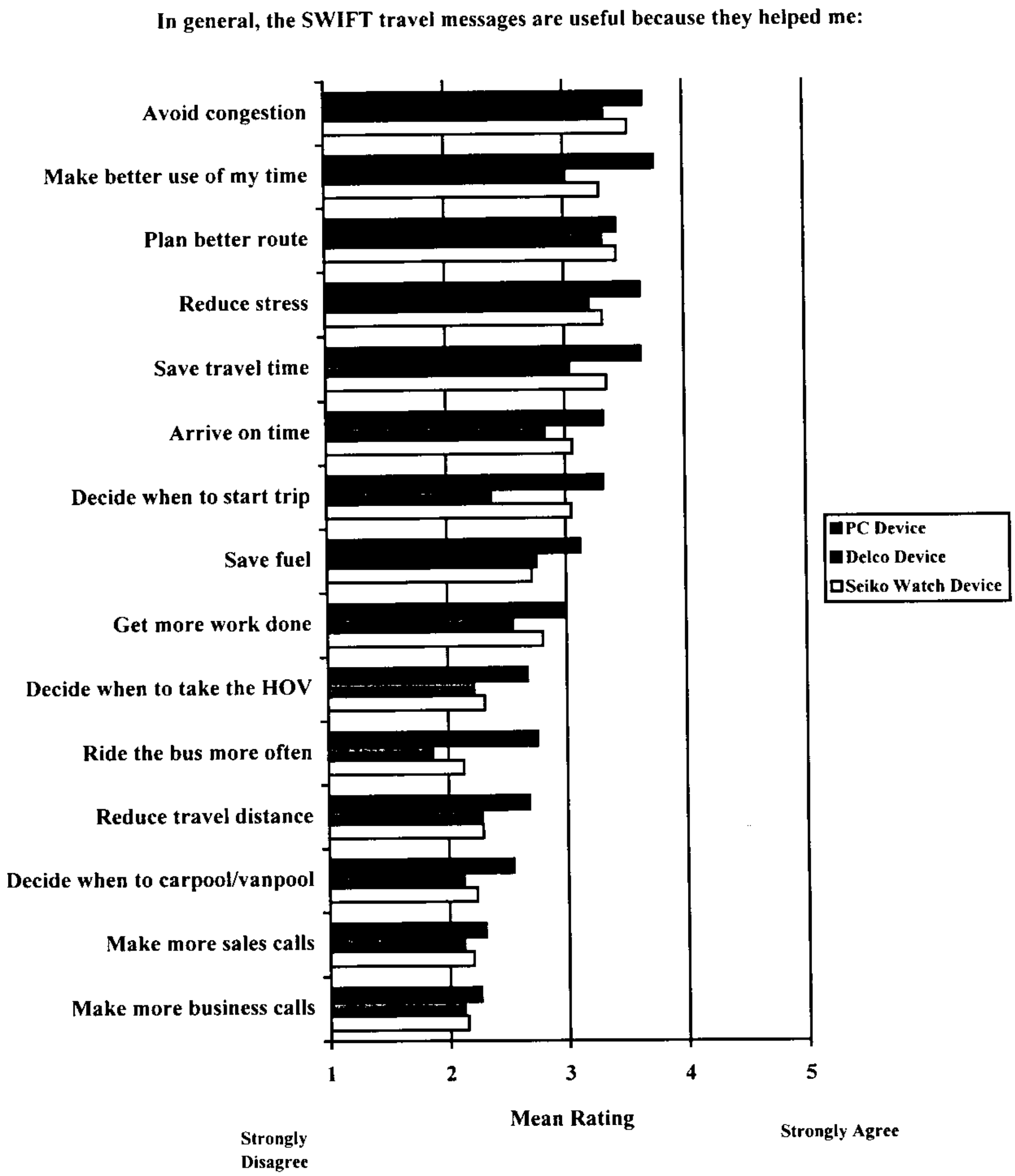

Figure 3-46. Ratings to the Assertion that SWIFT Travel Messages Helped the User Obtain the Listed Benefit.

