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Status of Paver Implementation within the US Air Force

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CIVIL ENGINEERING DEPARTMENT

STATUS OF PAVER IMPLEMENTATION WITHIN THE U.S. AIR FORCE

by

Capt D. Lawrence Eaddy

CE 598

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SCHOOL OF ENGINEERING

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A Report for
CE 598--Civil Engineering Project
Under Dr. Richard Kim

Civil Engineering Department
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Status of PAVER Implementation Within the U.S. Air Force

ABSTRACT

Regardless of how well conceived a pavement management system (PMS) is, unless well implemented and accepted by the end user its benefits cannot be realized. Designed to estimate the present status of implementation within the U.S. Air Force of the pavement management system, PAVER, the research described in this paper is based on a 100 percent population survey of over 100 U.S.A.F. civil engineering organizations, located throughout the U.S., Europe, and the Pacific, as potential users of PAVER.

This work is based in part on an initial effort by Captain Timothy R. McLean who in 1984 wrote his graduate thesis on "Improving PAVER Implementation." In his research he sought to determine the problems encountered in the field during the implementation of PAVER as well as recommendations from the field for improving or refining PAVER. He identified training, manpower, equipment, and top management support as key areas requiring attention to improve PAVER implementation.

The current work seeks to estimate and validate not only the present extent of these pre-identified problem areas, but also the current extent of PAVER's use and application. Example areas which the questionnaire addresses include an estimation of the following: the number of air bases which have partially or fully implemented PAVER, the accuracy of pavement distress and inventory data being used, the application of PAVER to project programming, the ranking of impediments to implementing and using PAVER, the ranking of benefits from using PAVER, and perceptions of PAVER as an innovation which have been identified in various literature as factors influencing the diffusion of innovation.

In addition, multiple regression is used to determine the existence of relationships between those variables which may influence the acceptance and active use of PAVER, such as training, manpower, equipment and diffusion-of-innovation variables, and those variables which may indicate PAVER's degree of use and acceptance, such as accuracy of data input into PAVER and the extent of a pavements network input into the system.

Finally, the special topic of alternate means of distress data collection as compared to the PAVER method is addressed and included in the Appendix.

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1. NEED FOR RESEARCH

Pavement management systems (PMS) have emerged as a means of effectively allocating funds for pavement maintenance and rehabilitation. The 1986 edition of the AASHTO Guide defines a PMS as "a set of tools that assist decision-makers in finding optimum strategies for providing, evaluating, and maintaining pavements in a serviceable condition over a given period of time" (1). Finn et al. (2) state that a PMS "will make cost-effective decisions relative to what, where, and when. What treatment is most cost-effective, where treatments are needed, and when is the best time (condition) to program a treatment." While much has been written on the subject of pavement management systems in general as well as on specific systems that have been developed, the subject of PMS implementation has yet to be fully investigated.

To state the obvious, regardless of how well conceived a PMS is, unless it is well implemented and accepted by the end user its benefits cannot be realized. In order to enjoy these benefits from one nationally recognized, state-of-the-art PMS, PAVER, the U.S. Air Force (and other organizations) have expended considerable effort in not only developing, but also implementing the PMS.

2. RESEARCH OBJECTIVE

The objective of this investigation is to determine the present extent of PAVER's use and application within one of its largest users, the U.S. Air Force, as well as the presence and impact of various problem areas which may impede PAVER implementation.

3. BACKGROUND ON THE PAVER PMS

The PAVER system provides to the facilities or public works manager a powerful tool for planning, programming, and developing projects for annual and long-range pavement maintenance and repair (3). Shahin presents a summary of background information on PAVER in his PAVER system course notebook (4):

> In 1968, the U.S. Army Construction Engineering Research Laboratory (USACERL) began developing the Pavement Maintenance Management System, now known as PAVER, to assist as a tool in making standard, practical [pavement maintenance and rehabilitation] decisions.
>
> PAVER was developed under the auspices of Headquarters, U.S. Army Corps of Engineers (HQUSACE) through funding from the Army and Air Force. It was originally designed to be operated on a mainframe computer at military installations, but also has far reaching application among municipalities, airports, and counties. PAVER was field tested and validated at Fort Eustis, VA, through full scale demonstration monitored by 21 pavement engineers. Mainframe PAVER has been (or will be) used at more than 100 military installations, including the full scale, centrally funded implementation of all U.S. Army Forces Command (FORSCOM) installations which began in [fiscal year] 85.
>
> One of the primary functions of a PMS is predicting pavement condition into the future. To make this projection, there must be an objective repeatable scale for determining the present pavement condition. PAVER uses the Pavement Condition Index (PCI); a numerical index from 0 to 100 that gives an indication of a pavement's structural integrity and operational condition. Developed at USACERL, the PCI is bases on the types, severity, and quantity of pavement distress identified during a condition survey.
>
> Acceptance of the PCI and the PAVER System as a basis for determining project funding requirements and allocations has been increasing in recent years. The Federal Aviation Administration (FAA) has issued an Advisory Circular detailing the procedures and guidelines for PCI airfield condition survey on AC and PCC pavements, and repair methods for the maintenance of airfield pavements. In recent action by the FAA, Federal funding was made available for performing PCI surveys. The U.S. Air Force, a cosponsor of the PCI's development, has mandated its use on all airfields and uses it for evaluation and prioritization of M & R [maintenance and repair] projects.

In 1984, USACERL began developing a microcomputer version of PAVER called "Micro PAVER." This project was initially sponsored by the FAA, with additional capabilities funded by the Army and Air Force. Micro PAVER maintains most of the capabilities of mainframe PAVER, while taking advantage of the more user friendly features of a microcomputer. Micro PAVER offers an economical solution to small database users seeking the advantages provided by a PMS. The American Public Works Association (APWA) has adopted Micro PAVER as the best available Pavement Management System (PMS), and has assisted in implementation at more than 90 military installations and 295 civilian facilities.

Many technological advancements and capabilities have been added to PAVER. New techniques in modeling pavement condition deterioration have led to better prediction methods, resulting in better budged forecasts. Lessons learned from the implementation of PAVER at military installations have triggered development of better tools for project planning as well as short- and long-range planning.

3.1 *The Pavement Condition Index (PCI)*

Although the reader is presumed to be familiar with the PMS concept, some background on the PCI may be helpful. A pavement condition index is a method of rating a pavement which requires a defined scale, a method to identify the parameters which affect the condition as used in developing the scale, and a method to weight the impact of those parameters on the rating. While a mechanistic procedure for defining the impact of each parameter on a pavement condition would be desirable, pavements are highly complex structures influenced by numerous environmental and imposed loadings, and as a result, most pavement rating procedures are based on subjective ratings (5).

A useful set of requirements for the PCI to meet the needs of the PMS in which it will be used has been proposed (5, 6):

1. The system must be based on state-of-the-art pavement engineering technology to allow use of available analysis techniques. All three distress characteristics, type, severity, and amount should be included. All distress types and severities must be clearly defined.

2. The system must provide reasonable measurements.

3. The system must provide standard pavement inspection procedures. The inspectors must be trained to collect and record the information in a standard manner. This requires a standard description of the distress types and accurate definition of severity levels which can be read and easily understood by the level of inspectors expected to be used in the inspection.

4. The rating based on the collected distress data must reflect the structural integrity and surface operational condition of the pavement.

5. The system must provide inspection frequency guidelines or applicable levels, network and project.

6. The system should lend itself to the use of computers to expedite data collection, processing, and analysis (and to minimize errors), but should be manually tested and manually implementable.

7. The system should be usable at both the network and project levels. This requires expediency at the network level and accuracy at the project level.

8. The system must be easily understood by all personnel associated with its use--field technicians, engineers, management, city council, etc.

9. The overall system must be organized to minimize training time at the technician, engineer, and management levels.

3.2 *The PAVER Pavement Condition Rating System*

Although several pavement rating systems are in use in the United States and abroad, the PCI used by the PAVER system has numerous advantages (7):

1. It was developed by a federal agency and is, therefore, not tied to a specific region of the country.

2. It is a comprehensive procedure in that both rigid and flexible pavement rating methods are included.

3. There is a well-documented data collection guide and analysis procedure.

4. The procedure is representative of the current state-of-the-art and similar to the methodology used by some states, such as Florida and Washington.

In addition, most agencies which have adopted the PAVER system have found the PCI system is simple to use once in place. It has been validated by both the U.S. Army and the American Public Works Association, and has become a highly used and well accepted procedure for roads, streets, and airfields (5). Many sources on the PAVER pavement management system are available (for example see references 8, 3, 9, 10, 11, 12). The brief description herein of the PCI used by the PAVER system is summarized from Smith (5).

A pavement condition index should expedite the pavement condition survey process and minimize the time required for training while providing adequate information to make reasonable maintenance and rehabilitation decisions. As a ranking and communication tool, PAVER ranks the inspected pavement management units from bad to good (1 to 100) and allows the user to communicate the relative condition to others. Through its use of an "expert witness" based system, PAVER provides a rating of the pavement equivalent to that of having a group of experienced pavement engineers who developed the system rating the pavement, but obviously at less cost. The PCI provides an index which can be used to track the condition of a pavement segment, project the future condition, measure the impact of various maintenance procedures, and determine maintenance and rehabilitation needs.

3.3 *Calculation of the PCI*

One hundred is considered equivalent to a new pavement, and each occurrence of a distress decreases the condition rating by a deduct value which is taken from standard curves. The curves were based on a comparison of calculated PCI's to the mean subjective ratings of experienced pavement engineers. Since the deducts were developed as if the distress type/severity level occurrence was the only one on the pavement surface, the effects of multiple distresses must be combined. Additionally, since the deduct values cannot be added directly (increased distresses have successively less impact on the rating), the uncorrected deducts are adjusted according to another set of curves. These curves compare the ratings for combinations of distress types/severity to the subjective ratings of experienced pavement engineers. Figures 1 and 2 (5, 10) illustrate these curves.

3.4 *Distress Identification and Inspection Procedure*

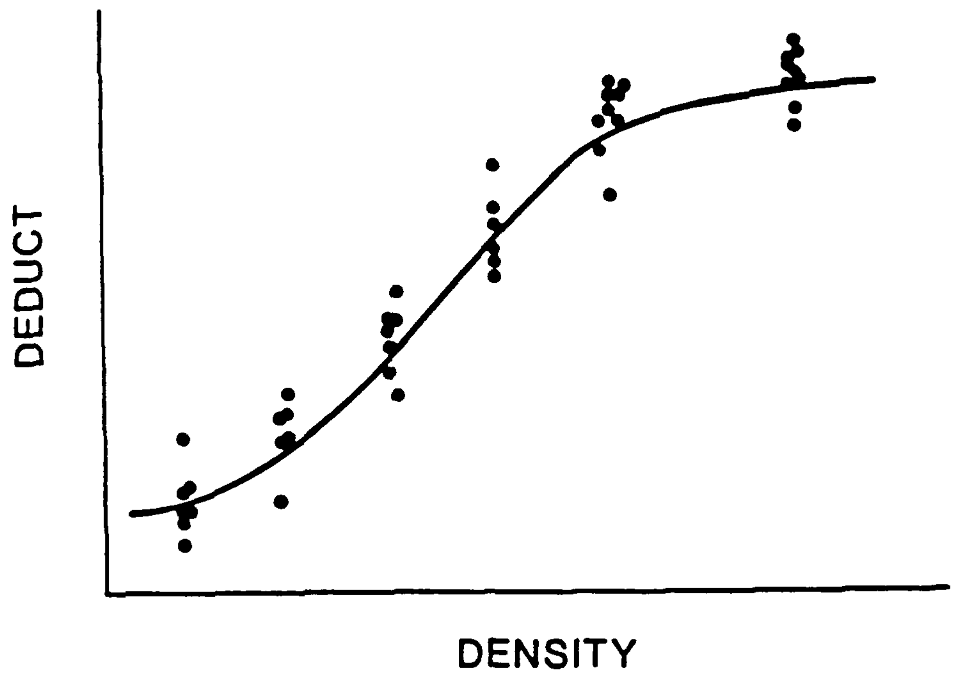
Distresses are identified based on an identification manual which helps to standardize definitions of the distress types and severities. For inspection the pavement network is divided into management units or uniform sections. The management unit is then divided into inspection units which, in order to save some of the costs of inspection, may be randomly or systematically sampled for actual inspection. Results of the inspection may be entered on standard forms or into a hand-held computer for later transmittal to the PMS data base. PCI calculations are then made either manually or by computer based on the data recorded. Generally, the PCI of the management unit is obtained by averaging the PCI's on the inspection units. Figure 3 (5, 13) illustrates the PCI calculation steps.

3.5 *Summary of Computerized PAVER Capabilities*

Shahin summarizes PAVER's capabilities as follows (4):

> The PAVER system provides the user with many important capabilities: data storage and retrieval, data base administration, pavement network definition, pavement condition rating, project prioritization, inspection scheduling, determination of present and future network condition, identification of M & R needs, performance of economic analyses, budget planning, and report generation. The system enables the user to identify the effects of performing no major repairs on the pavement network, determine life-cycle costs for various M & R alternatives, and determine a rational, objective basis for evaluating pavement condition and M & R needs and priorities.

It is important to note that PAVER may be operated as a manual system; for example, PCI's may be manually calculated and objective decision-making may be based on the results. Obviously, however, the manual system lacks the many time-saving features of the computerized system which are mentioned above.



$\overline{DV} = 100 - \overline{PCR}$ Single Distress Type and Severity

Figure 1: Development of Example Deduct Curve
Each point represents an individual rating point by an experience pavement engineer (5, 10).

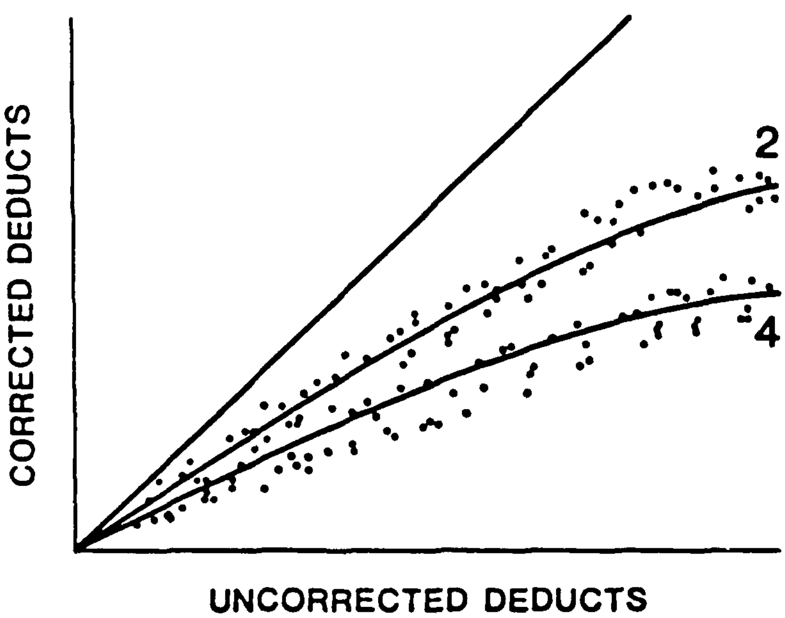


Figure 2: Development of Example Deduct Curve for Multiple Type/Severity Combinations (5, 10)

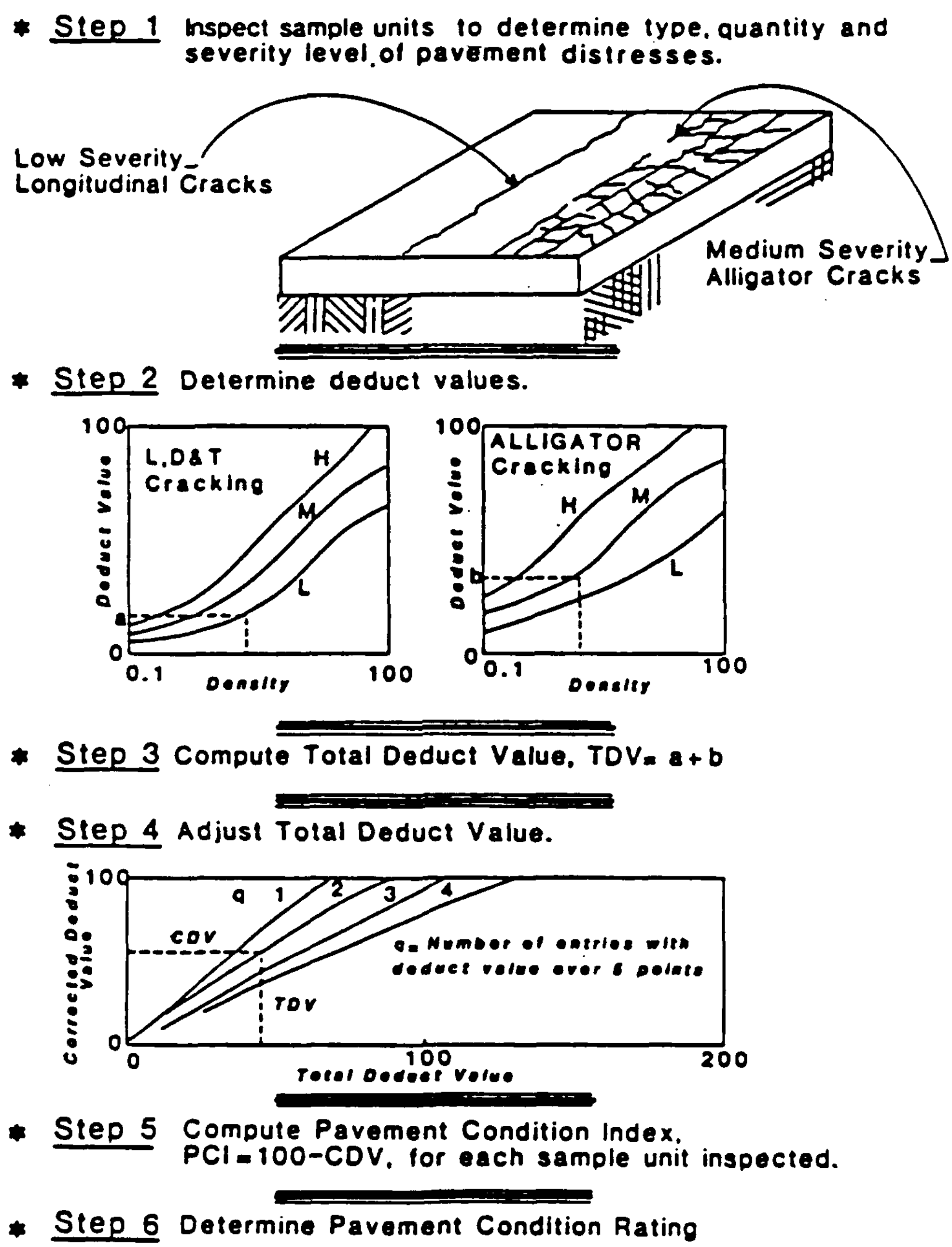


Figure 3: PCI Calculation Steps (5, 13)

4. IMPLEMENTATION OF PAVER WITHIN THE U.S. AIR FORCE

4.1 *Pre-Identified Problem Areas*

The whole issue of implementation of PAVER by the U.S. Air Force was first investigated and reported on in 1984 by Captain McLean (14). Using a survey to gather data on problem areas and recommendations for improvement from the active and potential users of PAVER within the U.S. Air Force, he identified several significant implementation problems being faced at that time (14):

1. Training.

> The current CERL [Construction Engineering Research Laboratory] and APWA [American Public Works Association] PAVER training courses are not entirely adequate for Air Force pavement engineers. Specifically, the courses do not provide sufficient coverage of implementation problems peculiar to the Air Force, not do they concentrate on management of airfield pavements. An Air Force sponsored course is necessary.
>
> Bases with PAVER have not been adequately trained. Two factors have caused this problem: MAJCOM's [major commands, an Air Force organizational element directly above the base level] have not put enough emphasis on receiving formal training and base level managers have failed to support formal training.
>
> Bases without PAVER have not been properly educated by MAJCOM as to what PAVER is, consists of, or can do for the pavement engineer.
>
> Many training-related problems or concerns are due to the user being forced to 'train-as-he-goes.' As the user gains knowledge of and experience with PAVER, these problems tend to diminish.

2. Manpower.

> Sufficient manhours do not exist for the pavement engineer to implement and operate PAVER by himself. Pavement engineers and base level managers must understand that assistance is needed from technicians, specialists, clerical staff, overhires, A&E contractors, or any other competent source that is available. The problem is a large one, but it is not insurmountable.
>
> Currently, base level supervisors severely restrict the number of manhours available for PAVER implementation, primarily due to the emphasis on project design.

3. Equipment.

Most equipment problems appear to be temporary ones. The basic equipment support problem will be solved by the installation of the WIMS [Work Information Management System] microcomputers. The interface problem between the microcomputers and the mainframe is currently being staffed. However, an understandable PAVER users' guide is still desperately needed.

Eighty-two percent of the bases responding to the survey who use or intend to use PAVER plan to use computers to operate some or all of the system. In order to keep this high percentage, equipment problems must be solved as soon as possible.

4. Top Management Support.

Top management support of PAVER from base level supervisors is severely lacking.

Top management direct support from MAJCOM is perceived very favorably at base level. That is, bases feel that they get good support and assistance when they deal directly with MAJCOM. However, indirect support from MAJCOM, such as 'encouraging' base level managers to support PAVER, is inadequate.

Top management support from HQ AFESC [Headquarters, Air Force Engineering and Services Center] is generally sufficient. More direct involvement is expected by bases and MAJCOMs in areas such as establishing an Air Force PAVER training course, solving the computer interface problem, and disseminating 'general interest' items applicable to all pavement engineers.

5. User Commitment.

User commitment is somewhat favorable at this time at bases with and without PAVER, however many still are hesitant to use the system.

User commitment is a direct function of PAVER training and experience. The amount of training and experience is directly affected by manhour availability, equipment status, and top management support.

User commitment is affected by problems in any of the...potential problem categories. ...For any given base, any problem category can become a key one.

(Exactly because Captain McLean concludes in his thesis that user commitment is a direct function of PAVER training and experience, the current research does not consider this to be a separate implementation problem category. It is assumed that if other implementation problems are abated or eliminated, good user commitment will most likely follow.)

4.2 *Recommendations to Address Pre-Identified Problem Areas*

Captain McLean made a number of common sense recommendations to address these key problem areas. Concerning training, he suggested that the Air Force Institute of Technology (AFIT) develop an Air Force sponsored PAVER short course to address problems peculiar to the Air Force and to management of airfield pavements. In addition, it was recommended that MAJCOMs and AFESC stress the importance of attending formal training as early in the implementation process as possible. Base level supervisors had to support this training if it was to be successful. Finally, he suggested that any and all information regarding PAVER implementation be disseminated to the field as soon as possible to permit the base level pavement engineer access to all available information.

Concerning manpower, it was recognized that the pavement engineer could not himself gather the massive volume of information (condition surveys, historical data, etc.) necessary for implementation. Other manpower sources such as site developers, pavements and grounds specialists, A&E firms, etc., would have to be used, and the pavement engineer would act as a team leader during implementation. Further, implementation could proceed gradually, beginning with key features (such as runways and taxiways) and adding others on a pre-defined schedule. The pavement engineer would need an organized plan, approved by base level supervisors, for conducting surveys, inputing data, and incorporating all key features. As a final suggestion, the pavement engineer might seek to have position descriptions for clerical staff and technicians changed to include various aspects of PAVER implementation and operation.

Equipment recommendations included the continued purchase of necessary computer equipment and support items for all bases, including modems, connections, supplies, etc. Although not strictly an equipment item, a complete user's manual for PAVER was seen as a critically needed resource. [The computer system, WIMS (Work Information Management System), was in the process of implementation in 1984 for U.S.A.F. civil engineering organizations. Micro Paver was not available at that time; hence, modem access to mainframe PAVER was the available means of operating the computerized PAVER system.]

Top management support recommendations included ensuring that a PAVER course was instituted at AFIT, assigning an individual at AFESC who would be directly responsible for PAVER implementation, disseminating information in the form of a PAVER Newsletter, and inculcating an appreciation of PAVER benefits in base level supervisors during management level courses offered at AFIT.

Concerning user commitment, MAJCOMs and AFESC were urged to actively encourage bases to use and experiment with PAVER and communicate new ideas and solutions to problems. Hands-on experience and direct education of pavement engineers would generate voluntary, enthusiastic users.

4.3 *Implementation Efforts to the Present*

Captain McLean clearly identified a number of problem areas requiring attention to enhance the implementation of PAVER. In a policy statement issued in the same year as his research was published, the Air Force signaled its commitment to implementation by making it mandatory to implement PAVER for a minimum of one base per major command during fiscal year (FY) 86 and for all bases by December, 1988. This policy was established based on Mainframe PAVER availability and was effective for all bases which had the required WIMS computer support (14). In a switching of emphasis to Micro PAVER, a new policy issued in July, 1989, recommended that all bases implement Micro PAVER for their primary pavements (primary runway, taxiway, and cargo aprons) by December of 1990. In part, the policy states: "Air Force wide implementation of Micro-PAVER will be an important step forward in our coordinated efforts to ensure the safety and reliability of airfield and other pavements." Where equipment was a concern, bases were recommended to upgrade existing WIMS personal computers to the required RAM and hard disk space for operating Micro PAVER. Implementation of non-primary pavements (for example, all roads) is left to the bases' discretion.

Implementation efforts since Captain McLean's 1984 thesis are described based in part on conversations with the Air Force's manager for PAVER implementation, Mr. Stewart Millard, who is based at HQ AFESC.

1. Training.

In March of 1990 HQ AFESC initiated a series of (approximately) monthly regional seminars wherein pavements engineers from three to four bases gather at a central location for instruction in Micro PAVER implementation and operation. Typically, an instructor from AFIT would have arrived earlier and taught the participating bases the PCI concept, updating or initially establishing the pavements data base for the host base as a means of hands-on training (as well as for an operational benefit). This assistance from AFIT, however, has not been based on standing AFIT policy, and therefore may or may not continue into the future. In an effort to accelerate the initial implementation of Micro PAVER, these seminars have been scheduled at the pace of roughly one per month for a two year period, after which they will likely occur once per quarter.

At the major command level, at least one MAJCOM has enhanced training and implementation by organizing five or six of the command's pavements engineers into an implementation team. This team, headed by the command pavements engineer, rotates between each of the team member's bases and performs the initial implementation for that base. Similarly, the Air National Guard has formed a team which performs the initial implementation for Air National Guard bases (as well as some active duty Air Force bases). Other Air Force commands have been considering this burden sharing concept.

In the area of more formal training, the University-of-Illinois-sponsored PAVER course was the earliest available source of training for Air Force pavements engineers, and remains today a good option. However, as mentioned by Captain McLean, it is not structured towards the management of airfields, and in response to this need, the Air Force Institute of Technology now offers formal training in PAVER.

According to Captain Mark Teepen, pavements instructor at the AFIT School of Civil Engineering, AFIT started to include the teaching of mainframe PAVER within its three-week pavements engineering short course in 1983. The course has been offered approximately twice a year with the PAVER portion having a duration of four days out of each class. In April of 1989 instruction switched to the teaching of Micro PAVER. In addition to the pavements engineering short course, AFIT began a three day seminar on Micro PAVER in October of '89, offering approximately two seminars per year to a maximum of thirty students per seminar. Captain Teepen stated that this separate PAVER seminar will likely continue to be taught until the Air Force has fully implemented Micro PAVER. Additionally, AFIT teaches a one-hour block on PAVER familiarization in two separate engineering management courses in order to inform management personnel in civil engineering organizations of the benefits of PAVER.

Finally, PAVER instructional materials have become more readily available through the various courses and seminars which are now being taught (University of Illinois, AFIT course and seminar, AFESC regional seminars).

2. Manpower.

The manpower issue remains a tough--but not impossible--problem. The burden sharing concept mentioned under training has an added benefit of enabling the host base to initiate or update its data base. Use of other manpower resources such as A&E firms, site developers, pavements and grounds specialists, etc., remains an option.

3. Equipment.

Unfortunately, the implementation of WIMS for civil engineering organizations did not solve the computer hardware problems, since the use of Micro PAVER requires micro computers of sufficient capacity that were not provided with WIMS. Using a strong equipment purchase justification provided by HQ AFESC, individual bases have used normal acquisition channels and base level funding to purchase the required computer hardware. Although the acquisition process is not immediate, purchases have in general proceeded without difficulty. As an alternative to new equipment purchase, those bases which have AUTOCAD have used this equipment for PAVER operation. With some exceptions, distribution of the PAVER software has proceeded from AFESC to the MAJCOMs and then from the MAJCOMS to the their individual bases.

4. Top Management Support.

Although HQ AFESC has maintained a PAVER consulting function for MAJCOMs and bases for the last ten years, an internal reorganization in January, 1989, enabled it to provide a greater emphasis on implementation. Through the regional seminars and increased exposure of consulting help to bases, AFESC now provides more direct help than in the past. As a means for AFESC to communicate directly with the base users, new PAVER information is now being disseminated through the Engineering and Services quarterly magazine. MAJCOMs, while generally providing good support to their bases, are not uniform in their quick dissemination of new PAVER information, however.

Finally, in an effort to inculcate an appreciation for PAVER in base level supervisors, AFIT provides an orientation on PAVER in its management level courses. Still, a good deal of top management support at the base level must depend on the pavement engineer's ability to "sell" the benefits of PAVER to his superiors, and this can best be accomplished with the effective training of base pavements engineers.

5. METHODOLOGY

Computerized methods were used to gather and analyze survey data relative to the research objective. The use of a mail-in questionnaire was selected as the most expedient means of gathering a large amount of data from numerous geographically dispersed civil engineering organizations located throughout the U.S., the Pacific, Europe, and elsewhere. Although the previous research conducted by Captain McLean helped significantly in isolating potential problem areas, and although Air Force managers can and do have a good "feel" for implementation problems and successes, only an objective survey can estimate the present extent of PAVER's use and application as well as the presence and impact of various problem areas.

5.1 *Survey Development*

The researcher developed the questionnaire based on personal knowledge of PAVER and pavement management systems gained from on-the-job experience as well as from a graduate course in pavement management systems taught at N.C. State University. The completed questionnaire package included the questionnaire itself, a privacy act statement, a definition of PAVER, cover letters written by the researcher and the Air Force's manager for PAVER implementation (to elicit maximum response), an optical scan sheet and instructions for completing it, and a stamped, self-addressed return envelope. The package was reviewed and edited by the researcher's graduate advisor, a statistics consultant, the Air Force's manager for PAVER implementation, and two Air Force organizations responsible for survey approvals (AFIT/XPX and HQ AFMPC/DPMYOS).

Sixty-six two-way and multiple choice, categorical questions were selected for the questionnaire. Although somewhat lengthy, the questionnaire was thought to be an appropriate length considering the interest in the subject of the population surveyed. Choices were designed to be mutually exclusive, well balanced, and to offer all reasonable alternatives. Because the researcher benefitted from the previous work by Captain McLean (significant potential problem areas were already known), open-ended responses were kept to a minimum. The questionnaire was designed with a single skip question to permit distinguishing between those bases which have and have not at least partially implemented PAVER. As a means of logically organizing the questionnaire for the benefit of respondents, easily answered factual type questions were listed first followed by more thought-provoking opinion and perception type questions. Background information was solicited last, and space was allotted for general comments on PAVER and the survey. Appendix B contains the survey package.

The initial population for the survey included all active duty base-level civil engineering organizations listed in AFR 4-16, Air Force Address Directory, which was assumed to contain a complete listing of Air Force organizations. A 100 percent sample was selected for a total of 125 organizations surveyed. Prior to sending the questionnaires, however, it was known that at least some of the organizations within the initial population estimate were not good candidates for using PAVER (due to a limited maintenance mission, for example) and the final population estimate would have to be adjusted downward based on respondents' survey comments. Bases in the United Kingdom, for example, were eliminated from the population because their maintenance and repair (M&R) work is contracted out. The final overall population estimate was 116.

5.2 *Questionnaire Topic Areas*

As previously mentioned, the questionnaire was designed to flow logically, not only for the benefit of respondents, but also for the benefit of analysis. The initial two survey questions serve as filters to determine which bases have partially or fully implemented PAVER and to obtain the familiarity of respondents with PAVER regardless of their implementation status.

The second section of the questionnaire, consisting of questions three through nine, serves to estimate PAVER's state of implementation and application for bases which have partially or fully implemented the system. The questions seek to determine the approximate amount of runways, taxiways, cargo aprons, and roads/streets entered in the system; the accuracy of data entered; and the extent of PAVER's use in project programming. This last topic area of the section is especially important to determine the bottom-line use of PAVER, for regardless of how fully implemented PAVER is, the system is of little real use if not applied in determining an objective, rational basis for evaluating pavement condition and M & R needs and priorities. Project programming is the avenue through which this determination is stated.

The following questionnaire section, consisting of questions ten through twenty-two, seeks information on three of the objective, pre-identified factors which are thought to help determine the state of PAVER's implementation, namely: training, equipment, and manpower. Importantly, question twenty-one filters respondents into micro, mainframe, and manual analysis users of PAVER. Obviously, questionnaire responses may differ for each group.

The next section (questions twenty-three through twenty-nine) expands on these areas (and adds the area of top management support) by requesting a ranking of various impediments to PAVER's implementation and use. Under the assumption that if users are deriving concrete benefits from PAVER, they are more likely to use it, questions thirty through thirty-seven are included to obtain a ranking of various factors as benefits from the active use of PAVER.

Questions thirty-eight through forty-one relate to some specific future considerations for PAVER. Specifically, survey participants are asked if they plan to add other pavement areas into their data bases, and are asked for their opinion of specified future changes in the system. Questions in this section concerning respondents' opinion of the data gathering process are discussed later in Appendix A.

The following questionnaire section (questions forty-two through fifty-three) is designed to be answered only by bases which have not fully or partially implemented PAVER, and seeks to determine weighted reasons for their decision, to include the pre-identified factors of manpower, equipment, training, and top management support. Question 53 asks respondents if they plan to implement PAVER in the future (next 1-2 years).

Questions fifty-four through fifty-nine were to be answered by all respondents and address perceptions of PAVER as an innovation which have been identified in various literature as factors influencing the diffusion of innovation (5, 15, 16). As a group, these factors (which include, for example, an innovation's perceived complexity, adaptability, and credibility) are thought to comprise an internal set which may influence PAVER's degree of implementation. According to Smith (5), "To increase the likelihood of adoption, the innovation (PMS) can be structured to maximize the advantages and minimize the disadvantages. The characteristics of the innovation have a major impact on the likelihood of them being adopted. Several characteristics which influence the rate of adoption have been identified." It follows then that if PAVER as an innovation is perceived positively by respondents, the external factors of manpower, equipment, training, and top management support may then be better isolated as factors influencing PAVER's degree of implementation.

The final questions (sixty through sixty-six) request general, background information such as the base's MAJCOM and the respondent's engineering and PAVER experience. At the end of the questionnaire information for a point of contact is requested, and space is allotted for written comments on PAVER or the survey.

6. SURVEY ANALYSIS

Survey responses were read from optical scan sheets and the resulting data base analyzed using SAS, a software system for data analysis. At the time of this writing, 67 out of 115 responses were received for a response rate of 58%; however, only 59 of these were received in time for analysis, so that for purposes of this report, the response rate was 51%. Two levels of analysis are presented including the presentation of summary statistics and multiple regression analysis. Finally, possible biases in the population are considered.

6.1 *Summary Statistics*

The population was subdivided into two major groupings: bases reporting having partially or fully implemented PAVER (completing questions 1-41 and 54-66) and bases reporting not having implemented PAVER (completing questions 1-2 and 42-66). Results show that 34 out of 59 bases responding or 58% have partially or fully implemented PAVER whereas 25 out of 59 bases responding or 42% have not implemented PAVER. Summary statistics are presented in Table 1 based on these groupings (sub-population category).

Values of 1, 2, 3, 4, and 5 are assigned to answers A, B, C, D, and E, respectively. All respondents were to answer questions 1-2 and 54-66, regardless of their major grouping. In addition, for questions identified as dependent variables estimating the state of PAVER implementation for the sub-population of PAVER implementers (questions 3-9, 38), SAS was used to determine the presence of any significant differences between micro, mainframe, and manual PAVER users. Questions 3-5 and 7 were found to show significant differences based on PAVER system in use. In addition, to illustrate varying responses based on sub-population category, statistics for question 2 are shown according to this method. Appendix C presents frequencies of responses graphically.

Table 1: Summary Statistics

Question	Sub-population Category*	Mean Response	Standard Error of the Mean
1	A	1.42	.07
2	M	4.3	.19
2	MF	4.0	.45
2	MA	3.25	.45
3	M	3.58	.14
3	MF	3.33	.33
3	MA	2.75	.31
4	M	3.45	.17
4	MF	3.33	.33
4	MA	2.75	.31
5	M	3.45	.15
5	MF	3.67	.21
5	MA	2.5	.38
6	I	2	.22
7	M	3.58	.19
7	MF	2.83	.48
7	MA	2.5	.33
8	I	3.18	.18
9	I	4.03	.23
10	I	3.5	.27
11	I	3.03	.27
12	I	4.72	.14
13	I	2.79	.27
14	I	3.47	.30
15	I	4.42	.23
16	I	4.58	.19
17	I	4.21	.24
18	I	3.45	.24
19	I	2.70	.17
20	I	2.85	.22
21	I	2.06	.11
22	I	2.24	.22
23	I	2.26	.14
24	I	1.65	.14
25	I	2.59	.13
26	I	2.15	.15
27	I	2	.15
28	I	1.88	.14
29	I	2.4	.24
30	I	1.74	.15
31	I	2.5	.127
32	I	1.28	.09
33	I	1.5	.13
34	I	1.97	.13
35	I	2.	.13
36	I	1.69	.13
37	I	1.94	.16
38	I	1.44	.21

Table 1: Summary Statistics-cont.

Question	Sub-population Category*	Mean Response	Standard Error of the Mean
39	I	2.12	.20
40	I	1.18	.07
41	I	1.70	.15
42	NI	2.42	.17
43	NI	2.64	.11
44	NI	2.52	.15
45	NI	1.88	.18
46	NI	2.4	.15
47	NI	2.52	.14
48	NI	2	.18
49	NI	2.16	.19
50	NI	2.68	.13
51	NI	2.72	.14
52	NI	2.36	.28
53	NI	1.38	.10
54	A	1.40	.10
55	A	1.44	.1
56	A	2.01	.06
57	A	1.25	.08
58	A	1.37	.10
59	A	1.31	.09
60	A	SEE APPENDIX C FOR NUMERICAL	
61	A	RESPONSES	
62	A	"	
63	A	"	
64	A	3.53	.15
65	A	1.12	.09
66	A	1.86	.19

Note: *The following symbols are used to represent various sub-population categories:

A = All Bases
I = Bases Partially or Fully Implementing PAVER Regardless of PAVER System (Micro, Mainframe, or Manual)
NI = Bases Which Have Not Implemented PAVER
M = Bases Using Micro PAVER Only
MF = Bases Using Mainframe PAVER Only
MA = Bases Using Manual PAVER Only

6.2 *Multiple Regression Analysis*

After the survey questions were categorized into groups by the factor analysis, the multiple regression analyses with a general linear model (GLM) were conducted on the sub-population categories A (all bases), I (bases partially or fully implementing PAVER), and NI (bases not implementing PAVER). The results from the multiple regression procedure provide two types of information; an analysis of variance (ANOVA) table and results describing the general linear model.

The general linear model is one of multiple regression models in which a response is related to a set of quantitative independent variables, and for models that relate a response to a set of qualitative independent variables. This model has the following form:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon$$

where x_i = independent variables,

β_i = regression constants, and

ε = random error term.

The ANOVA test procedure employs the F-value as the test statistic to test the null hypothesis that the coefficients of independent variables are zero, i.e., $\beta_i = 0$. The level of significance for this test is the probability of having F-value larger than the calculated F-value from a data set for the factor in question. Smaller value of this probability implies the heavier weight of the sample evidence for rejecting the null hypothesis. For example, a statistical test with a level of significance of $p = 0.03$ shows more evidence for the rejection of the null hypothesis than does another statistical test with $p = 0.50$. Thus, in relation to the general linear model, a lower p-value for a certain independent varialbe, say x_k, means that the probability of having the coefficient of the variable x_k equal to zero is lower, and therefore, the significance of the variable x_k in the model is greater.

Once the variables which are significant to the model have been identified, the direction of influence between independent and dependent variables can be determined by checking the signs of coefficient values for independent variables. An increase in an independent variable with a positive coefficient implies the increase in the value of a dependent variable.

The results from the multiple regression analyses are summarized in Tables 2 to 6. Table 2 presents the results for sub-population category A. A culling process was used to determine insignificant independent variables for categories I and NI. P-values for this analysis are shown in Tables 3 (sub-population category I) and 4 (sub-population category NI). Once the significant independent variables (those with p-values greater than .15) were identified, the multiple regression was run again with the significant independent variables only to refine the p-values. Variables were retained as significant if their p-values were less than or equal to .05. Results of this analysis are shown in Tables 5 (sub-population category I) and 6 (sub-population category NI).

The multiple regression analysis proceeded in four stages. In the first, the independent variables consisting of the major organizational element of the base (MAJCOM) (questions 60-63) and the level of engineering experience of the respondent (question 64) were tested to determine if they influenced the bases' implementation of PAVER (the dependent variable for question 1). Neither independent variable was found to be significant for the criterion of p-values less than or equal to .05 (see Table 2). This first stage in the analysis considered the entire population of potential PAVER users, and included only those independent variables representing conditions which existed prior to the presence of PAVER. This distinction was necessary because the dependent variable was PAVER's initial implementation, not its stage of implementation, and inclusion of independent variables representing conditions after PAVER's presence would not have been appropriate.

Analysis then shifted to the sub-population of PAVER implementers. Before looking for causal relationships between the independent variables (manpower, training, etc.) potentially

Table 2: Summary of Multiple Regression Analysis for Sub-population Category A

Dependent Variable	Level of Significance (p-value) Independent Variables: MAJCOM	Q64[a]
Q1[a]	.126	.344

Note: [a]Q##: A variable for the question indicated by question number ##.

Table 3: Summary of Multiple Regression Analysis for Sub-population Category I

Independent Variable	Level of Significance (p-value) Dependent Variable: EXTIMP1	EXTIMP2	Q6[a]	Q9[a]	Q38[a]
MAJCOM	.755	.731	.297	.337	.566
Q64[a]	.802	.508	.639	.854	.995
Q66[a]	.078	.281	.301	.685	.161
EQUIP	.034	.039	.949	.488	.255
MANPWR	.443	.601	.655	.792	.078
MGTSPT	.970	.082	.191	.052	.682
TRAIN	.323	.035	.359	.301	.176
DATAGATG	.176	.251	.723	.115	.675
BENEFITS	.978	.309	.315	.153	.410
FAVORBL	.526	.684	.648	.318	.283

Note: [a]Q##: A variable for the question indicated by question number ##.

Table 4: Summary of Multiple Regression Analysis for Sub-population Category NI

Independent Variable	Level of Significance (p-value) Dependent Variable FUTINT
MAJCOM	.037
Q64[a]	.918
Q66[a]	.966
TRAIN	.809
RESOUR	.641
PRIORITY	.387
EQUIP	.391
FAVORBL	.027

Note: [a]Q##: A variable for the question indicated by question number ##.

Table 5: Summary of Multiple Regression Analysis for Sub-population Category I

	Level of Significance (p-value) Dependent Variable				
Independent Variable	EXTIMP1	EXTIMP2	Q6[a]	Q9[a]	Q38[a]
MAJCOM	X	X	X	X	X
Q64[a]	X	X	X	X	X
Q66[a]	.023	X	X	X	X
EQUIP	.019	.021	X	X	X
MANPWR	X	X	X	X	.007
MGTSPT	X	.050	X	.008	X
TRAIN	X	.010	X	X	X
DATAGATG	X	X	X	.059	X
BENEFITS	X	X	X	X	X
FAVORBL	X	X	X	X	X

Notes: [a]Q##: A variable for the question indicated by question number ##.