3.9. SWIFT System Reliability from a User Perspective

3.9.1. Questionnaire Items

In the second SWIFT questionnaire, participants were asked to indicate the proportion of time their device operated properly using the following rating scheme:

- All of the time (greater than 90% of the time)
- Nearly all of the time (between 75% and 90% of the time)
- Most of the time (between 50% and 75% of the time)
- Some of the time (between 25% and 50% of the time)
- Rarely (less than 25% of the time).

The results of this question are presented in Figure 3-47.

The results indicate that users of the Seiko MessageWatch and Delco in-vehicle-navigation device reported a higher level of reliability than the users of the SWIFT portable computer. Approximately 93% of the Seiko MessageWatch users reported that the system was available "all of the time" or "nearly all of the time," in contrast to 79% of the Delco in-vehicle-navigation device users and 44% of the SWIFT portable computer users.

3.9.2. Questionnaire Comments

SWIFT participants provided comments concerning the reliability of devices in cases were devices were found to not be working as a result of technical problems. For example, in cases where a device was not operating properly, a respondent would provide a comment consistent with this problem. In general, however most comments indicated few problems with device operation.

3.9.3. Focus Group and Telephone Interview Findings

SWIFT portable computer users expressed a major concern with the reliability of the signal connection. The most common performance problems were the intermittent signal connection and an inability to receive general-information messages.

3.10. SWIFT System Availability from a User Perspective

3.10.1. Questionnaire Items

In the second SWIFT questionnaire, participants were asked to indicate their level of agreement with the statement that such factors as terrain, weather, time of day and location impacted the receipt of messages on their SWIFT device. Figure 3-48 presents a summary of the results.

In general, users of the SWIFT portable computer perceived a greater level of problems associated with system availability than did other device users. SWIFT portable computer users appeared to perceive the highest level of impact while inside buildings, or while in and around high rise buildings and as a result of terrain patterns. Users of the Delco in-vehicle-navigation perceived the highest level of problems receiving messages while in parking garages.