An X in a dependent variable column indicates that the independent variable was not found to be significant.

Table 6: Summary of Multiple Regression Analysis for Sub-population Category NI

Independent Variable	Level of Significance (p-value) Dependent Variable FUTINT
MAJCOM	.014
Q64[a]	X
Q66[a]	X
TRAIN	X
RESOUR	X
PRIORITY	X
EQUIP	X
FAVORBL	.040

Notes: [a]Q##: A variable for the question indicated by question number ##.

An X in a dependent variable column indicates that the independent variable was not found to be significant.

influencing PAVER's state of implementation and dependent variables such as accuracy of data, extent of pavements network input into the system, etc., factor analysis was employed to reduce the number of variables input into the multiple regression model. As Comrey (17) explains, "with a large number of variables and many substantial correlations among the variables, it becomes very difficult to keep in mind or even to contemplate all the intricacies of the various interrelationships....One common objective of factor analysis [then] is to provide a relatively small number of factor constructs that will serve as satisfactory substitutes for a much larger number of variables. These factor constructs themselves are variables that may prove to be more useful than the original variables from which they were derived."

For the dependent variables (questions 3-9, 38) the factor analysis yielded two readily distinguishable factors. The first, which for convenience is referred to as extent-of-implementation 1 (EXTIMP1) combines into a mean score the variables for questions 3-5, which in turn are related to the extent of the airfield pavements network input into PAVER. The second, which was called extent-of-implementation 2 (EXTIMP2) combines into a mean score the variables for questions 7-8, which are related to the active use of PAVER as estimated by the accuracy of data used. The variable for question 6 is related to the extent of roads/streets input into the PAVER data base and was not aggregated into a factor. The variable for question 9 also was left unfactored and estimates the active use of PAVER by its use in project programming. Finally, the variable for question 38 is related to the respondents' interest in adding other areas into the PAVER data base in the future, and was not aggregated into a factor.

Factors for the independent variables (questions 10-37, 39-40, and 54-66) were determined as follows: The factor EQUIP (equipment) became a variable for the mean of questions 20, 21, and 26; the factor MANPWR (manpower) was a variable for the mean of questions 22 and 24; TRAIN (training) became a variable for the mean of questions 13-15, 19, and 23; BENEFITS was a variable for the mean of questions 30-37, and FAVORBL (favorableness score) became a factor for the mean of questions 54-59. DATAGATG became a factor for the mean of questions 39 and 40. Questions 60-63 were rescored to represent one variable for the base's MAJCOM, and question 64 (engineering experience), 66 (PAVER experience), and 27 (top management support, labeled MGTSPT) were left as unfactored variables.

The final model statement for the multiple regression was entered into SAS so that the independent variables were analyzed in their causal order. The background variables (MAJCOM, questions 60-63; engineering experience, question 64; and PAVER experience, question 66) were listed first followed by the mechanical variables (EQUIP; MANPWR; management support, question 27; TRAIN; and DATAGATG). Attitudinal variables (BENEFITS and FAVORABL) were listed last.

From the multiple regression analysis, Tables 3 (for all independent variables) and 5 (for significant independent variables only) were generated for subpopulation category I. EQUIP and the variable for question 66 (paver experience) were found to significantly influence EXTIMP1 with p-values of .019 and .023, respectively. In each case the β_i value indicates that with the increasing presence/availability of equipment and PAVER experience, the state of implementation of PAVER also increases. EQUIP, the variable for question 27 (top management support), and TRAIN were found to significantly influence EXTIMP2 with p-values of .021, .050, .010, respectively. The β_i values show that with the increasing presence of these independent variables, the state of PAVER implementation (EXTIMP2) likewise increases. MGTSPT and DATAGATG significantly influenced the variable for question 9 (application of PAVER in project programming) with p-values of .008 and .059, respectively. In this case, the β_i values indicate that with the increasing presence of management support (MGTSPT) and decreasing presence of data gathering (DATAGATG) as a perceived problem area, the state of PAVER implementation as estimated by the variable for question 9 also increases. MANPWR significantly influenced the variable for question 38 (future intent for adding other pavements into PAVER) with a p-value of .007. Here, the β_i value shows that with the decreasing presence of manpower problems (MANPWR), the state of PAVER implementation as estimated by the variable for question 38 increases as well. No independent variables influenced the variable for question 6 (extent of roads/streets entered into PAVER).

The third step in the analysis looked at the sub-population group of PAVER non-implementers. The dependent variable for this group came from question 53, which asks if the respondent plans to implement PAVER in the future (next 1-2 years). For convenience, this variable was labeled FUTINT (future intent). Factor analysis was applied to the independent variables (questions 42-52 and 54-66). From this analysis the factor PRIORITY became a variable for the mean of questions 46 and 47, representing bases' priorities relative to implementing PAVER. The factor RESOUR (resources) was a variable for the mean of questions 43-45, representing bases' availability of resources (funds, manpower) to implement PAVER. EQUIP became a variable for the mean of questions 48 and 49 (availability of the Micro PAVER computer program and the hardware for PAVER. Question 42 (a variable for availability of training, labeled TRAIN) was left unfactored. Responses to questions 50 and 51 did not indicate that an awareness of benefits of using PAVER was a problem area (in other words, there was little variability in responses), and hence they were not included in the analysis. FAVORBL and background variables for the MAJCOM, engineering experience (question 64), and PAVER experience (question 66) were included as they were for the group of PAVER implementers.

Again as in the population group of PAVER implementers, the multiple regression model statement listed variables in their causal order. Background variables (including the base's MAJCOM and variables for questions 64 and 66) were listed first followed by mechanical variables (TRAIN, RESOUR, PRIORITY, and EQUIP). The attitudinal variable FAVORBL was listed last. The P-values from this analysis are in Tables 4 (for all independent variables) and

6 (for significant independent variables only). Only the bases' MAJCOMs and FAVORBL were found to significantly influence the bases' intention of implementing PAVER in the future with p-values of .014 and .040, respectively. The β_i value for FAVORABL shows that as the perception of PAVER as an innovation becomes more favorable, a base is more likely to report that it intends to implement PAVER in the future. Since the responses for MAJCOM are categorical (a base is in only one MAJCOM), the β_i value for this variable is not useful.

These results showing that FAVORBL (representing how favorable the respondent perceives the PAVER system itself) influences the non-implementers but not the implementers indicated the need to add a fourth and final step in the analysis. The frequency of responses to 54-59 (comprising FAVORBL) for the non-implementers were examined. Not surprisingly, for each question 70% or more of the respondents held consistent attitudes; that is, if they indicated that they planned to implement PAVER in the future, they likewise held a favorable opinion of PAVER. On the other hand, if they indicated that they did not plan to implement PAVER in the future, they also indicated an unfavorable opinion of PAVER. Significantly, for each question (regardless of intent to implement) no less than 83% of respondents held a favorable attitude of PAVER.

6.3 *Potential Biases*

As with any mail-in survey, respondents are self-selected (as opposed to randomly selected), and bias may result. In one approach to examining the presence of bias, the researcher randomly selects a group from the non respondents and obtains (through strong persuasion, or as in the case of the national census, by force of law) their responses. The non-respondent group may then be analyzed for bias. In another approach, at least two successive attempts are made (other than the initial mailing) to obtain completed questionnaires from the non respondents, and again, this group is analyzed for the presence of bias. The second approach requires roughly fifteen responses per additional solicitation for analysis of this survey. For this survey, the researcher did not have at his disposal the power to force a response as for the first approach. Although a second solicitation was attempted and yielded 11 responses, the chances for sufficient replies to a third solicitation appeared slim. In addition, time constraints prevented a third solicitation.

As a final, weaker approach to examining bias, the researcher must apply his own knowledge of the population to hypothesize on the presence of bias. One consideration is the difference in responses based on organizational affiliation (the bases' MAJCOMs) and geographic location (particularly, overseas vs. stateside). However, response rates do not differ significantly for these groups. Furthermore, although bases have varying missions and MAJCOMs may have varying command emphases, overall policy guidance on PAVER is provided Air Force wide by HQ AFESC. Therefore, it is not unreasonable to assume that the group of non respondents are operating under similar constraints and conditions as the group of respondents. While the possibility of bias cannot be ruled out, its presence and impact, if any, is assumed to be minimal.

7. DISCUSSION OF RESULTS

The data generated by responses to sixty-six questions leave many possible avenues and approaches to analysis. However, in keeping with the approach laid out previously, summary statistics for questions dealing with the original issues: training, manpower, equipment, and top management support, are considered first followed by the implications from the multiple regression analysis. PAVER implementers and non implementers are discussed separately. The special topic area of data gathering for PAVER is discussed in Appendix A.

7.1 *Summary Statistics*

For the PAVER implementers, the heaviest response for training from the various sources listed in questions 10-18 came from the AFIT pavements engineering course (and somewhat less from the PAVER short course). For those who use the pavements course (25 respondents) approximately 72% rate their training as good or better. Only 12% rate their training as poor. For the PAVER short course, 87% rate it as good or better, and 0% rate it as poor. These results suggest that AFIT remains the Air Force's main source for PAVER training, and that it is doing an effective job. Results for other sources of training are available in Appendix C.

Overall, about 48% of respondents rate the adequacy of their training from all sources combined as good or better, 33% as fair, 12% as poor, and 6% as very poor. From these results it is apparent that training has improved significantly since Captain McLean wrote his thesis in 1984. However, a reasonable goal would be to move more of the percentage points out of the fair category and into the good and excellent categories. With a continued availability of the AFIT courses and emphasis on the regional seminars, this goal should be attainable.

The manpower issue is raised in questions 22 and 24. Signifying that this remains a crucial issue in PAVER implementation, approximately 80% of respondents rate the lack of adequate manpower as a major or minor impediment to implementing and using PAVER. Also enlightening, 44% of respondents state that they have sufficient manpower to maintain and use PAVER but have higher priority uses for their manpower. "Doing more with less" (often, with less people) is a time-worn phrase in the Air Force. Greater automation (i.e., more computer equipment, and application of more automation in data gathering as discussed in Appendix A) has its place as one way to address this problem. As always, applying resourcefulness in using the people we do have (i.e., A&E contracts, broadening technicians' job experience to include PAVER, etc.) has its place as well. However, each base must weigh its manpower priorities. PAVER has proven long-range benefits, but unless the pavements engineer is allowed the time to operate it, those benefits will never come to fruition.

Equipment-related questions included 20, 21, 25, and 26. Forty-seven percent of respondents report operating all portions of PAVER on the computer, whereas 26% report not having the equipment and are therefore operating PAVER manually. For those who have the computer equipment, 77% use Micro PAVER, followed by 23% who are still using mainframe PAVER, suggesting, not unexpectedly, Micro PAVER's greater user friendliness and continuing dominance over mainframe PAVER. Significantly, only 23% of respondents state that lack of the Micro PAVER computer program is a major or minor problem, although the researcher feels that dissemination of such a readily attainable resource should be even better. Concerning hardware, the problem becomes more severe. Fifty-three percent of respondents state that lack of computer hardware to run PAVER is a minor or major problem. As stated previously, bases have had to pursue their equipment purchases individually, and this process can be somewhat time consuming. As more and more bases obtain the needed equipment, one might reasonably expect the percentage of PAVER implementers to rise, given that the incentive to operate PAVER manually is not that great when the hardware is "on the way."

Thirty-six percent of respondents rate a lack of top management support as a major contributing factor (impediment) to implementing and using PAVER. Twenty-seven percent rate it as a minor contributing factor, and 36% as not a contributing factor. This issue is related to the manpower issue, in that top management at the base level must perceive PAVER as useful and beneficial and then permit the dedication of manhours for it to be implemented and actively used. These results suggest that more in the way of educating top management on the benefits of PAVER may be necessary.

Significantly, approximately 79% of respondents believe that PAVER's data collection process either takes too long, is too manpower intensive, or both (question 39). In addition, approximately 82% of respondents favor the introduction of more automation in the data gathering process (question 40). These results enhance the argument for greater application of automation in the data collection process.

For the nonimplementers of PAVER, a lack of manhours (68% rating as a major or minor contributing reason) and equipment problems (48% rating lack of hardware as a major or minor contributing reason, 60% rating lack of the Micro PAVER computer program as a major or minor contributing reason) appear to be the most significant problems. Sixty-five or more percent of respondents do not rate training (from questions 42-44) as a problem area. As discussed already, the training and equipment issues can be readily addressed with time and effort; the manpower issue is more intractable.

7.2 *Multiple Regression Analysis*

As discussed in the analysis section, EQUIP and the variable for question 66 (PAVER experience) were found to significantly influence EXTIMP1, the first dependent factor (variable) for extent of implementation. EQUIP, MGTSPT, and TRAIN were found to significantly influence EXTIMP2, the second dependent factor (variable) for extent of implementation. The variable for question 27 and DATAGATG significantly influenced the dependent variable for question 9. MANPWR significantly influenced the variable for question 38 (future intent for adding other pavements into PAVER), and no independent variables influenced the dependent variable for question 6 (extent of roads/streets entered into PAVER). Not surprisingly, then, each of the originally postulated problem areas in implementing PAVER--in addition to the new variable of data gathering--are found to be significant in influencing its state of implementation: equipment, training, top management support, and manpower. Finally, as one instructor of PAVER stated, "PAVER sells itself", perhaps explaining why the degree of PAVER experience the respondent has influences its state of implementation.

For the nonimplementers of PAVER, FAVORBL (representing how favorably the respondent perceives the PAVER system itself based on the characteristics of an innovation in questions 54-59) and the bases' MAJCOM influenced the dependent variable FUTINT (intent to implement PAVER in the future). Thus, the results appear to support the idea of diffusion of innovation, that various characteristics of an innovation (adaptability, credibility, etc.) enhance its probability of acceptance.

8. CONCLUSIONS

1. From the results of this survey, the following factors have been found to influence the state of PAVER implementation: training, manpower, equipment, and top management support. A new factor, data gathering, has been found to influence the state of PAVER implementation as well.

2. The majority of respondents rate overall PAVER training as at least fair or better. Although this result appears to be a significant improvement since Capt McLean identified training as a key problem area, the emphasis on improving the quality and availability of training must continue.

3. An overwhelming majority of respondents rate the lack of adequate manpower as a major or minor impediment to implementing and using PAVER. Bases must continue to use resourcefulness in finding people to do the job, and automation in data gathering should be explored as a means of reducing the manpower requirement.

4. A minority of respondents state that lack of the Micro PAVER computer program is a major or minor problem; however, since disseminating the program is cheaply and easily done, this problem should be eliminate altogether.

5. About half of the respondents state that lack of computer hardware to run PAVER is a minor or major problem. In time, the continued emphasis on purchasing the required hardware should remedy this problem as well.

6. A majority of respondents rate a lack of top management support as a major or minor contributing impediment to implementing and using PAVER. More in the way of educating top management on the benefits of PAVER may be necessary for them to perceive it as beneficial and therefore dedicate the manpower resources necessary

for its implementation and operation.

7. A majority of respondents believe that PAVER's data collection process either takes too long, is too manpower intensive, or both. Consequently, more automation is data collection may be needed.

8. The results of the survey indicate that the factor, FAVORBL, representing PAVER's aggregate rating in diffusion of innovation chacteristics, influences non-implementers' intentions of implementing PAVER some time in the future. This result supports the idea of diffusion of innovation, that various characteristics of an innovation (adaptability, credibility, etc.) enhance its probability of acceptance.

9. The overwhelming majority of respondents have a favorable perception of PAVER as an innovation.

9. REFERENCES

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APPENDIX A: ALTERNATE MEANS OF DISTRESS SURVEY AND EVALUATION

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1. INTRODUCTION

From past experience the researcher was aware that a likely potential problem area in implementing PAVER was the manpower-intensive process of distress data collection. For this reason, questionnaire questions thirty-nine and forty address the issue of distress data collection. Significantly, approximately 79% of respondents believe that PAVER's data collection process either takes too long, is too manpower intensive, or both. This factor of data gathering, consisting of the mean of variables from questions 39 and 40, was found to significantly influence the status of PAVER implementation. In addition, approximately 82% of respondents favor the introduction of more automation in the data gathering process. Because of these results, and to consider PAVER's distress data collection method in context with other available methods, this appendix has been included as a non-comprehensive survey of alternate means of distress survey and evaluation.

2. RELATION OF DISTRESS SURVEY AND EVALUATION TO PMS

2.1 *Pavement Distress Defined*

Pavement distress surveys, sometimes termed condition surveys, measure various types and degrees or severity of distress. And while there are numerous methods for conducting the surveys, the following general classes of factors can be identified (4): surface defects, permanent deformation or distortion, cracking, and patching. The surveys are usually detailed, and in addition to type and severity of distress, include the extent and location. Unlike roughness measurements, distress surveys do not represent user response, but the two types of data are related insofar as distress is the cause of both present and future loss of serviceability (4).

2.2 *Data Collection*

Good decision-making first requires good information, and given limited time and resources, the basic options for collecting data must be considered and compared. One option is through the visual survey in which inspection teams may use standard forms to collect the type, extent, and location of the particular distresses required for analysis by the PMS in use. However, visual surveys are subjective, and almost always lead to inconsistencies in distress detail over space and across evaluations (2). Additionally, they require extensive time and resources for data collection, and given time and resource constraints, are limited to small sample sizes, simple record keeping procedures, and infrequent data collection. Alternatively, automated techniques are potentially more consistent and thorough, and can collect distress data at relatively high speeds (2).

2.3 *Field Procedures (1)*

Several factors must be considered in planning and implementing procedures for conducting pavement condition surveys. These include determination of homogeneous sections; type, density, and severity of conditions to be catalogued; productivity requirements (continuous vs. sampling procedure); training; quality assurance; and data processing.

2.4 *Pavement Condition Models*

Raw data by itself may have little direct use, and must be processed and analyzed to aid in decision making. Various agencies use different categories and combinations of categories of data (distress, skid, roughness, structural) within their PMS's. In general, however, two types of pavement condition indices are in use: one type which represents raw data from only one pavement condition parameter (distress, for example), and the other which represents a combination of more than one parameter (5). for example, the Ohio DOT uses one index, the Pavement Condition Rating (PCR) which represents distress data only, as well as the present serviceability index (PSI), which represents roughness and distress data (5). The index itself is a mathematical model which aggregates pavement condition data into a single rating number. The index, then, can be expected to reflect decline of pavement condition with time under the effects of such factors as materials or construction quality control inadequacies, accumulated traffic and climatic conditions, and the effects of the environment over time (5). To make use of this knowledge that the pavement index will reflect declining pavement conditions, various models have been designed based on statistical laws to forecast the pavement changes. They are derived from observations and measurements on different types of pavements in service and therefore reflect real traffic and climatic conditions (5).

3. MANUAL SURVEY AND ANALYSIS METHODS

Numerous techniques have been developed for distress collection and analysis with varying degrees of automation involved. Purely as a convention for this report, manual means are defined as those requiring human visual survey and categorizing of pavement distress in the field. Equally confounding, various PMS's require the identification of different distresses, with varying definitions, identification procedures, and severity levels. However, the Distress Identification Manual for the Long-Term Pavement Performance (LTPP) Studies (7) does promote a standard listing of distresses for various pavement categories. For more information regarding description and severity levels, this reference may be consulted.

3.1 *Manual Mapping - AASHO Method (8,9)*

Although exceedingly labor intensive, manual mapping provides a permanent record of the pavement surface. The test section is mapped in 20-foot intervals using a 100-foot tape measure marked at 5-foot intervals as a guide. A separate tape is used to measure the extent of distress, and a 10-foot straightedge is used to measure rut depth. Special map forms are used to draw in the distress and mark severity. Those distresses that cannot be drawn (bleeding, for example) are indicated in the comments block. A standard guide may be used to identify and rate distresses. Data from the maps are recorded and compiled for the measured 100-foot subsections. Results are then extended (multiplied by number of subsections in the test section) to obtain the final extent of distress types.

3.2 *The PAVER Pavement Condition Rating System*

The PAVER method of distress survey and evaluation was discussed in the main report in the section, "Background on the PAVER PMS."

3.3 *The Portland Cement Concrete Pavement Evaluation System (COPES)*

The COPES system was developed for the evaluation of the three types of conventional concrete pavements including: plain jointed, jointed reinforced, and continuously reinforced concrete pavements. The objective of COPES is to provide a system to periodically collect and evaluate data from in-service concrete pavements. Major components of the system are data collection, storage, and retrieval and evaluation. COPES relies heavily on the use of existing pavement distress to conduct the analysis and evaluations. Patterned after the PAVER system, a comprehensive distress identification manual was developed to provide for standardized uniform data collection. The field survey procedure itself has been standardized and provides for the efficient collection of all existing distress data on seven field data collection sheets. Again similar to PAVER, COPES permits inspection of random sample units within a pavement section in order to reduce the time and effort required for data collection. Information within COPES can be analyzed and sorted in a variety of ways. Brief or comprehensive summaries of an agency's pavement condition can be generated, although these summaries do not include the aggregation of distresses into a single pavement condition index. Reference 20 comprehensively describes the COPES system.

3.4 *Manual Distress Survey with Automated Data Recording*

Automation is not an all or nothing choice; it can be applied in degrees. To illustrate, the distress survey may be performed manually, that is, using trained observers to classify, measure, and record distresses, while the data itself is entered directly into a computer, thus applying a measure of automation to the process. In one FHWA investigation of the application of this method (8), a detailed distress survey was performed using a battery operated Epson HX-20 portable computer programmed by ARE Inc. to record distress and section information. This system uses an interactive program that prompts the rater for input of the severity and extent of each previously defined distress category. The information is stored on a computer-encoded microcassette which then allows it to be down loaded in the office using hardwired connections between computers and a communications program. Paper tapes are produced in the field as a backup. In a separate study sponsored by the Texas State Department of Highways and Public Transportation in 1985, distress data was recorded using a microcomputer mounted inside the survey van. In this way, data could be entered directly into the PMS (22). The Washington State Department of Transportation published a report on yet another example of an automated data entry system (23). Additionally, at least three commercial automated pavement condition measurement systems, the Automated Road Analyzer (ARAN), the Dynatest 5000 RDM, and the Portable Universal Roughness Device (PURD) possess automated distress data entry capability (24, 8) The advantages of automated over manual data entry thus appears to have been recognized through equipment development.

3.5 *Network Level Distress Surveys*

Until this point, the manual distress survey has been described as a detailed, time consuming data collection process. The question arises, then, how can government agencies responsible for thousands of miles of road maintain current distress data for the entire network? Obviously, the data is needed for all road sections in order to select projects at the network level. Two possibilities include sampling techniques and automated data collection. As another means, however, the New York State Department of Transportation (NYSDOT) has published a method for network level distress survey which can fully account for all sections (25, 27). The NYSDOT employs a windshield survey, developed in 1981, to accurately estimate the condition of highway pavements from a rapidly moving vehicle. Goals for the windshield condition survey data were established as follows (27): consistent between regions or highway types, rapidly collectable, repeatable over time, reasonably accurate but not overly precise, easily understandable by lay persons, inexpensive to collect, and consistent with existing procedures. The method uses visual scales developed through a modified psychological perception measurement technique known as Q-sort (27). Pavement photographs rated 1 to 10 by experts are compiled in a field scoring manual. The surface and base of the pavement being evaluated are rated separately (the base condition is assumed to be manifested through certain surface distresses). The evaluation is made by comparing the pavement observed to the rated photographs in the field manual and then selecting the photograph which most closely matches the pavement condition. Verbal scales supplement the visual scales. The data collection method is decentralized in that well trained crews from regional offices perform the surveys. Results are then compiled for the entire state. This survey method is claimed to yield accurate results, in that 97 percent of highway sections were rated in 1985 within 1 percent of the modal estimates for each section (25). Perhaps most impressive, use of the windshield survey method in 1985 enables NYSDOT to complete a full inventory of their 16,400 mile system within 3 months, with high accuracy (25).

3.6 *Cost Comparisons of Manual Distress Survey Techniques*

As of 1982, the scoring cost for NYSDOT's survey method was \$3.12/mile (34). Reference 8, published in 1987, cites total equipment, operating, and data processing costs per lane mile for manual methods as follows: manual mapping, \$2533/lane mile; visual survey with manual recording, \$268/lane mile; and visual survey with automated data logger, \$132/lane mile.

4. AUTOMATED DISTRESS SURVEY AND ANALYSIS METHODS

The advantages of automated distress survey and analysis (speed of survey, safety, consistency, elimination of subjectivity, etc.) were previously noted, and numerous equipment systems have been developed in response to these advantages. It is important to note that some systems collect more than one class of data (roughness and distress, for example), while in the discussion that follows only distress data collection capability is considered. For a good overview of pavement data collection equipment in general, reference 1 may be consulted. The technology involved in some of these methods is quite complex; therefore only a summary description of some of the technology available is provided. For purposes of organization, data collection technology is divided into three types: photologging, laser method, and video imaging. With the exception of video imaging, specific systems are used to illustrate the technology in general.

4.1 *Photologging Technology*

In essence, photologging involves the taking of a continuous photograph of the pavement at highway speeds then later analyzing the distress information captured in the photograph. Several states and foreign countries have made use of photologging equipment for years (1). It is claimed that the transfer of pavement distress type, extent, and severity from photographs or other images to a digital form for establishing pavement condition scores has proved to be both time-consuming and expensive (1). However, suggesting mixed opinion of the usefulness of photologging, the Iowa Department of Transportation assessed one system as capable of providing improved data collection speed, accuracy, and reliability [over their manual system], and a visible record of pavement condition for comparable costs (28).

4.2 *Photologging - PASCO ROADRECON (8, 28)*

The PASCO Corporation of Japan developed the continuous pavement surface photographing device in the late 1960's. The objective of their ROADRECON series of equipment is to collect data on cracking, patching, rut depth, and roughness so that the present condition of the road can be evaluated and future condition predicted. The present pavement condition is scored from these data according to PASCO's Maintenance Control Index (MCI). Cracking, patching and other distresses are recorded using the continuous road surface photographic recorder, the ROADRECON-70 system. Elkins, et. al., summarize the system operation as follows (8):

> The vehicle travels at speeds between 3 and 53 mph.... A continuous photographic record of the pavement surface is made using a 35-mm slit camera. The system synchronizes film speed and camera aperture with the speed of the vehicle in order to equalize image density and photographic reduction. A continuous film record of approximately 37 miles (60km) of road can be created with 1000 feet (305m) of film. Road width of up to 16 feet (5m) can be filmed. Photographing is performed at night using on board lights. The lights are set at an angle to the road surface so that shadows are produced at cracks and other defects in the surface, making interpretations easier. Interpretations of the distresses present on the road are made by a technician viewing the developed 35-mm film enlarged ten times on the ROADRECON Film Digitizer. A grid pattern is overlaid on the film to aid in qualification of the distresses for input into a computer data base.

Although not discussed in this report, the GERPHO (Groupe Examen Routier Photographic) System, also described by Elkins, et. al. (8), is another well-known example of a photologging system.

4.3 *Laser Method - Laser RST (8)*

The Laser Road Surface Tester is a Swedish system capable of measuring crack depths and width, rut depths, longitudinal profile from which roughness is computed, macrotexture, cross profile, and distance. Significantly, processed data is provided in real time.

Four of the RST's eleven laser sensors, which are mounted on the front of a dedicated van, supply signals for measuring cracks and categorizing them according to width and depth. Essentially, cracks are determined to be present when amplitudes are greater than texture. However, while the system detects and measures cracking, longitudinal and alligator cracking and patches must be identified and recorded visually by using eight manual switches, thus requiring some subjective assessment. System components include a dedicated van and generator, laser bar, distance and velocity measurement transducer, on-board computer system, subjective switches, inventory computer and accelerometer. The system may be operated day or night and requires three operators. System output shows inventory data, longitudinal roughness summary statistics, rut depths, section length information, crack and texture data. Summary output includes also: subjective ratings based on entries from the eight toggle switches, mean profile based on all eleven sensors' data, and deviation of each laser from the mean profile. Although not discussed in this report, the Komatsu Automatic Pavement Distress System (2, 29) is another example of a laser-based system.

4.4 *Video Imaging*

Unlike photologging, video imaging offers the capability to fully automate crack detection in pavements by eliminating the need for the operator to interpret and score images. The technology in general involves the gray level scaling of an array of television picture element (pixels), using a high speed analog to digital converter module. Since cracks are observed as shadows, they produce a difference in grey scale which is easily detected by threshold techniques. The "gray-scaled" pixels are used to produce a histogram from which cracks may be detected (30). At least one state department of transportation (Idaho) has reported trying to incorporate this technology into their PMS (31). An example system using this technology is the Automated Crack Monitor (ACM) (32).

4.5 *Cost Comparisons of Automated Distress Survey Techniques*

Reference 2, published in 1987, reports total equipment, operating, and data processing costs for selected automated survey techniques as follows: GERPHO, $83/lane mile; PASCO ROADRECON, $107/lane mile; and Laser RST, $89/ lane mile.

5. METHOD SELECTION CONSIDERATIONS

Obviously, there are no easy choices in selecting from the myriad of possible distress survey and analysis techniques. Elkins, et. al. (8), tested a number of methods and devices which were mentioned in this report. They concluded that the PASCO and GERPHO photologging survey vehicle were useful for both network and project level distress survey in that either summary or detailed distress information can be interpreted from the photograph as desired. However, they also stated that the costs associated with film development, office interpretation, and film storage may offset their advantages for some agencies. Concerning the Laser RST, this source suggested that it is useful for network level distress surveys because it can cover the network and process the information in a relatively short time; however, some of the information this method provides is of very limited use. Finally, if manual surveys are selected for use, Elkins, et. al., recommend that an automated data logger be used to record the distress survey information in the field and for transfer to an office computer. Fortunately, the technology associated with distress measurement is not static, thus enhancing the likelihood of cost effective improvements in automation. A side effect of growing technology, of course, is the problem of selecting a technique from the new choices available; previous research comparing alternatives, such as the report mentioned above, can easily become dated. The potential user of a system must then perform his own evaluation. Some guidance in this area is available. Haas and McNeil (2), for example, outline in their report a method of evaluation which proposes a set of criteria including economic costs, system reliability, quality of data, survey rate, manufacturer support, and system flexibility.

6. IMPLICATIONS FOR PAVER

In view of ever-present manpower shortages, the consequent negative impact on distress data collection within PAVER will likely remain a problem area. One option, of course, is to maintain the present manual data collection method and use resourcefulness in finding the time and manpower to perform the distress surveys; use of A & E contracts is one such possibility; impressing upon base-level upper management the need for diverting resources away from other priorities and permitting the devotion of time and personnel to perform surveys, is another.

However, at least the possibility of using other data collection means--specifically the introduction of more automation into the process--should be considered. At the far end of automation, systems such as the Laser RST and video imaging may not be practical at this time, primarily due to the high cost of the equipment and the logistical problem of sharing it among scores of geographically dispersed Air Force bases. However, according to the Air Force's manager for PAVER implementation, the use of a portable computer for automated data entry has been successfully tried at at least one Air Force base. Considering the lower cost of the visual survey with automated data logger vs. manual recording as reported in this appendix, this initiative should be aggressively pursued. Costs will be saved and bases may be more likely to perform the periodic surveys so necessary for accurate analysis.

Finally, there may be some merit in Air Force use of the network level distress survey method described in this appendix. For the present, only approximately 27% of survey respondents report having implemented PAVER for any of their roads/streets, and only about 26% plan to do so within the next two years. At least in part, this reluctance to expand the use of PAVER may be due to the time and manpower-consuming nature of the distress survey. One option here may be to continue the use of detailed surveys for primary pavements, but allow the use of network level "windshield surveys" for roads and streets. Of course, the PAVER system would have to be modified to accept a new data collection method, and personnel would have to be trained in the new method.

7. CONCLUSIONS

Distress surveys provide a crucial element in the PMS data base. In addition to providing the information necessary for project selection in network level PMS, distress survey and analysis aids in the selection of maintenance and rehabilitation techniques at the project level. Numerous manual and automated systems have been developed to aid in the data collection and analysis, some of which have been discussed in this appendix. Finally, as new technologies work their way into developed systems, the potential user must perform his own evaluation of costs and benefits to help ensure a good selection.

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APPENDIX B: SURVEY PACKAGE

The following pages contain the survey package sent to all CE organizations thought to be in the population. Each package contained the following:

1. Cover letter from the Air Force's manager for PAVER implementation (to elicit maximum response).

2. Cover letter from the researcher.

3. A privacy act statement.

4. A definition of PAVER.

5. The questionnaire itself.

5. Instruction for completing the optical scan sheet.

6. Optical scan sheet.

7. A stamped, self-addressed return envelope.

Items 6 and 7 are not included in this appendix.

USAF SCN 90-68
Exp. Date: 31 Dec 90

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE ENGINEERING AND SERVICES CENTER

TYNDALL AIR FORCE BASE FL 32403-6001

3 JUL [illegible]

REPLY TO ATTN OF: DEMP

SUBJECT: Status of PAVER Implementation Survey

TO: Survey Participants

1. The effective maintenance and repair of our extensive Air Force pavements network depends on the application of proven engineering management techniques. The pavement management system, PAVER, has been and continues to be one of our primary engineering management tools. To help us assess the current status of PAVER implementation, please take the time to complete the enclosed questionnaire package.

2. A graduate student in the AFIT Civilian Institute Program has developed this questionnaire as a part of his graduate research. Survey results will be used not only in his graduate project, but also by the Engineering and Services Center to help gage how well implemented PAVER is to date and to reveal areas where we might improve implementation.

3. While your participation in this survey is entirely voluntary, your response is critical if we are to know how we are doing and what we must do to improve in this important area. Thank you in advance for your help.

K. STUART MILLARD, GM-13
Pavement Consultant

1 Atch
Survey Package

DEPARTMENT OF THE AIR FORCE
DETACHMENT 595, AIR FORCE ROTC (ATC)
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, N.C. 27695-7308

REPLY TO ATTN OF: AFIT-CI (Capt D.L. Eaddy, Commercial (919) 469-8334)

21 Aug 90

SUBJECT: Status of PAVER Implementation Survey

TO: Survey Participants

1. Please take a few minutes out of your valuable time to complete the enclosed Status of PAVER Implementation questionnaire. Use the enclosed envelope to return the completed questionnaire and optical scan sheet within one week after receipt.

2. As a civil engineering officer (5525C), I appreciate how busy your schedule is, and I very much appreciate your assistance. The results of the survey will be incorporated into my graduate project on pavement management systems; furthermore, HQ AFESC will have the results available for its evaluation.

3. If you have any questions while completing this survey, please contact me at commercial (919) 469-8334. Any contact with me, including all responses to this questionnaire, will be kept in strict confidence. Specific questions on the questionnaire on MAJCOM and other background information are only for trend analysis of responses. Questions regarding the point of contact are strictly for use in clarifying responses and for follow-up, if required.

4. Thank you very much for your time and cooperation. Your help will play an important role in improving management of Air Force pavements in the future.

D. LAWRENCE EADDY, Capt, USAF
Graduate Student
North Carolina State University

5 Enclosures:
1. Privacy Statement
2. Definition of PAVER
3. Questionnaire
4. Computer Score Sheet with Instructions
5. Return Envelope

PRIVACY STATEMENT

In accordance with paragraph 8, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Department Regulations; and/or

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or

(3) EO 9397, 22 Nov 43, Numbering System for Federal Accounts Relating to Individual Persons; and/or

(4) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal Purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on data provided, will be included in written master's project report and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

DEFINITION OF PAVER

For purposes of this survey, the PAVER pavement management system is defined as EITHER the manual procedures OR the computer-based program which have been developed and tested by the U.S. Army Construction Engineering Research Laboratory (CERL) for HQ AFESC.

As described in CERL Technical Report M-294 (October, 1981), the PAVER pavement management system

> "is designed to optimize the funds allocated for pavement maintenance and rehabilitation (M&R). The system includes procedures for dividing the pavement into manageable sections, pavement condition survey and rating, pavement evaluation, rational determination of M&R needs and priorities, performance of life-cycle costing on feasible M&R alternatives, and manual and automated systems for data storage and retrieval. The automated system provides custom-designed reports based on stored and/or processed data.
>
> An important part of PAVER is the pavement condition survey and rating [PCI] procedure...
>
> The PAVER system offers the flexibility of implementation at various levels. The highest level of implementation would be the inclusion of all pavements on the installation and use of the automated system. The lowest level would be the use of the PCI as the basis for project approvals and establishment of priorities. A gradual implementation includes starting with a specific group of pavements...and then including other pavements on a predefined schedule."

As described here by CERL, PAVER, as a manual system, is complete in itself. That is, it includes all of the aspects and capabilities necessary to manage pavements.

PAVER, as a computer program, operates on the same basic principles as the manual system, but adds numerous time-saving capabilities. These include: a) automated data entry, storage, update, and retrieval processes; b) data manipulation, formatting, and processing; and c) custom-designed report-generating programs that aid the user in determining, planning, and scheduling pavement maintenance and repair.

QUESTIONNAIRE ON STATUS OF PAVER IMPLEMENTATION

You may wish to read the enclosed definition of PAVER before answering this survey. Then, answer the multiple choice questions by circling the letter or filling in the blank for the one response which best reflects your answer. At the end of the questionnaire space is allotted for you to make general comments and suggestions and to amplify on any specific questions.

After you have completed this questionnaire, please encode your answers on the enclosed optical scan sheet. Instructions for completing the optical scan sheet are provided in a separate enclosure. Return this survey and optical scan sheet in the envelope provided.

---

1. Has your base either partially or fully implemented PAVER?

A. Yes
B. No

2. How familiar are you with the PAVER pavement management system?

A. I have never heard of PAVER.
B. I have heard of PAVER but am not familiar with it.
C. I understand the basic components of PAVER.
D. I am able to use my understanding of PAVER to ensure that proper data are input into the system.
E. I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.

If you answered **no** to question 1, please **skip** to question 42 and complete all remaining questions. If you answered **yes** to question 1, please continue on to the next question.

For questions 3 - 9, we would like to know the present extent and currency of PAVER implementation at your base as well as your future plans for implementation.

3. Have you implemented PAVER for your runway(s)?

A. No, and we have no plans to in the future (next 1-2 years).
B. No, but we plan to in the future (next 1-2 years).
C. Yes, some.
D. Yes, all.

4. Have you implemented PAVER for your taxiways?

A. No, and we have no plans to in the future (next 1-2 years).
B. No, but we plan to in the future (next 1-2 years).
C. Yes, some.
D. Yes, all.

5. Have you implemented PAVER for your cargo aprons?

A. No, and we have no plans to in the future (next 1-2 years).
B. No, but we plan to in the future (next 1-2 years).
C. Yes, some.
D. Yes, all.

6. Have you implemented PAVER for your roads/streets?

A. No, and we have no plans to in the future (next 1-2 years).
B. No, but we plan to in the future (next 1-2 years).
C. Yes, a third or less.
D. Yes, 1/3 to 2/3.
E. Yes, 2/3 or more.

7. How accurate is the pavement distress data that is entered into your PAVER system?

A. Very little (less than 35%) of the data is accurate.
B. Some (35 - 65%) of the data is accurate.
C. Most (65 - 90%) of the data is accurate.
D. Almost all (90 - 100%) of the data is accurate.

8. How accurate is the inventory data that is entered into your PAVER system (including surface type, pavement structure, traffic, etc.)

A. Very little (less than 35%) of the data is accurate.
B. Some (35 - 65%) of the data is accurate.
C. Most (65 - 90%) of the data is accurate.
D. Almost all (90 - 100%) of the data is accurate.

9. Which of the following statements best describes the active use of PAVER in programming pavements projects?

Pavements projects are programmed:

A. Entirely through the application of PAVER.
B. Entirely through the application engineering judgement.
C. Entirely through the application of command priorities.
D. Through the combined application of PAVER and engineering judgement.
E. Through the combined application PAVER, engineering judgement, and command priorities.

For questions 10 - 22, we would like to know the status of training, equipment, and manpower as pertaining to your implementation of the PAVER system.

The following code is for answering questions 10 - 18:

A. Excellent C. Fair E. Not Used/Not Applicable
B. Good D. Poor
(Please mark the appropriate letter for each blank)

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

10. HQ/AFESC: __________
11. Your MAJCOM: __________
12. Other bases: __________
13. AFIT (Pavements Engineering short course): __________
14. AFIT (PAVER short course): __________
15. Univ. of Illinois (3-day short course, "The PAVER System: An Intensive Short Course") : __________
16. Construction Engineering Research Lab. : __________
17. Command-Sponsored Workshops : __________
18. PAVER publications : __________

19. How would you rate the adequacy of your training from all sources combined (questions 10 - 18) in preparing you to implement and use PAVER?

A. Excellent C. Fair E. Very Poor
B. Good D. Poor

20. Which of the following statements best describes the status of computer use for PAVER at your base?

A. We do not have the required computer equipment (hardware and/or software) and therefore must rely totally on manual analysis procedures.
B. We have the required computer equipment (hardware and software), but still prefer to operate PAVER manually.
C. We operate portions of PAVER manually, and operate other portions by computer.
D. We operate all applicable portions of PAVER on the computer.

21. If you operate all or portions of PAVER on the computer, please indicate which computer system you are using.

A. Mainframe PAVER C. Not Applicable; we use manual analysis procedures.
B. Micro PAVER

22. Which of the following statements best describes the status of available manpower to maintain the data base and use PAVER.

A. We lack sufficient manpower to maintain and use PAVER.
B. We have sufficient manpower to maintain and use PAVER but have higher priority uses for our manpower.
C. We have sufficient manpower to maintain and use PAVER but are required to spend it satisfying the requirements of higher levels of management.
D. We have sufficient manpower and use it to maintain and use PAVER.
E. Other; please specify:

Questions 23 - 37 solicit your opinion on both problems with PAVER implementation and its usefulness as an engineering tool and aid to decision-making.

For questions 23 - 29, rate each of the listed factors as impediments to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor). Please mark the appropriate letter for each blank.

23. Lack of adequate training. ______
24. Lack of adequate manpower. ______
25. Lack of Micro PAVER computer program. ______
26. Lack of PAVER hardware. ______
27. Lack of top management support. ______
28. Difficulty of gathering pavement distress data. ______
29. Other; please specify: ______

For question 30 - 37, rate each of the listed factors as benefits from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit). Please mark the appropriate letter for each blank.

30. Reduction in manhours required to perform pavement management. ______
31. Project cost reduction. ______
32. Improved project justification. ______
33. Elevation of project priority. ______
34. Increased funding for pavement projects. ______
35. Elimination of projects due to improved preventive maintenance. ______
36. Improved decision making. ______
37. Better communication among various levels in your organization. ______

Questions 38 - 41 relate to future considerations for PAVER.

38. Do you intend to add other pavement areas into your PAVER data base in the future (next 1-2 years)?

A. Yes.
B. No.
C. Not applicable; we have fully implemented PAVER for all of our pavements.

39. Which of the following statements best describes your opinion of PAVER's pavement distress data gathering process?

A. The data gathering process takes too long and is too manpower intensive.
B. The data gathering process does not take too long and is not too manpower intensive.
C. The data gathering process takes too long but is not too manpower intensive.
D. The data gathering process does not take too long but is too manpower intensive.

40. Would you favor the introduction of more automation in the data gathering process?

A. Yes.
B. No.

41. A soon-to-be-released version of Micro PAVER will include certain changes, some of which are as follows:

(1) A graphics summary capability to produce histogram summaries of existing data.
(2) An automated annual work plan that will permit the quicker development of the pavements improvements plan as well as enable the user to determine changes to the work plan and consequences to network condition based on changing funding levels.
(3) Large data bases may be automatically broken down into smaller, more manageable data bases for quicker report generation. Individual data bases may also be combined into one large database for overall planning.
(4) Tables with default values that can be modified to meet local costs and conditions will be included.
(5) The family curve concept will be made an integral part of reports.