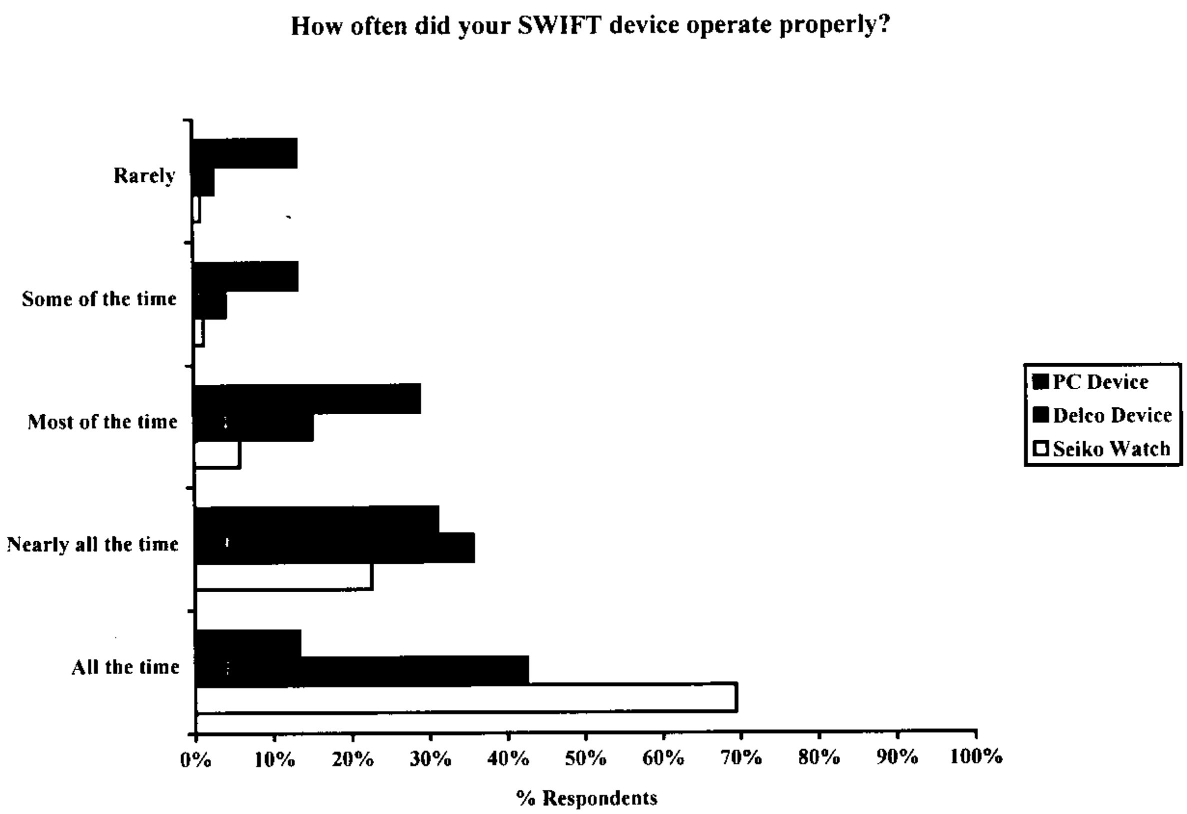

Figure 3-47. SWIFT System Reliability.

3.10.2. *Questionnaire Comments*

Users commented that distance from Seattle appeared to have an impact on the availability of the SWIFT system. In general, users reported few problems in receiving messages beyond any known problems or problems drawn out in focus groups and telephone interviews.

3.10.3. *Focus Group and Telephone Interview Findings*

Seiko MessageWatch users reported that Black Diamond and Everett, in particular, were weak-signal areas. Several participants reported encountering paging problems from within their work facility. Participants in the first focus group meetings for Delco in-vehicle-navigation device users reported receiving very few messages. This was consistent with the early problems encountered with the system. These system problems were fixed with an upgrade that was issued by Delco in October 1996. SWIFT portable computer users identified the following weak signal areas: Bainbridge Island, West Seattle, High Point, White Center, Capitol Hill, Enumclaw, Boeing Field, Boeing Access Route near Alboro and the Swift/Alboro Exit on I-5. A number of participants also reported that they were unable to receive a signal from within their work facility. Otherwise, transit users reported that while riding on the bus, the SWIFT signal intermittently went on- and off-line and that the bus icons would disappear from the screen. Users also reported loss of signal when traveling through the Downtown Seattle bus tunnel.

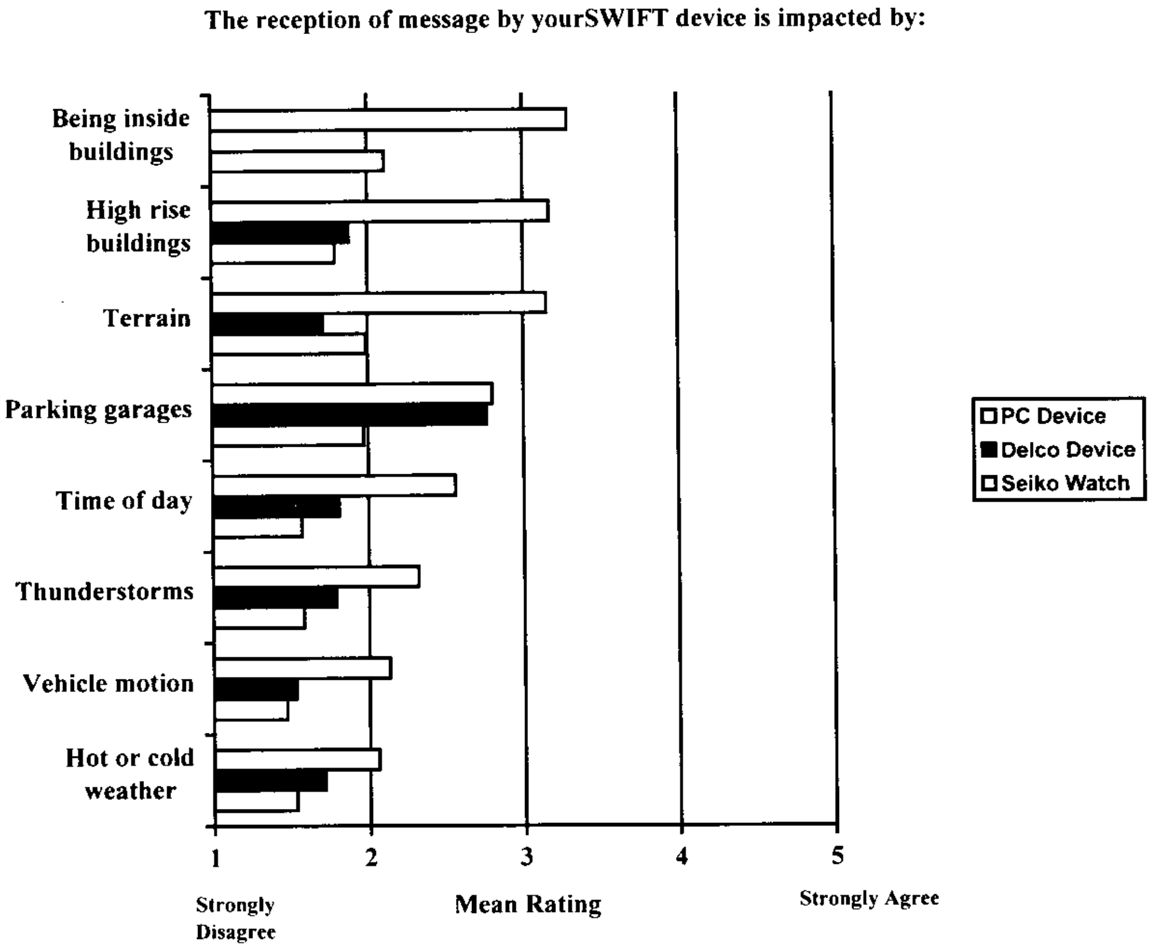

Figure 3-48. System Availability.

4. DISCUSSION

A total of 690 users were recruited to participate in the SWIFT Operational Field Test. A significant share of these users returned competed questionnaires and participated in focus group discussions and telephone interviews. The focus group and questionnaire findings were largely complementary— there were no obvious discrepancies between the findings from these two data sources.

SWIFT participants included 520 Seiko MessageWatch users, 90 Delco in-vehicle-navigation device users, and 80 portable computer users. A total of 25 Delco in-vehicle-navigation device users were also participants in the Metro Transit vanpool project.

SWIFT users were predominately male and a significant proportion reported owning their own computers. In addition, questionnaire results suggest that a large proportion of respondents had access to the Internet, cable TV, cellular phone and personal-paging services. These findings indicate that SWIFT users were generally familiar with technology.

Questionnaire results indicated that SWIFT users were generally very mobile, traveling over 15,000 miles per year for personal travel and 7,500 mile per year for work-related purposes. Further evidence of the mobility of users was the high rates of auto ownership reported.

A significant share of SWIFT questionnaire respondents reported traveling 30 or more minutes to work, including nearly one-fifth that travel 60 or more minutes. Respondents also reported a high degree of variability in travel time for commuting. Nearly one-fifth reported that their travel time to work varied by 26 or more minutes, reflecting the impact of congestion and incidents on travel within the greater-Seattle region.

Questionnaire results indicated that most users have three or more routes to choose from when commuting and have more flexibility in leaving work for home than in leaving home for work. These results suggested that SWIFT users were able to exercise travel route and time options in response to traveler information provided by the SWIFT system.