Please select the response which best reflects your opinion of these changes.

A. These changes will enhance the usefulness of PAVER greatly.
B. These changes will enhance the usefulness of PAVER somewhat.
C. These changes will enhance the usefulness of PAVER a little.
D. These changes will not enhance the usefulness of PAVER.
E. These changes will detract from the usefulness of PAVER.

If you answered **no** to question 1, please complete questions 42 through the end of the questionnaire. If you answered **yes** to questions 1, please **skip** to question 54 and complete all remaining questions.

For items 42 - 52, please rate each item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason).

42. Training in PAVER has not been made available. _____
43. Training in PAVER has been made available but we cannot afford the manpower loss to participate in training. _____
44. Training in PAVER has been made available but we do not have the funds to participate in training. _____
45. We lack sufficient manhours to implement PAVER. _____
46. We have sufficient manhours but have higher priority uses for these manhours. _____
47. We have sufficient manhours but are required to spend them satisfying the requirements of higher levels of management. _____
48. We lack the Micro PAVER computer program. _____
49. We lack the hardware for PAVER. _____
50. We are not aware of the benefits of using PAVER. _____
51. We do not think PAVER can solve our pavement management problems. _____
52. Other; please specify: _____

53. Do you plan to implement PAVER in the future (next 1-2 years)?

A. Yes
B. No

Questions 54 - 59 ask about certain perceptions you may have concerning the PAVER system.

54. Do you perceive PAVER as an innovation to be an improvement over previously used methods of pavement management?

A. Yes.
B. No.
C. Not applicable; I am insufficiently familiar with PAVER or previous pavement mgt. methods.

55. Do you perceive PAVER to be compatible with existing management methods in your organization?

A. Yes.
B. No.
C. Not applicable; I am insufficiently familiar with PAVER to judge.

56. Do you perceive PAVER to be too complex, that is, too difficult to understand and use?

A. Yes.
B. No.
C. Not applicable; I am insufficiently familiar with PAVER to judge.

57. Do you perceive PAVER to provide you with results which you can relate to peers and higher management?

A. Yes.
B. No.
C. Not applicable; I am insufficiently familiar with PAVER to judge.

58. Do you perceive PAVER to be adaptable, that is, able to be modified to be useful for your base's particular needs?

A. Yes.
B. No.
C. Not applicable; I am insufficiently familiar with PAVER to judge.

59. Do you perceive PAVER to be credible, that is, soundly based on technical content?

A. Yes.
B. No.
C. Not applicable; I am insufficiently familiar with PAVER to judge.

Questions 60 - 66 request general, background information.

60. What is your MAJCOM or SOA?

A. TAC
B. SAC
C. PACAF
D. USAFE
E. None of the above.

61. What is your MAJCOM or SOA?

A. ATC
B. AAC
C. MAC
D. AFSPACECOM
E. None of the above.

62. What is your MAJCOM or SOA?

A. AFDW
B. AFLC
C. AFSC
D. None of the above.

63. What is your MAJCOM or SOA?

A. AU
B. USAFA
C. None of the above.

64. How many years have you been engaged in the engineering profession?

A. 0-2
B. 3-5
C. 6-10
D. 11-20
E. More than 20

65. What is your engineering discipline?

A. Civil
B. Mechanical
C. Electrical
D. Architectural
E. Other; please specify:

66. How much experience have you had in using PAVER?

A. Less than 6 mths.
B. 6 mths. - 1 year.
C. 1 - 2 years.
D. 2 - 5 years.
E. More than 5 years.

67. Please provide a point of contact at your base regarding this survey. A point of contact is necessary in case of questions regarding responses to the survey, or in case any other questions should arise. (Contents of this survey WILL be held in confidence).

Name:

Rank/title:

Position title:

Duty mailing address:

Duty phone (Autovon):

Duty phone (commercial):

If you have any other comments on PAVER or this survey, please include them on this page and the next, if needed. Thank you very much for your time and assistance.

COMMENTS

INSTRUCTIONS FOR COMPLETING OPTICAL SCAN SHEET

1. In the block marked, "name", fill in and blacken the appropriate bubbles for the name of your base or location.

2. Use a No. 2 pencil to blacken **completely** the bubble corresponding to the chosen response for each question.

3. Do not press too hard. If you change your mind and have to erase, the first mark must be erased **completely**.

4. Do not make stray marks or checks on the optical scan sheet.

5. Do not fold, bend, or otherwise damage the optical scan sheet.

APPENDIX C: GRAPHICAL PRESENTATION OF SURVEY RESPONSES

The following pages display the frequency of responses to each question by population category according to the following legend:

A = All Bases

I = Bases Partially or Fully Implementing PAVER

NI = Bases Which Have Not Implemented PAVER

M = Bases Using Micro PAVER Only

MF = Bases Using Mainframe PAVER Only

MA = Bases Using Manual PAVER Only

NOTE: The number (count) and percentage responses are listed in parentheses beside each question. Percentage responses on the pie charts are rounded to the nearest percent; percentage responses listed in parenthese have been rounded to the nearest tenth of a percentage point by SAS and may not total to 100%.

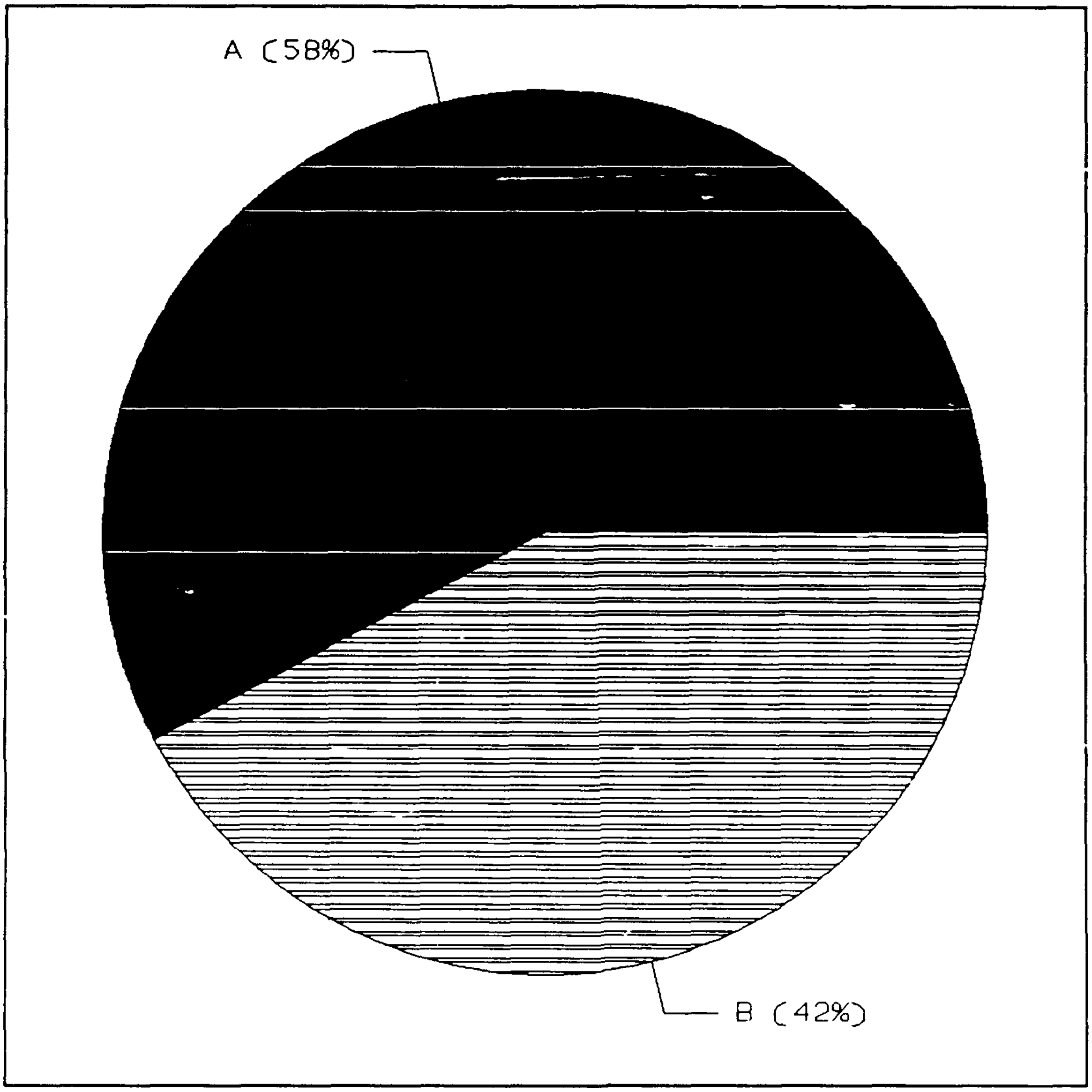

Figure D1: RESPONSE TO QUESTION 1, POPULATION CATEGORY A.

1. Has your base either partially or fully implemented PAVER?

A(34/57.6%). Yes
B(25/42.4%). No

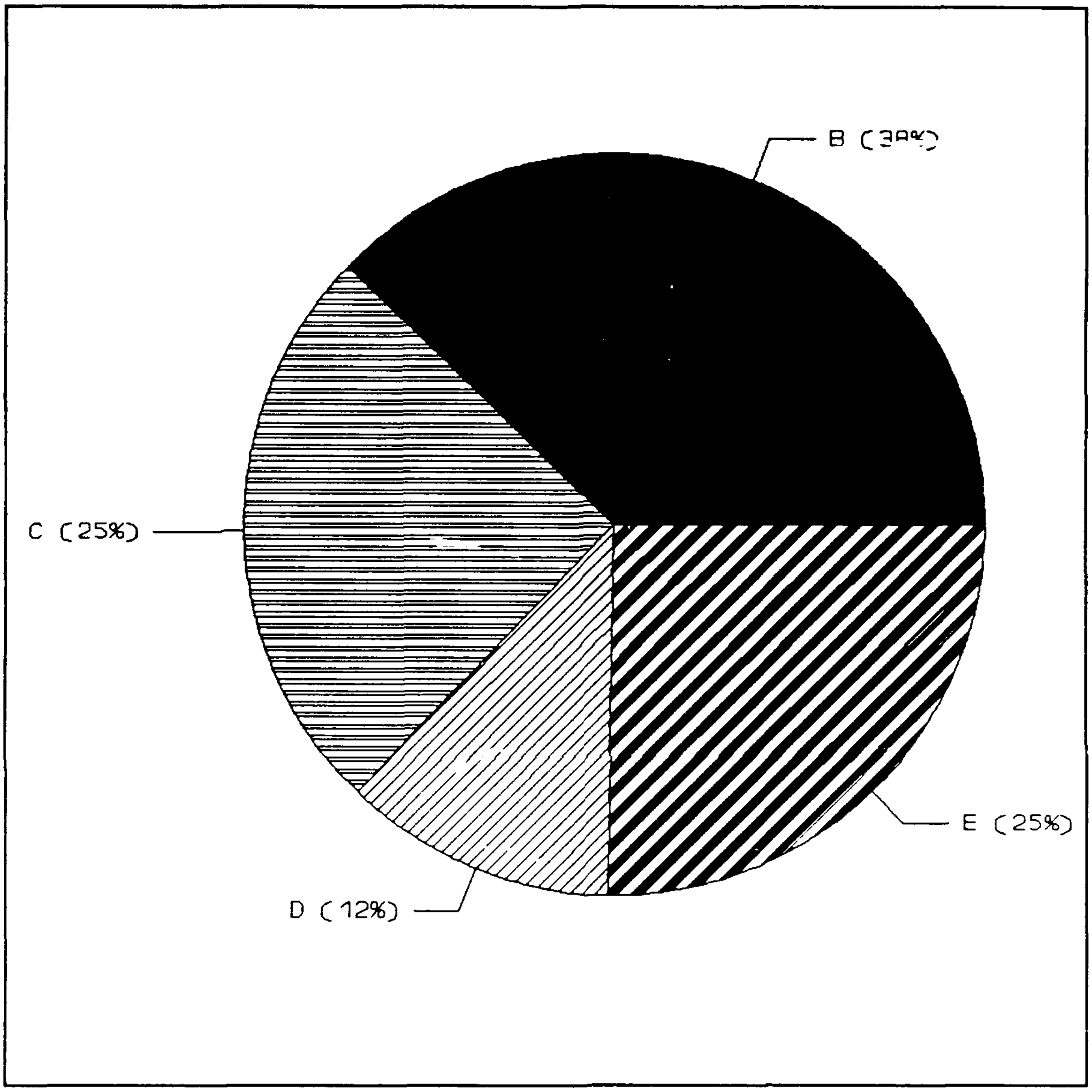

Figure D2: RESPONSE TO QUESTION 2, POPULATION CATERGORY I-MA

2. How familiar are you with the PAVER pavement management system?

A(0/0%). I have never heard of PAVER.
B(3/37.5%). I have heard of PAVER but am not familiar with it.
C(2/25%). I understand the basic components of PAVER.
D(1/12.5%). I am able to use my understanding of PAVER to ensure that proper data are input into the system.
E(2/25%). I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.

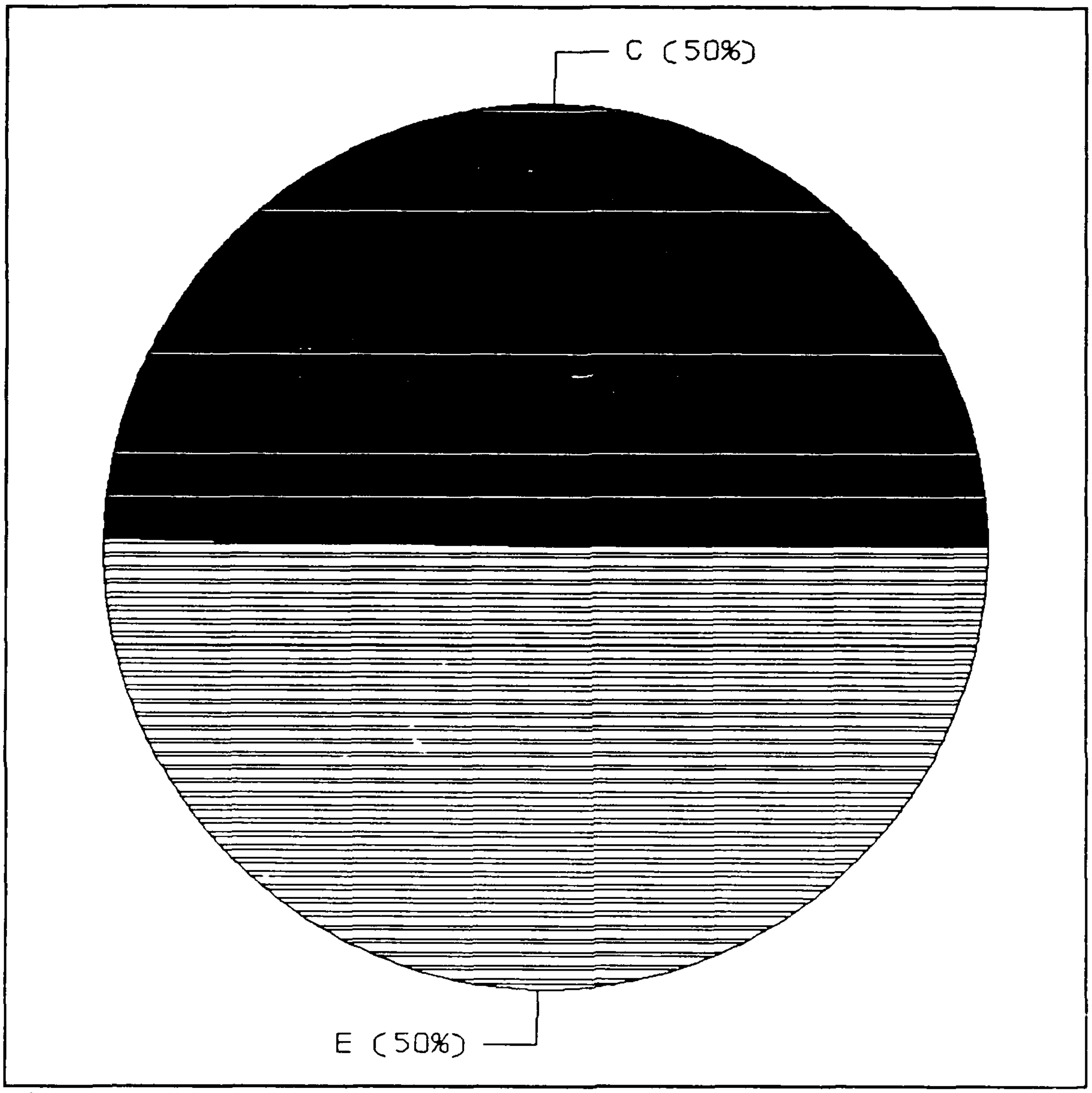

Figure D3: RESPONSE TO QUESTION 2, POPULATION CATEGORY I-MF

2. How familiar are you with the PAVER pavement management system?

A(0/0%). I have never heard of PAVER.
B(0/0%). I have heard of PAVER but am not familiar with it.
C(3/50%). I understand the basic components of PAVER.
D(0/0%). I am able to use my understanding of PAVER to ensure that proper data are input into the system.
E(3/50%). I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.

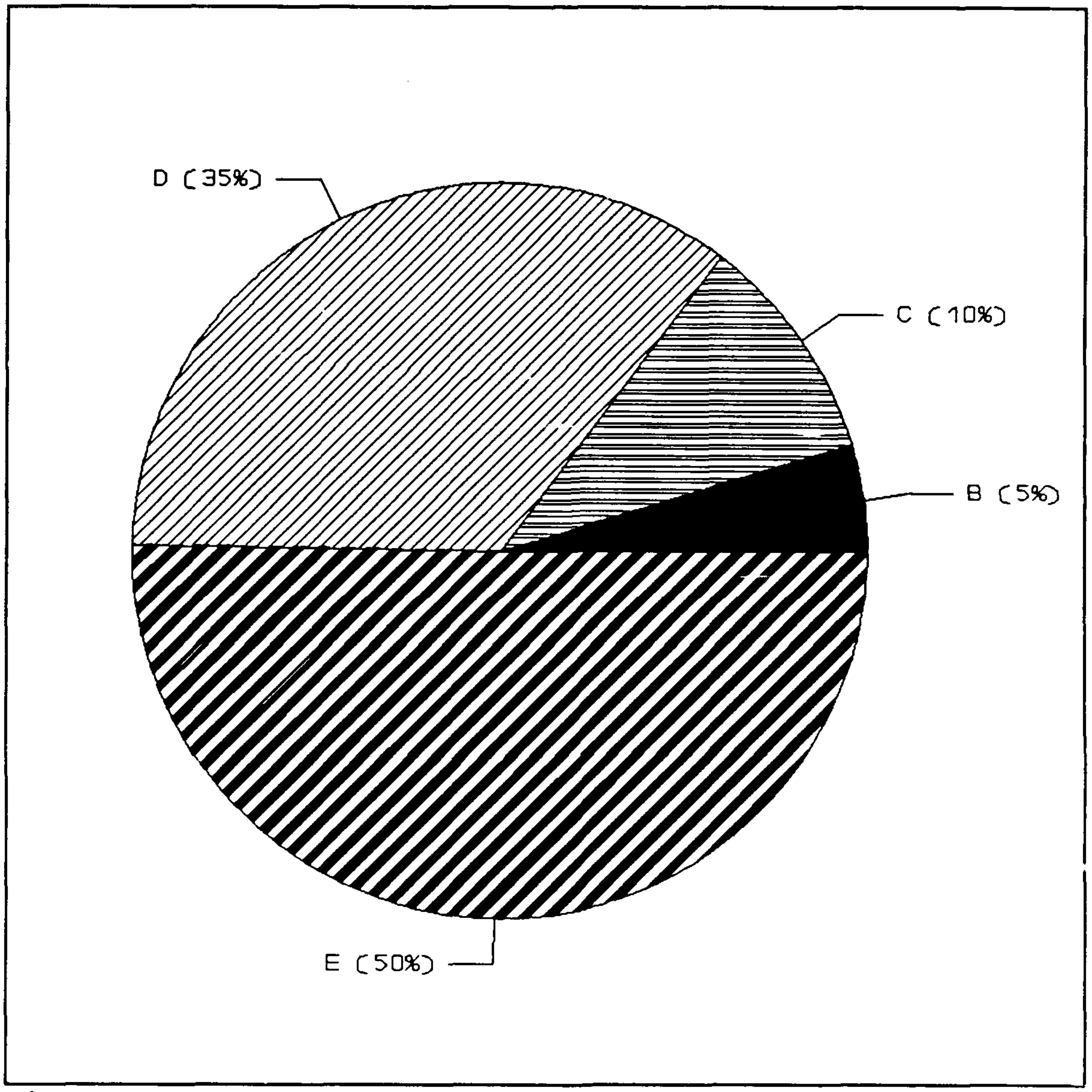

Figure D4: RESPONSE TO QUESTION 2, POPULATION CATEGORY I-M

2. How familiar are you with the PAVER pavement management system?

A(0/0%). I have never heard of PAVER.
B(1/5%). I have heard of PAVER but am not familiar with it.
C(2/10%). I understand the basic components of PAVER.
D(7/35%). I am able to use my understanding of PAVER to ensure that proper data are input into the system.
E(10/50%). I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.

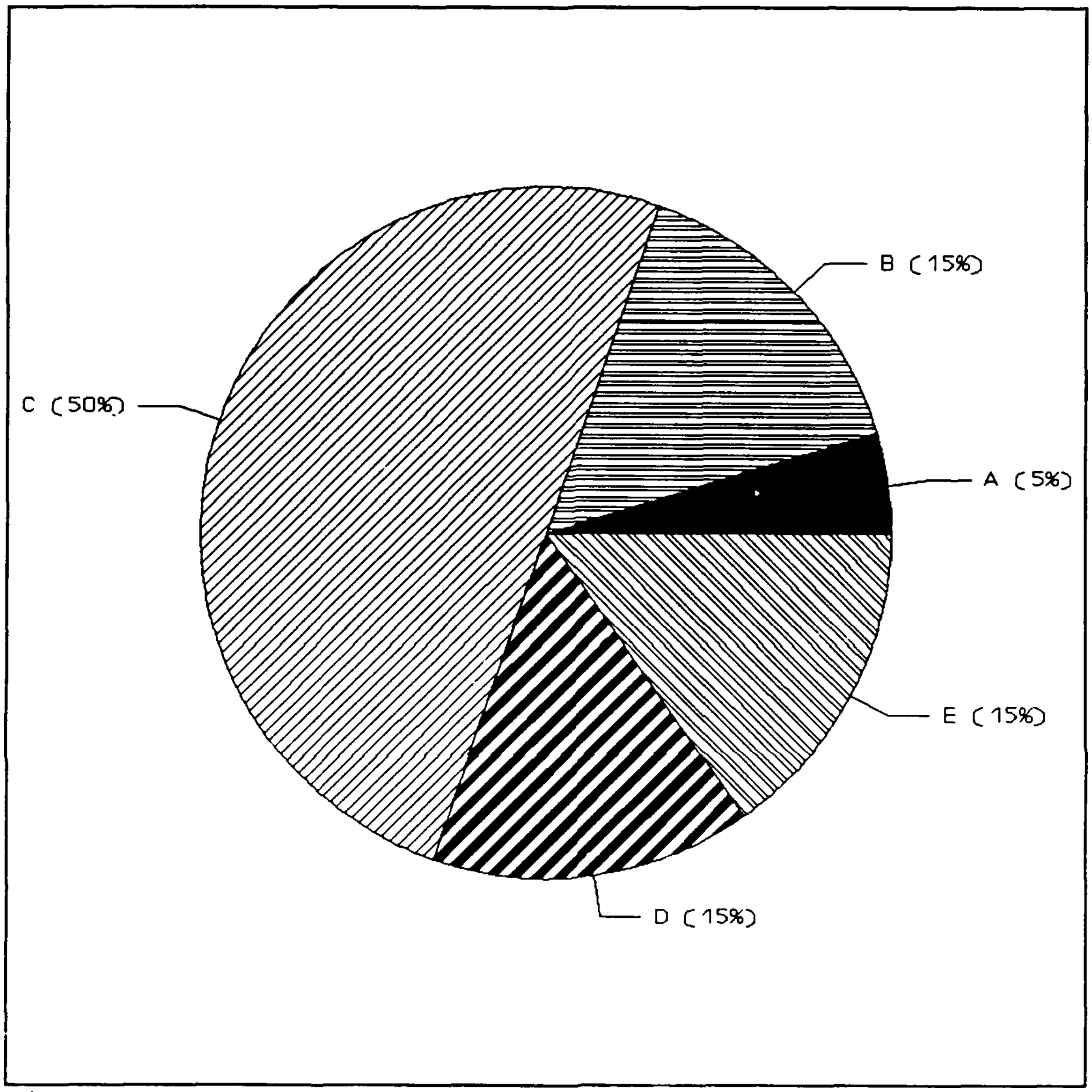

Figure D5: RESPONSE TO QUESTION 2, POPULATION CATEGORY NI

2. How familiar are you with the PAVER pavement management system?

A(1/5%). I have never heard of PAVER.
B(3/15%). I have heard of PAVER but am not familiar with it.
C(10/50%). I understand the basic components of PAVER.
D(3/15%). I am able to use my understanding of PAVER to ensure that proper data are input into the system.
E(3/15%). I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.

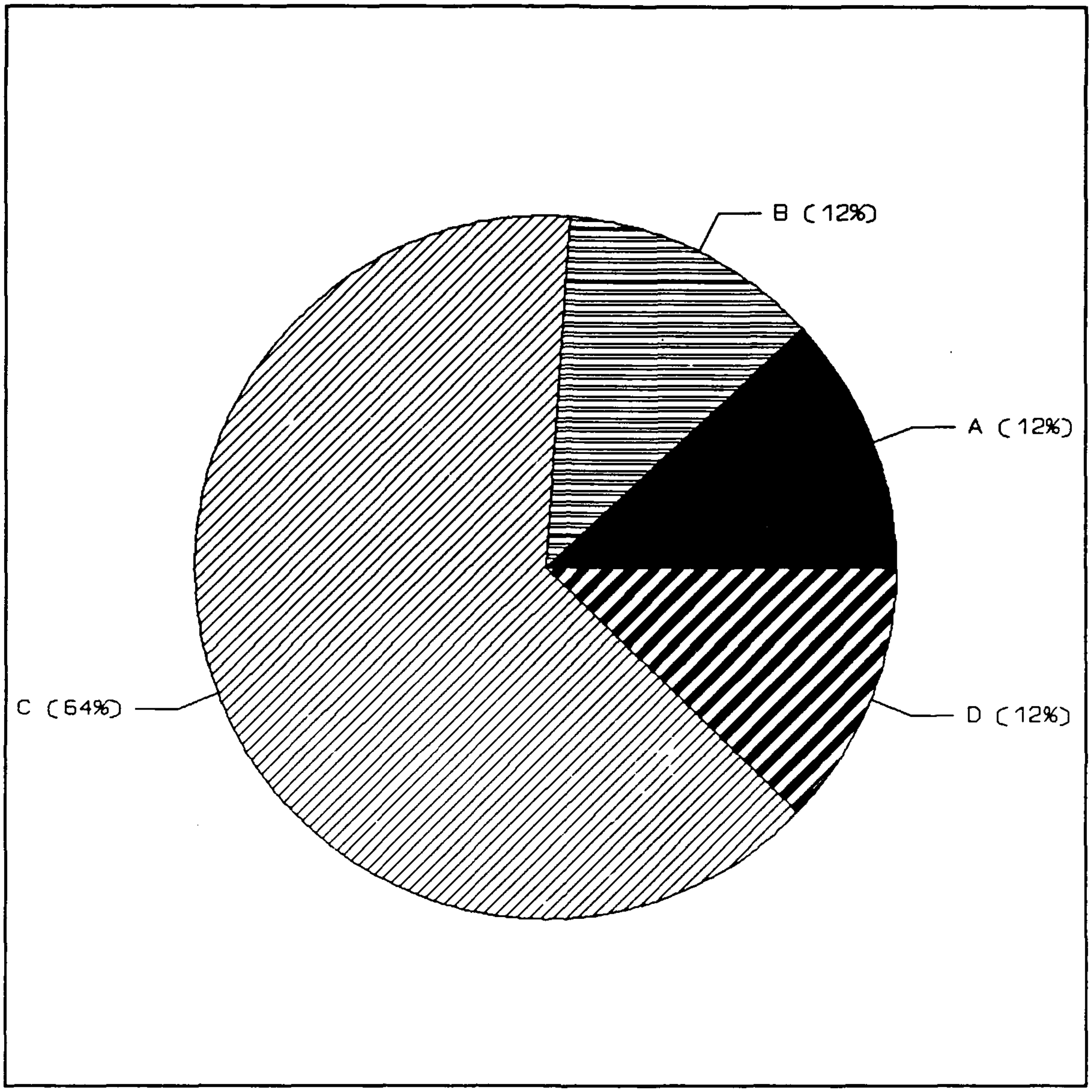

Figure D6: RESPONSE TO QUESTION 3, POPULATION CATEGORY I-MA

3. Have you implemented PAVER for your runway(s)?

A(1/12.5%). No, and we have no plans to in the future (next 1-2 years).
B(1/12.5%). No, but we plan to in the future (next 1-2 years).
C(5/62.5%). Yes, some.
D(1/12.5%). Yes, all.

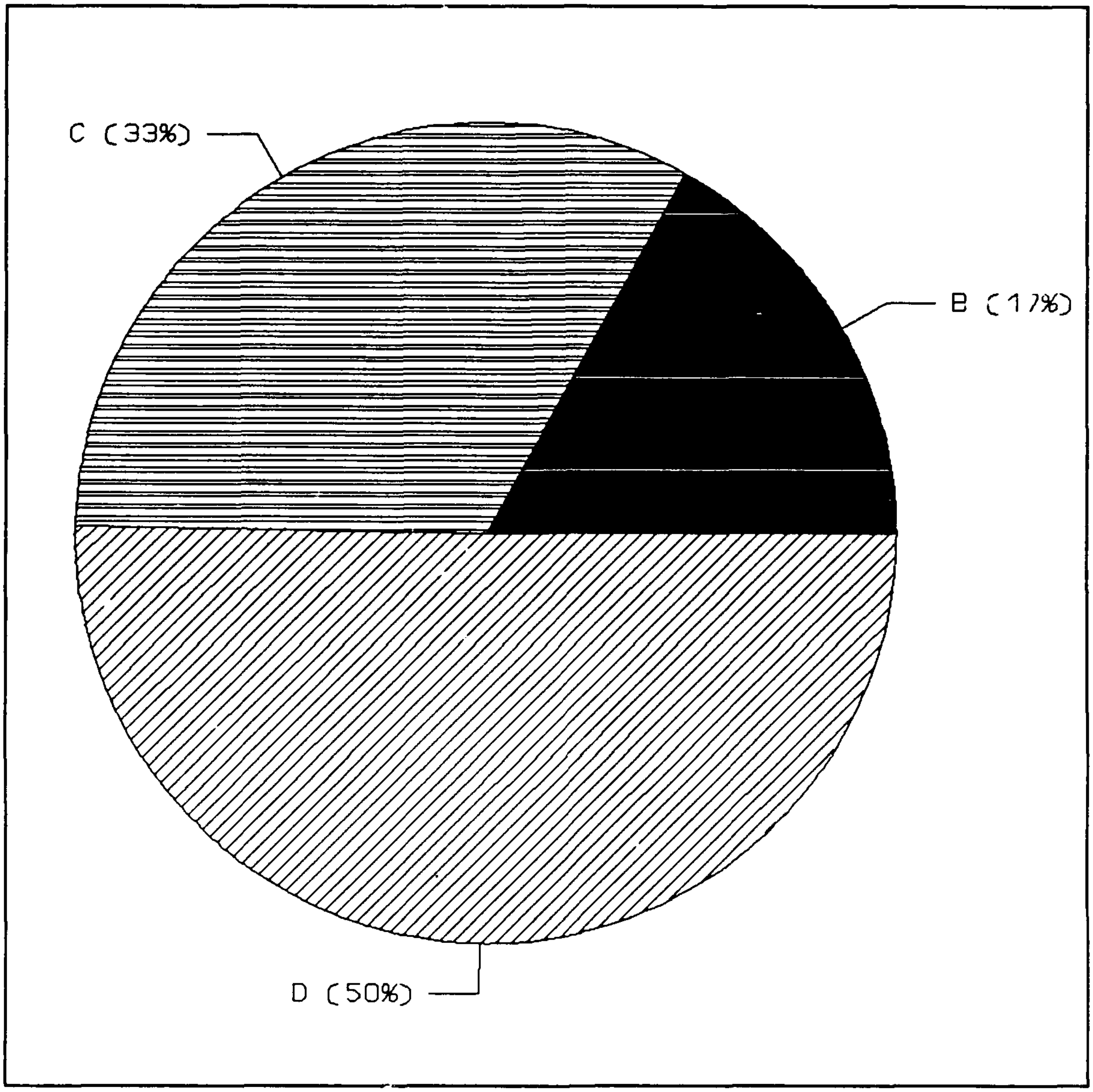

Figure D7: RESPONSE TO QUESTION 3, POPULATION CATEGORY I-MF

3. Have you implemented PAVER for your runway(s)?

A(0/0%). No, and we have no plans to in the future (next 1-2 years).
B(1/16.7%). No, but we plan to in the future (next 1-2 years).
C(2/33.3%). Yes, some.
D(3/50%). Yes, all.

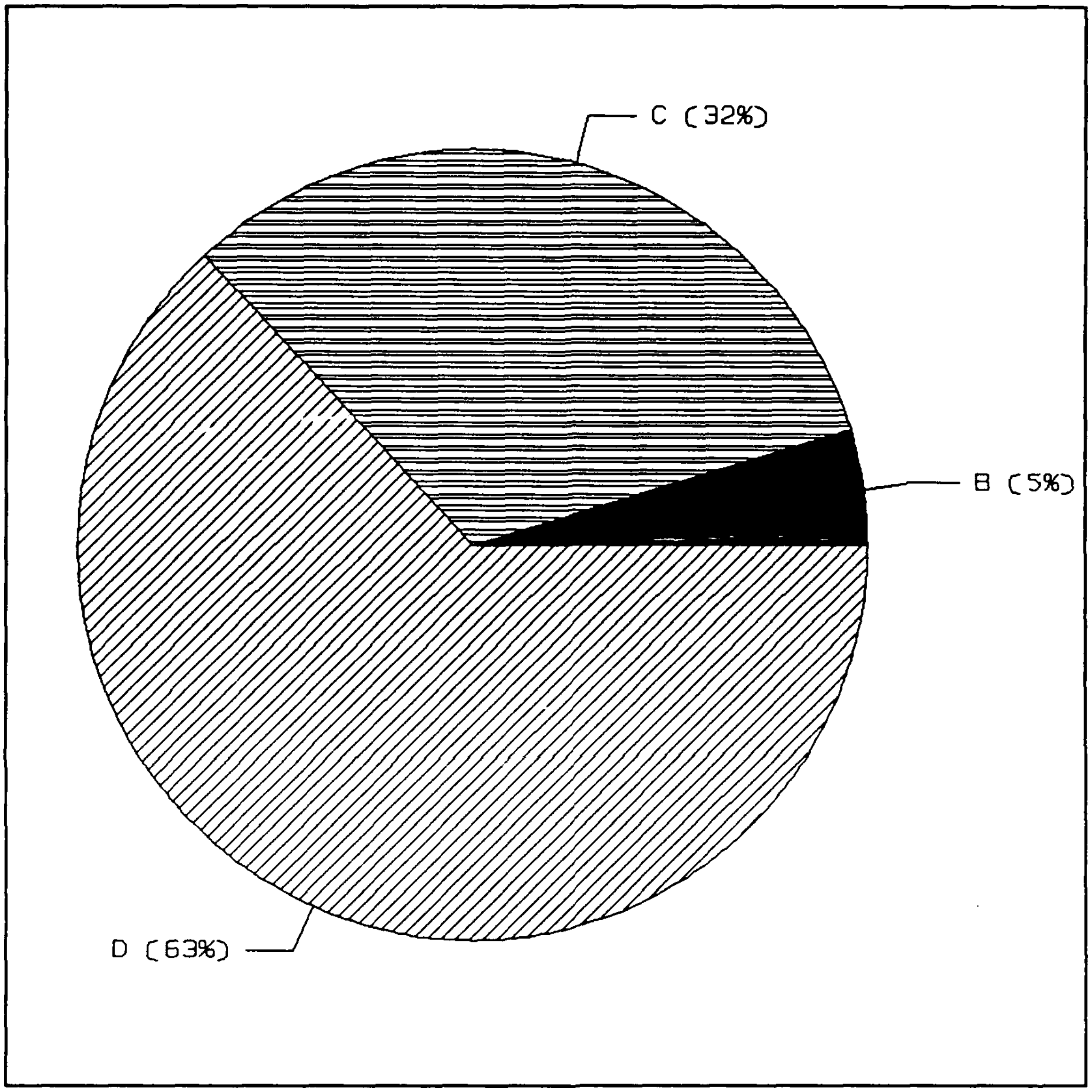

Figure D8: RESPONSE TO QUESTION 3, POPULATION CATEGORY I-M

3. Have you implemented PAVER for your runway(s)?

A(0/0%). No, and we have no plans to in the future (next 1-2 years).
B(1/5.3%). No, but we plan to in the future (next 1-2 years).
C(6/31.6%). Yes, some.
D(12/63.2%). Yes, all.

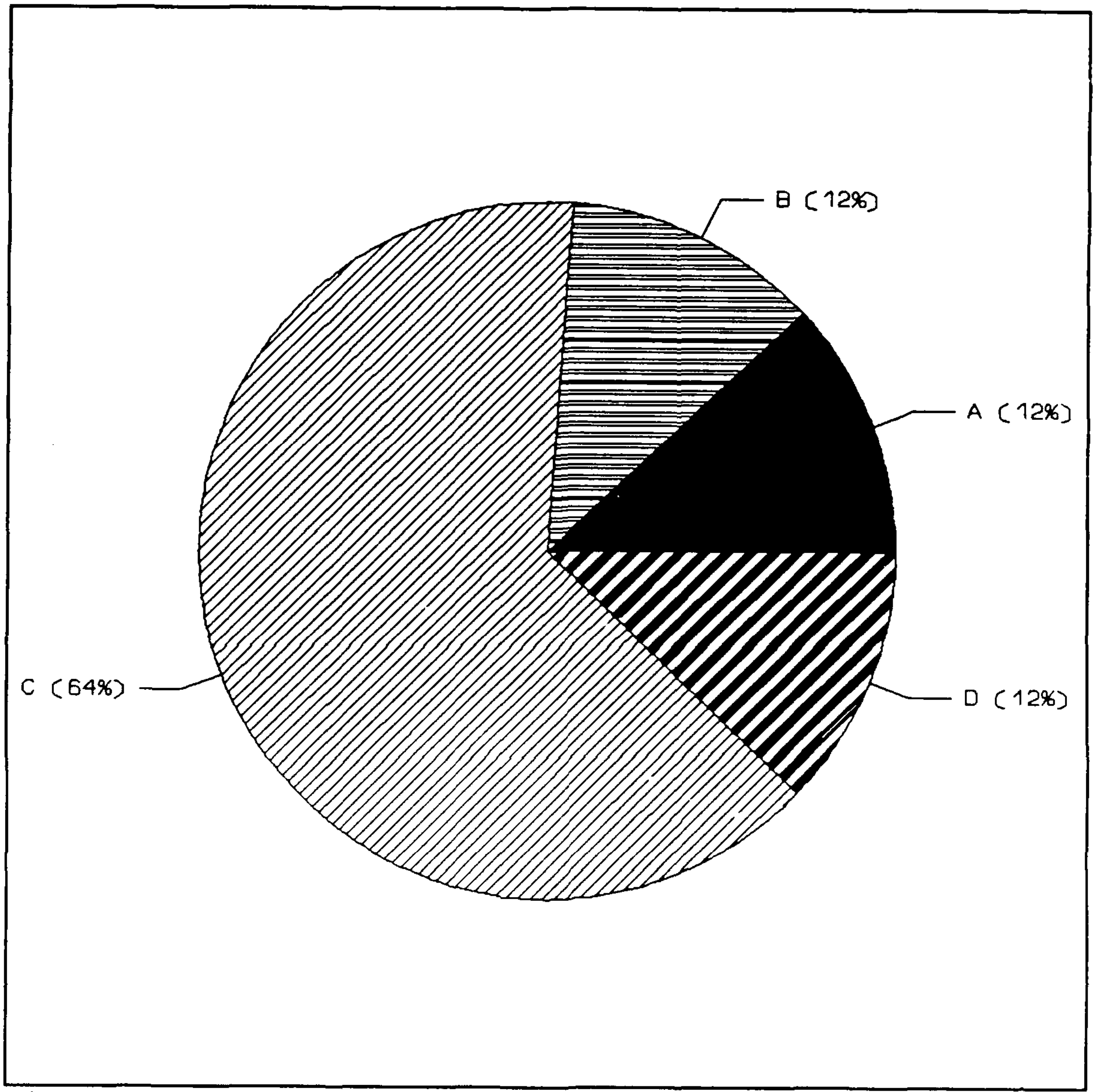

Figure D9: RESPONSE TO QUESTION 4, POPULATION CATEGORY I-MA

4. Have you implemented PAVER for your taxiways?

A(1/12.5%). No, and we have no plans to in the future (next 1-2 years).
B(1/12.5%). No, but we plan to in the future (next 1-2 years).
C(5/62.5%). Yes, some.
D(1/12.5%). Yes, all.