4.1. Perceptions of Importance of Traveler Information

Results indicated that SWIFT users tended to place a high degree of importance on congestion and incident-related information in travel planning. Incident location and duration information was rated quite high in importance along with general traffic congestion information. For the group as a whole, information concerning bus schedule and route information and bus-location information was rated very low in importance. This was consistent with the general dependence on the automobile reported by the group, and suggests that information concerning non-automobile travel options would not be used by the automobile-dependent group. Since users of the SWIFT portable computer were recruited from among transit users and were the only group to receive bus-location information, this group generally rated transit information higher in importance than did other device users groups. Nonetheless, the importance of this information was not as high as congestion and incident-related information.

Receipt of various general-information messages was not rated very high in importance by questionnaire respondents, with the exception of weather, sports and news items. Most respondents indicated that the receipt of financial and other environmental information was not important. Of course, from a transportation perspective, the receipt of these general-information messages was inconsequential. However, if device users were attracted by these messages, it may be prudent to make such services commercially viable to augment any potential benefit perceived to be gained through the receipt of travel-related information.

4.2. Perceptions of SWIFT Traveler Information Usefulness

Users tended to view the messages they received from the SWIFT systems as accurate, reliable, timely, easy to understand and useful. Among device types, respondents representing users of the Seiko MessageWatch expressed concern with the timeliness of incident-related messages. In addition, these respondents tended to rate ease of understanding lower than other user groups. Users of the Delco in-vehicle-navigation device and SWIFT portable computer experienced problems in receiving personal-paging messages, and these problems were reflected in respondent ratings.

The map-based display provided by the SWIFT portable computer resulted in generally higher ratings for that device over other devices in understanding incident location and the nature of congestion. Seiko MessageWatch users reported difficulty in understanding the extent of expected delay, as well as the nature of congestion. Delco in-vehicle-navigation device respondents reported difficulty in understanding the time for which a message applied.

Generally speaking, SWIFT users endorsed a wide range of improvements to messages provided by the system. Most seemed to consider the operational test as a suggestion of what might be possible, rather than a demonstration of a final product. Among Seiko MessageWatch users, respondents expressed a desire for improved timeliness of messages as a top priority. Delco in-vehicle-navigation device respondents endorsed the need to develop route-specific messages, and portable computer respondents expressed a desire to cover more roads as high priority improvements.

4.3. Perceptions of Desired Services and Features

An examination of user perceptions regarding the physical and operation performance of SWIFT devices reveals the following:

Delco In-vehicle Navigation Device. Respondents reported a generally high level of satisfaction with the physical characteristics of the device. The most frequently encountered problems include difficulty in operating the message filtering feature and difficulty in reading the display monitor in sunlight. Respondents also expressed a high level of dissatisfaction with the personal-paging feature, and were somewhat neutral toward the voice "reading" messages. Respondents, however, did not perceive the "voice" announcement of messages to be a safety concern. Rather, respondents endorsed a number of improvements to the unit's features and operation, including the addition of a map-based display, provision of route-specific information and dissemination of alternative-route information.

Portable Computer. Results indicated that Dauphin users were extremely dissatisfied with their device, both in terms of physical and operational characteristics. The IBM and Toshiba portable computers also experienced difficulties in this regard. In general, SWIFT respondents were dissatisfied with the size and weight of the devices and the design of the communications connection. Respondents were satisfied with the information displayed— in particular, the map information provided— but respondents generally endorsed the need for a smaller, lighter and more portable device with an easier communications connection.

Seiko MessageWatch. Respondents rated the physical and operational characteristics of the device very high. However, improvements to the message display, including background lighting and message encoding, were recommended. Respondents endorsed a need for a full alphanumeric display, more storage capability and different types of wrist bands. Finally, respondents found SWIFT travel profiles easy to use but quite limiting in terms of the number of roads available. Respondents suggested that an on-line update capability would provide the flexibility to maximize the usefulness of travel-profile data.