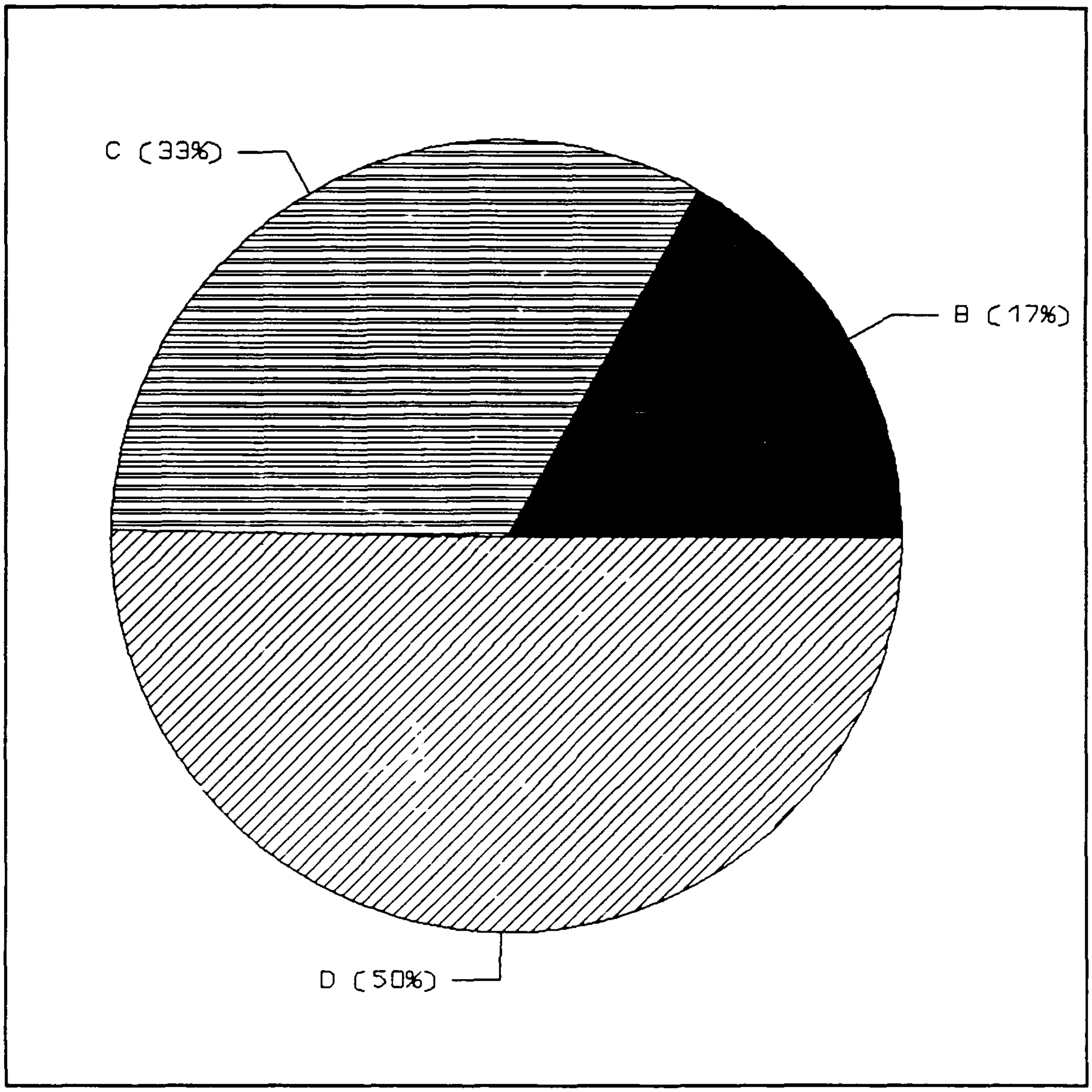

Figure D10: RESPONSE TO QUESTION 4, POPULATION CATEGORY I-MF

4. Have you implemented PAVER for your taxiways?

A(0/0%). No, and we have no plans to in the future (next 1-2 years).
B(1/16.7%). No, but we plan to in the future (next 1-2 years).
C(2/33.3%). Yes, some.
D(3/50%). Yes, all.

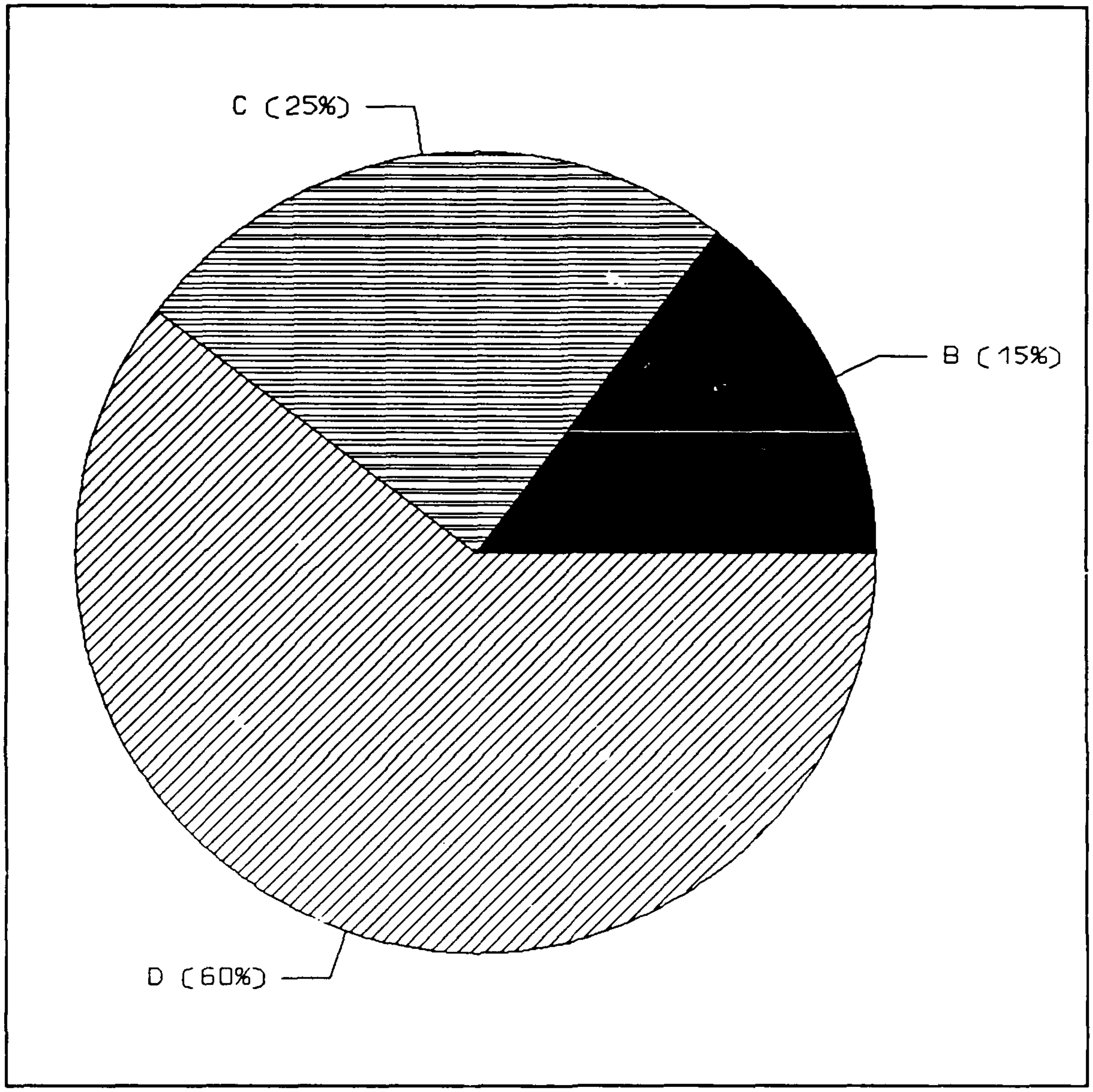

Figure D11: RESPONSE TO QUESTION 4, POPULATION CATEGORY I-M

4. Have you implemented PAVER for your taxiways?

A(0/0%). No, and we have no plans to in the future (next 1-2 years).
B(3/15%). No, but we plan to in the future (next 1-2 years).
C(5/25%). Yes, some.
D(12/60%). Yes, all.

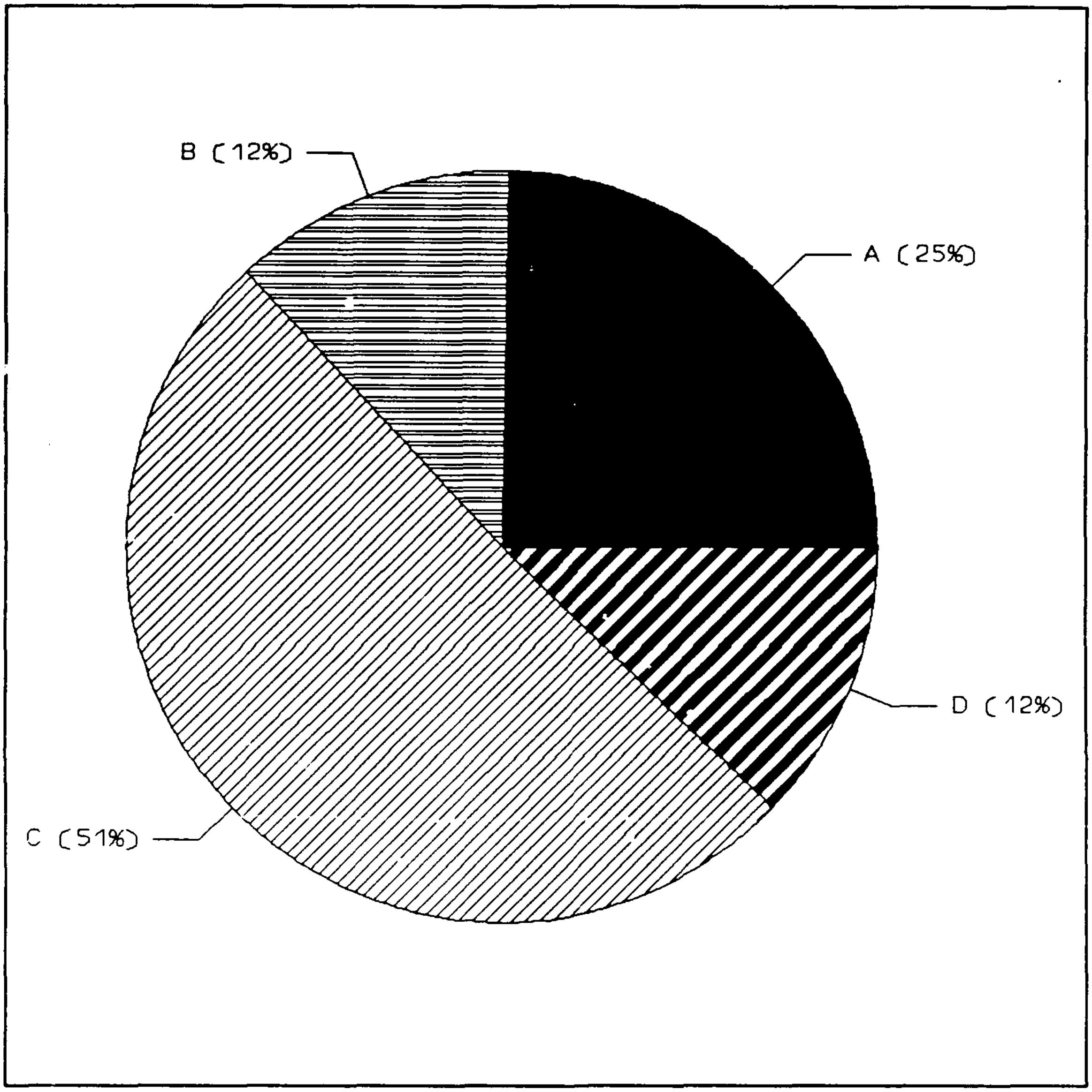

Figure D12: RESPONSE TO QUESTION 5, POPULATION CATEGORY I-MA

5. Have you implemented PAVER for your cargo aprons?

A(2/25%). No, and we have no plans to in the future (next 1-2 years).
B(1/12.5%). No, but we plan to in the future (next 1-2 years).
C(4/50%). Yes, some.
D(1/12.5%). Yes, all.

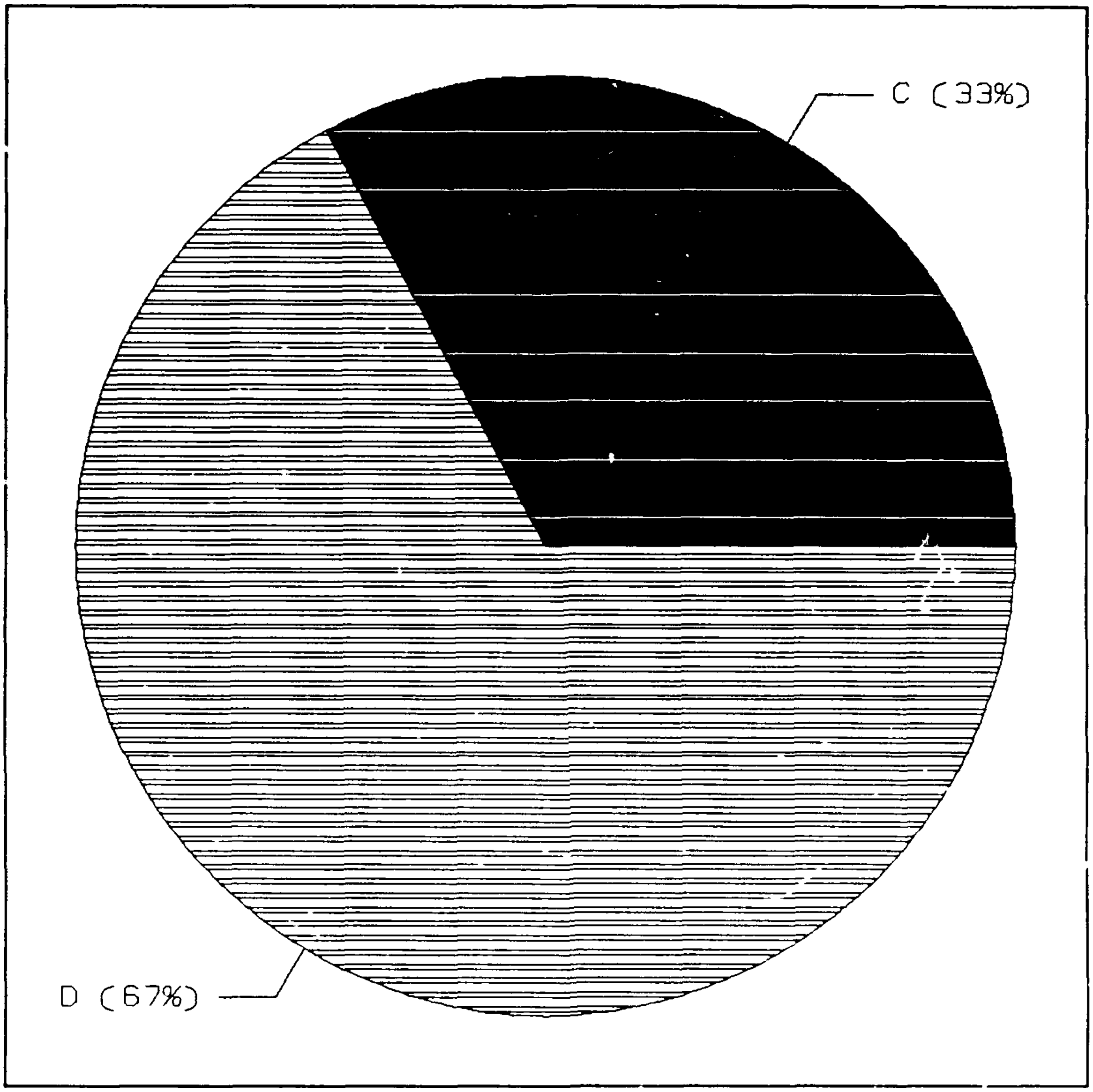

Figure D13: RESPONSE TO QUESTION 5, POPULATION CATEGORY I-MF

5. Have you implemented PAVER for your cargo aprons?

A(0/0%). No, and we have no plans to in the future (next 1-2 years).
B(0/0%). No, but we plan to in the future (next 1-2 years).
C(2/33.3%). Yes, some.
D(4/66.7%). Yes, all.

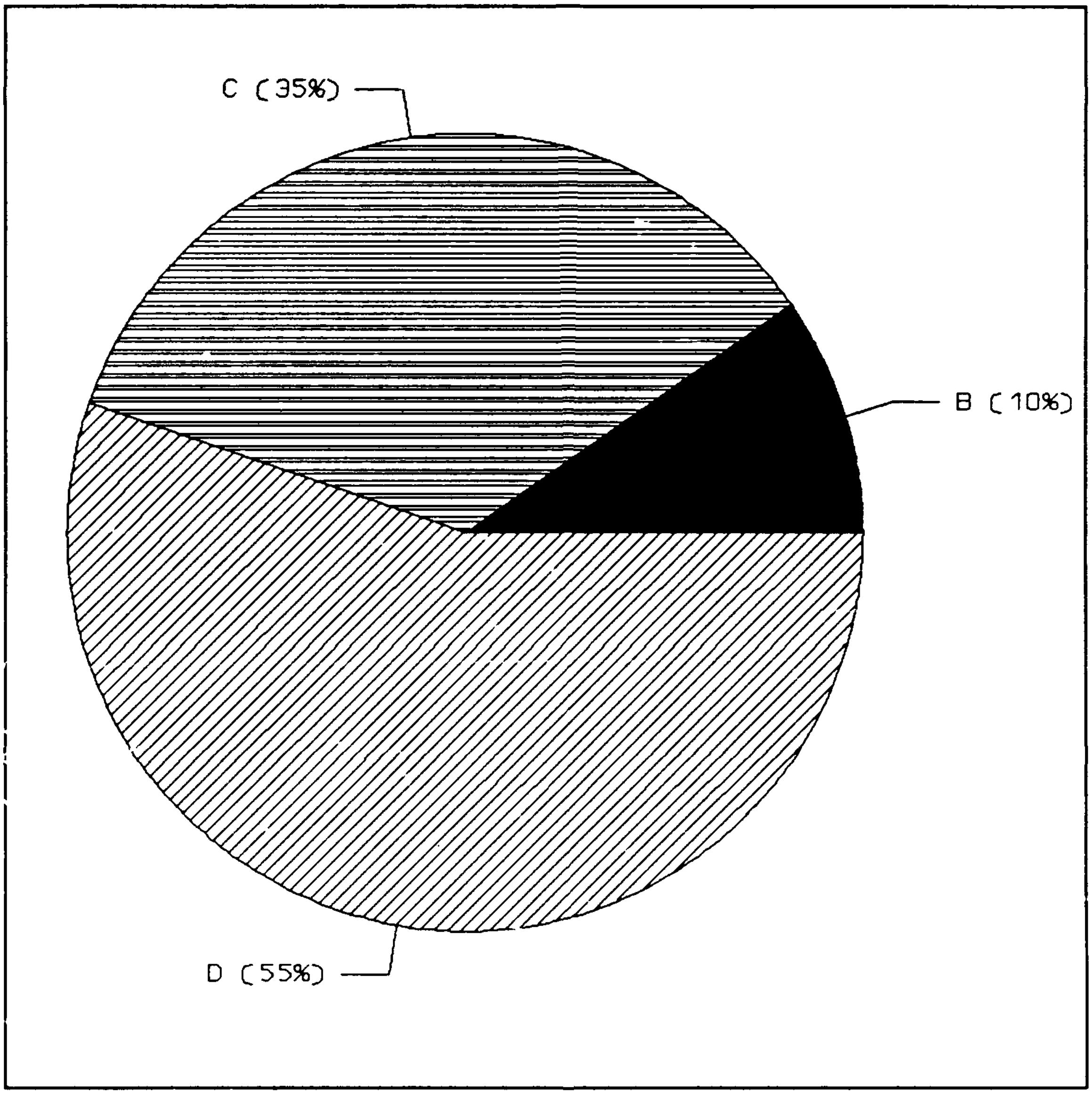

Figure D14: RESPONSE TO QUESTION 5, POPULATION CATEGORY I-M

5. Have you implemented PAVER for your cargo aprons?

A(0/0%). No, and we have no plans to in the future (next 1-2 years).
B(2/10%). No, but we plan to in the future (next 1-2 years).
C(7/35%). Yes, some.
D(11/55%). Yes, all.

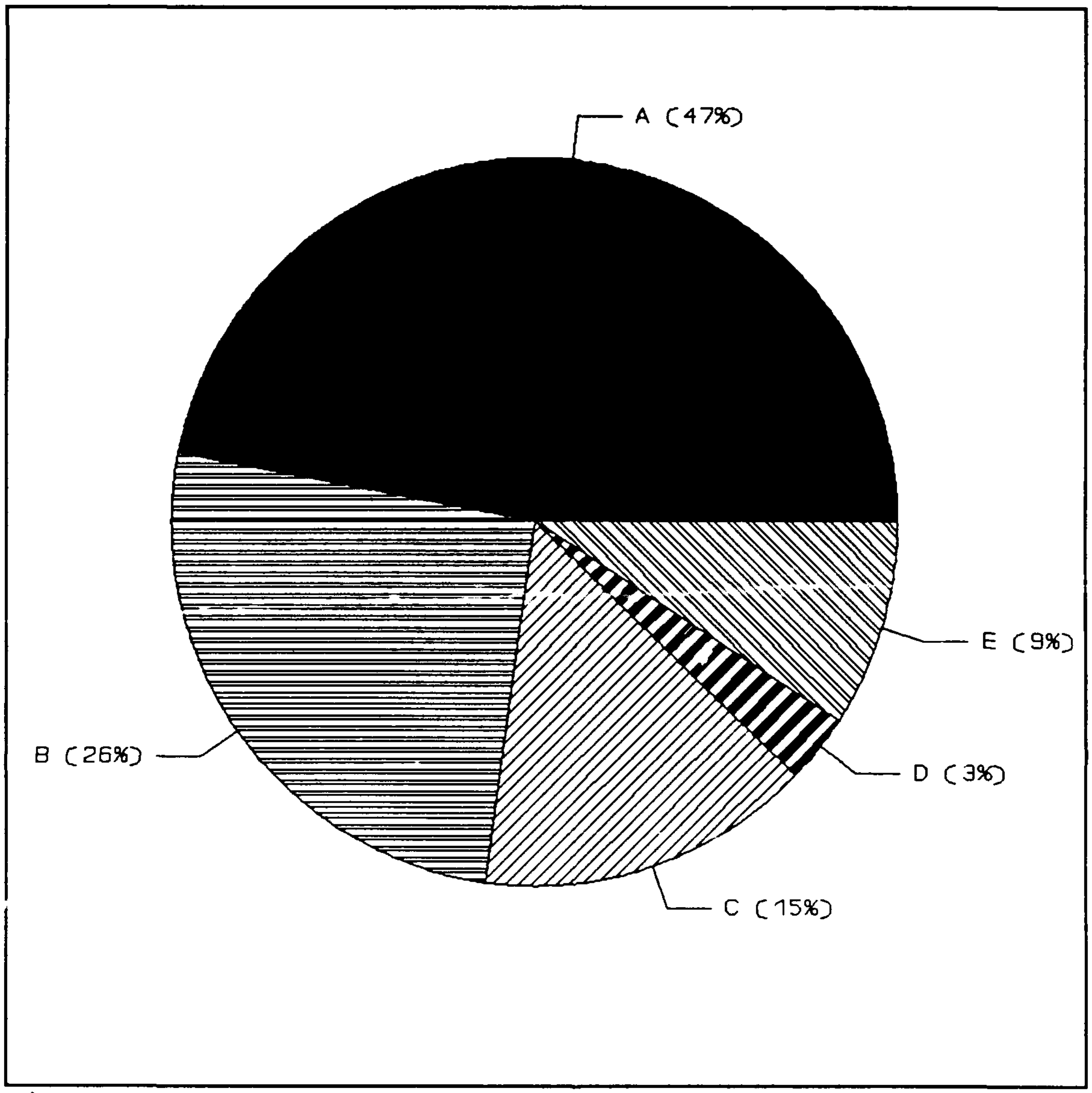

Figure D15: RESPONSE TO QUESTION 6, POPULATION CATEGORY I

6. Have you implemented PAVER for your roads/streets?

A(16/47.1%). No, and we have no plans to in the future (next 1-2 years).
B(9/26.5%). No, but we plan to in the future (next 1-2 years).
C(5/14.7%). Yes, a third or less.
D(1/2.9%). Yes, 1/3 to 2/3.
E(3/8.8%). Yes, 2/3 or more.