4.4. Perceptions of SWIFT Device Usefulness

SWIFT participants were clearly making use of their respective devices for travel planning. The results indicated that most users were consulting their devices to make travel-related decisions at least weekly. The results showed that many device users relied upon commercial broadcasts as a first choice in trip planning, with the SWIFT device used as a primary source for a significant number of participants. Users of the Seiko MessageWatch and Delco in-vehicle-navigation device found their devices to be convenient, comfortable, safe and easy to use, while SWIFT portable computer users generally rated their devices lower in these areas.

4.5. Perceptions of Willingness-to-Pay

SWIFT participants were eager to maximize opportunities to avoid congestion and improve travel convenience, safety and efficiency. Therefore, given some improvements in the service, they expressed a willingness to pay for the service. In focus groups, estimates of the value of SWIFT service tended to range between $5 and $10 per month. In questionnaires, willingness-to-pay was derived by asking participants to compare the value of other services with that of SWIFT. In this comparison, SWIFT was viewed as more valuable than on-line services (e.g., MSN, America On-line), satellite television and 4-hours of parking in downtown Seattle. Traffic information on the radio was rated higher in value than SWIFT and similar to telephone voice mail and cellular phone service. Based on this comparison of value with other products and services, it was concluded that SWIFT users might be willing to pay up to $20 per month for the service

4.6. Perceptions of Changes in Travel Convenience and Efficiency

Users tended to perceive that SWIFT services allowed them to reduce stress and commute times, and allowed them to "keep moving." Reducing travel distance or changing means of travel were not viewed as major benefits. User of transit-related information stated that the SWIFT services provided them an opportunity to improve transfers, reduce stress and stay inside while waiting for the bus. Also, users reported that radio traffic reports, SWIFT travel messages and actually encountering an incident were key factors in influencing route-choice decisions on a weekly basis. In the majority of cases, commuters implemented route-changing behavior to avoid congestion and did not report frequent mode changes in response to congestion.

4.7. Perceptions of Changes in Traffic Congestion, Air Quality, Energy Consumption, and Safety

Participants perceived a number of benefits as a result of widespread use of the SWIFT services including avoiding congestion, making better use of time, planning better routes, reducing stress and saving travel time. Focus group participants were hopeful that widespread use of SWIFT services would reduce congestion and commute times.

4.8. Perceptions of System Reliability

SWIFT users generally found their devices to be reliable. Seiko MessageWatch users perceived the highest reliability rates followed by Delco in-vehicle-navigation device and portable-computer users. In focus group discussions, portable-computer users expressed a concern with the signal- connection capability of SWIFT, particularly regarding the receipt of general-information messages.

4.9. Perceptions of System Availability

Participants generally perceived that the system was available. Terrain and being inside buildings appeared to have the greatest impact on receipt of messages for portable-computer users. Users of the Delco in-vehicle-navigation device reported problems receiving messages while in parking garages. Users of the Seiko MessageWatch reported few problems receiving messages, but were concerned about the timeliness of the messages.

5. CONCLUSIONS

The SWIFT FOT was a successful demonstration of HSDS technology for presenting ATIS data to travelers in a large, congested metropolitan area. Three types of traveler information were sent to three groups of SWIFT FOT participants with a reasonable degree of reliability.

SWIFT FOT participants generally viewed SWIFT as a beta—or proof of concept—test rather than a test of a finished product. Nonetheless, most indicated that they found the traveler information to be useful, incorporated it to make travel decisions and came to rely on it. Overall, the conclusions that can be drawn from the SWIFT FOT include the following:

- SWIFT was important for travel planning—the majority of users, regardless of device type, indicated that they found traffic incident and congestion information to be very important for making travel decisions.
- SWIFT was useful for travel planning—most participants, including those receiving the real-time bus-position information, indicated that they found the majority of the information presented by SWIFT to be useful for making travel decisions, such as what road/bus to take, what time to leave, etc.
- SWIFT had many desired features, but many suggestions for improvement were offered. Among those provided were to improve message timeliness, provide route-specific messages, improve accuracy, tell when an incident occurred and provide messages when the system goes down.
- SWIFT devices were perceived as useful, although improvements in portability were suggested for the portable computers, in particular.
- SWIFT participants indicated a willingness to pay of between $5.00 and $20.00 per month for a service that incorporated several improvements to timeliness, accuracy, reliability and convenience
- SWIFT users indicated that information provided by the system primarily helped them to "keep moving," "reduce my stress level" and "reduce my commute time." Others indicated that the information helped them change commute routes, change commute times and saved them time by assisting with the monitoring of bus arrivals.
- SWIFT was viewed as assisting, or improving the following: congestion, time utilization, route planning, stress levels and travel time.
- SWIFT was viewed as a reliable system—93% of Seiko MessageWatch users viewed the system as being available 75-100% of the time, while 79% of Delco-in-vehicle-navigation device and 44% of SWIFT portable-computer users made this attribution.
- SWIFT was viewed as being an available system, but one that was affected by buildings and terrain, particularly the SWIFT portable computers.

6. REFERENCES

Seiko Communications Systems, Inc. (1996), *SWIFT System Requirements Specification*, Hillsboro, OR.

The MITRE Corporation (1993), *Generic ITS Operational Test Guidelines*, McLean, VA.

Science Applications International Corporation (1995), *SWIFT Evaluation Plan*, McLean, VA.

United States Department of Transportation (1994), *National Program Plan for ITS*, Washington, DC.

APPENDIX—SWIFT "PROBLEMS"

Various operational "difficulties" or "glitches" experienced by SWIFT participants included the following. Some of these problems were fixed during the field operational test, while others were not. Nonetheless, these "problems" represent the most salient of those encountered by SWIFT end-users. Other difficulties—often due to an incomplete understanding of the operational characteristics of SWIFT—were solved by the Evaluator by providing the appropriate training and/or instruction to the individual involved.

Seiko MessageWatches

Traffic Workstation (TWS) Updates Would Require System to be Turned Off—Importing of SWIFT traveler profiles could only be accomplished if SWIFT system was shut down and traffic-incident operations stopped. (Not fixed during SWIFT)

Server Connectivity Problems—SWIFT operations would be interrupted by inability of TWS to connect to Seiko server. (Not fixed during SWIFT)

Message Delay—Each SWIFT message was sent three (3) times, once every 1:52, or one message every 5:36. If more than one message was sent at one time, message transmission to user was delayed proportionally. This is an inherent feature of the Seiko MessageWatch. (Not fixed during SWIFT)

Delco In-vehicle-Navigation Devices

Unit "locks up"—booting problem upon startup caused units to freeze up, or not work. (Fixed with software update)

Readout of Affected Roadways Obscured—SWIFT messages presented in display monitor were presented in long-text form, thus making it impossible for driver to see complete incident roadway intersection. (Fixed with software update)

Wrong Direction Indicated—"Voice" readings of SWIFT messages provided opposite roadway direction. (Fixed with software update)

No General-Information Messages and Personal-Paging Services—general-information messages were not received and the personal-paging function did not work. (Not fixed during SWIFT, but this function has limited value since people are not in their vehicles most of the time.)

Water Leakage—water leaked into vehicle from area where GPS-antenna wire was threaded from roof around door jam into vehicle dashboard. (Fixed upon request)

Portable Computers

Incorrect Display of Speed/Congestion Information—Data conversion problems caused incorrect mapping of speed data for locations and/or incorrect interpretation of speed data for a given location (Fixed with software upgrade)

No General-Information Messages and Personal-Paging Services—general-information messages were not received and the personal-paging function did not work (i.e., would cause missed messages when either the computer or RRM units were turned off.)

Real-Time Bus Position Information Missing—approximately 30% of all buses were not displayed (Not fixed during SWIFT)

RRM Connectivity Problems—RRM would connect on an intermittent basis, possibly due to an insufficient battery charge since this problem became less frequent as the SWIFT FOT elapsed and SWIFT RRMs were used more regularly. (Not fixed during SWIFT)