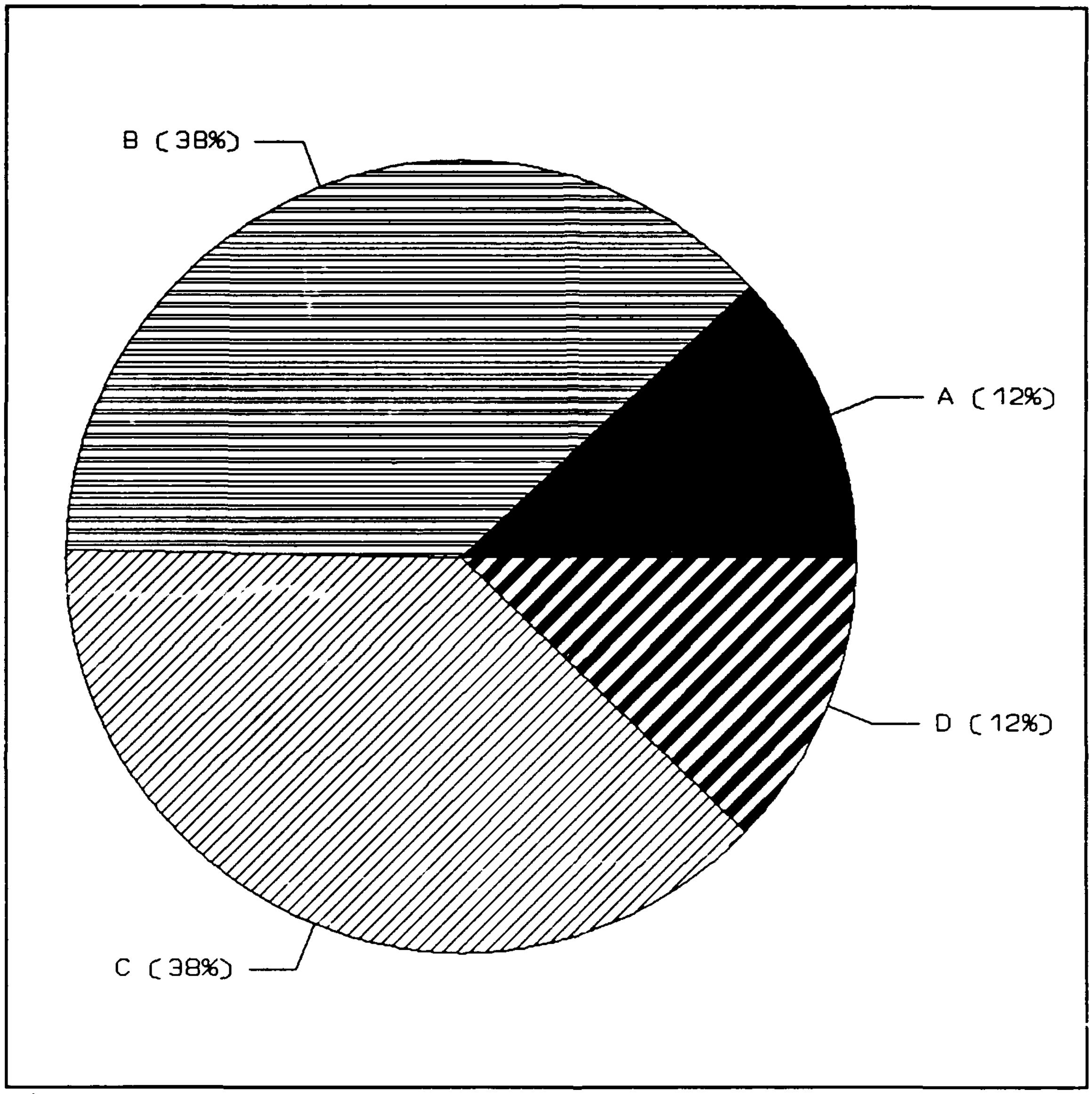

Figure D16: RESPONSE TO QUESTION 7, POPULATION CATEGORY I-MA

7. How accurate is the pavement distress data that is entered into your PAVER system?

A(1/12.5%). Very little (less than 35%) of the data is accurate.
B(3/37.5%). Some (35 - 65%) of the data is accurate.
C(3/37.5%). Most (65 - 90%) of the data is accurate.
D(1/12.5%). Almost all (90 - 100%) of the data is accurate.

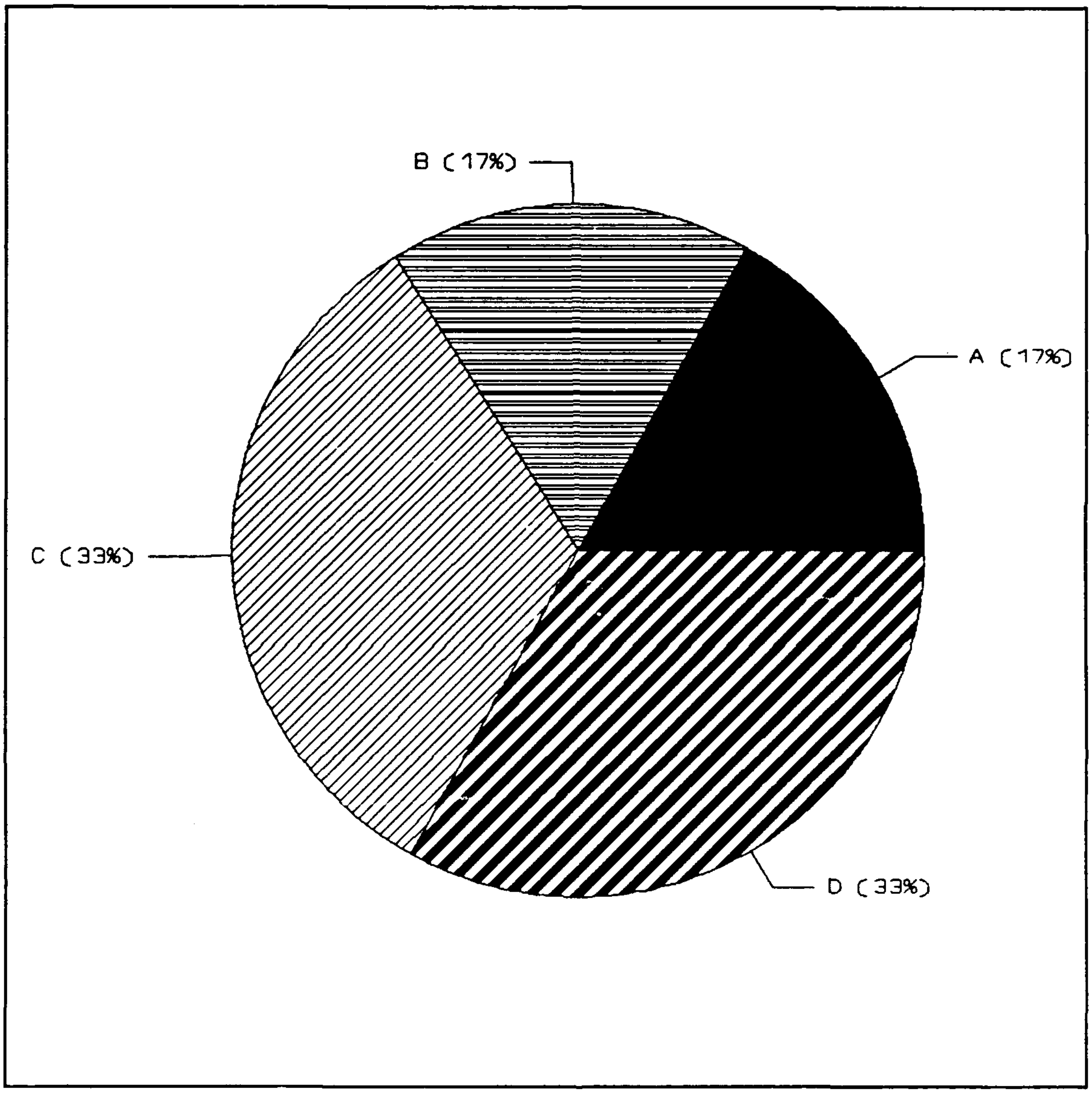

Figure D17: RESPONSE TO QUESTION 7, POPULATION CATEGORY I-MF

7. How accurate is the pavement distress data that is entered into your PAVER system?

A(1/16.7%). Very little (less than 35%) of the data is accurate.
B(1/16.7%). Some (35 - 65%) of the data is accurate.
C(2/33.3%). Most (65 - 90%) of the data is accurate.
D(2/33.3%). Almost all (90 - 100%) of the data is accurate.

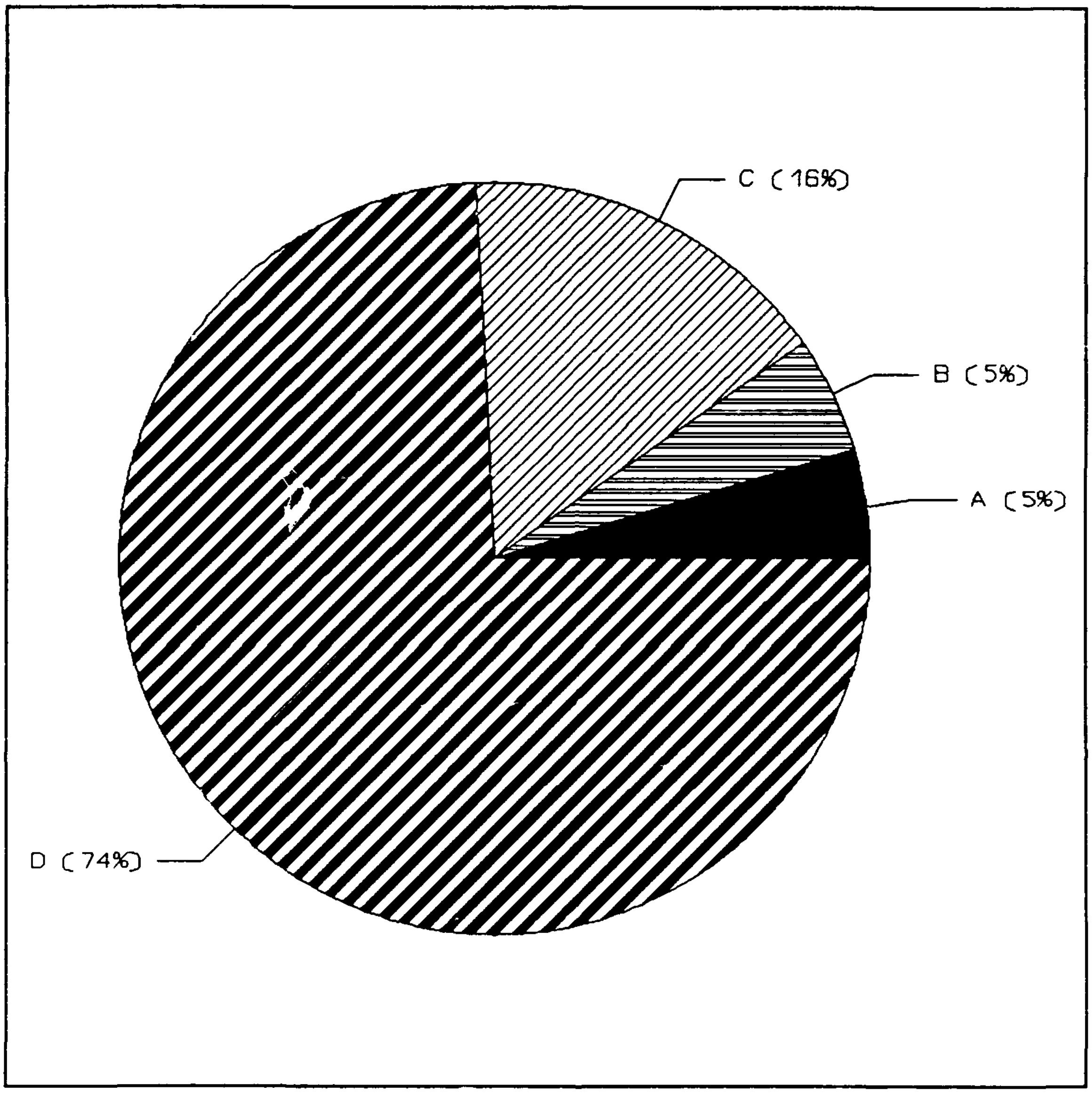

Figure D18: RESPONSE TO QUESTION 7, POPULATION CATEGORY I-M

7. How accurate is the pavement distress data that is entered into your PAVER system?

A(1/5.3%). Very little (less than 35%) of the data is accurate.
B(1/5.3%). Some (35 - 65%) of the data is accurate.
C(3/15.8%). Most (65 - 90%) of the data is accurate.
D(14/73.7%). Almost all (90 - 100%) of the data is accurate.

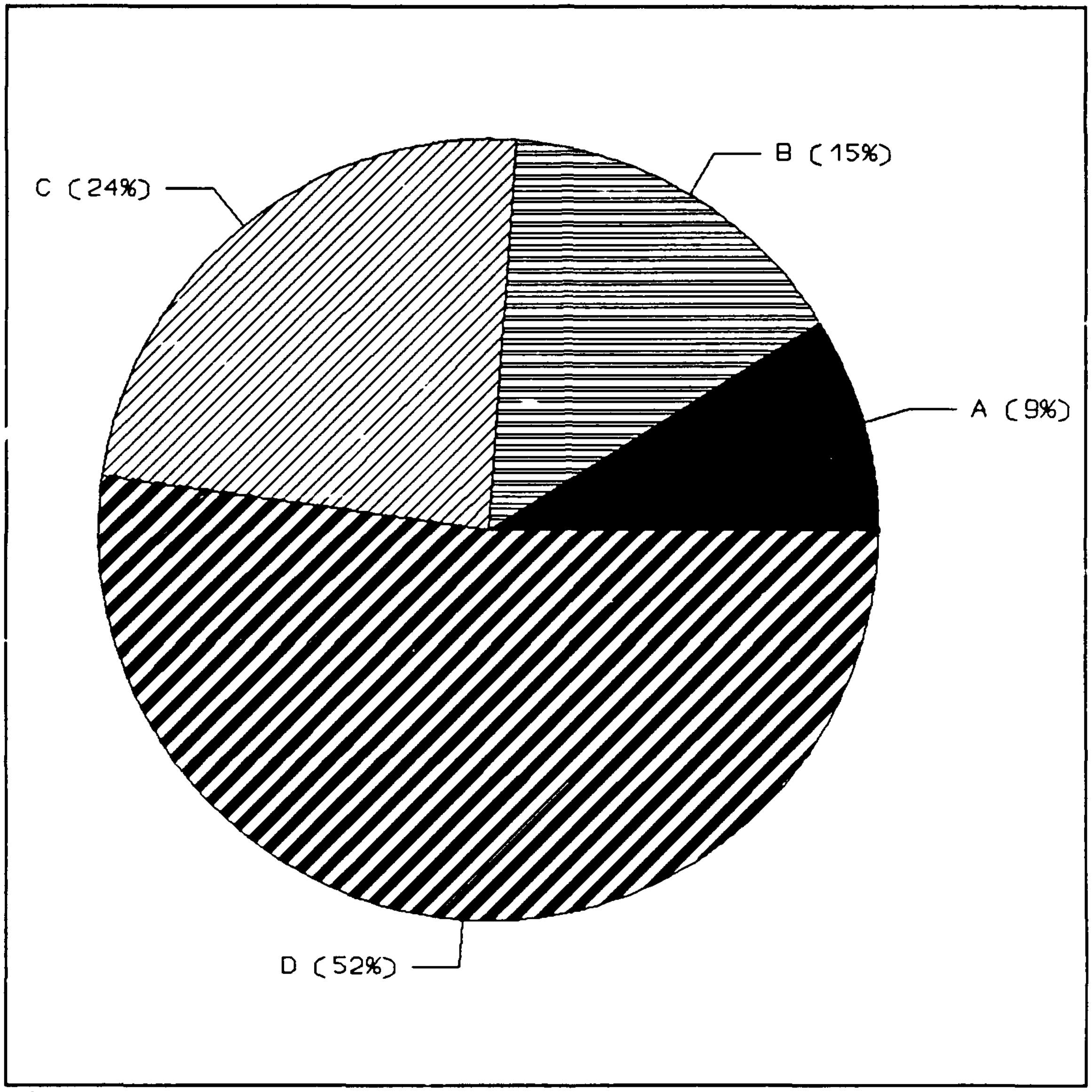

Figure D19: RESPONSE TO QUESTION 8, POPULATION CATEGORY I

8. How accurate is the inventory data that is entered into your PAVER system (including surface type, pavement structure, traffic, etc.)

A(3/9.1%). Very little (less than 35%) of the data is accurate.
B(5/15.2%). Some (35 - 65%) of the data is accurate.
C(8/24.2%). Most (65 - 90%) of the data is accurate.
D(17/51.5%). Almost all (90 - 100%) of the data is accurate.

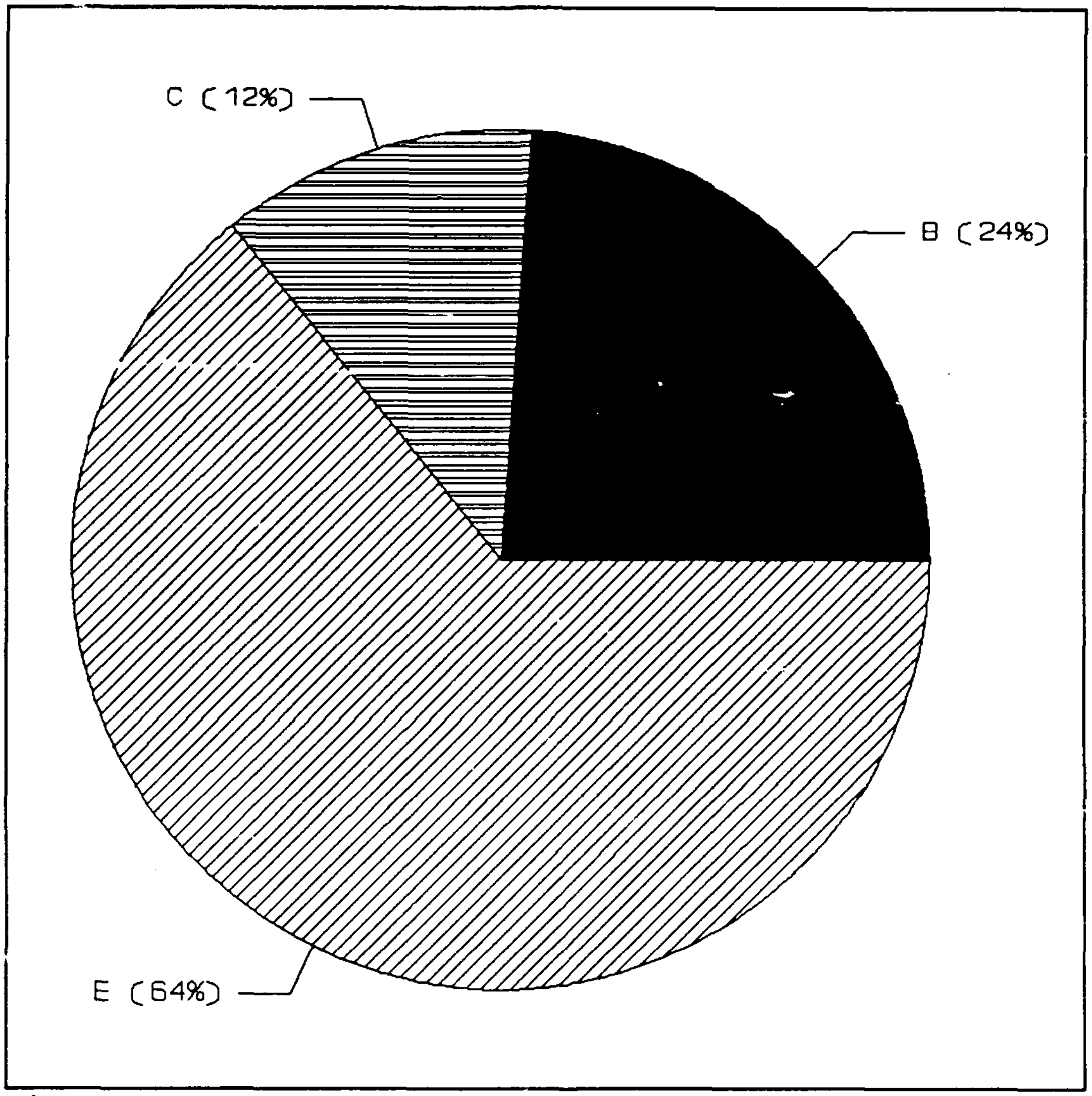

Figure D20: RESPONSE TO QUESTION 9, POPULATION CATEGORY I

9. Which of the following statements best describes the active use of PAVER in programming pavements projects?

Pavements projects are programmed:

A(0/0%). Entirely through the application of PAVER.
B(8/24.2%). Entirely through the application engineering judgement.
C(4/12.1%). Entirely through the application of command priorities.
D(0/0%). Through the combined application of PAVER and engineering judgement.
E(21/63.6%). Through the combined application PAVER, engineering judgement, and command priorities.

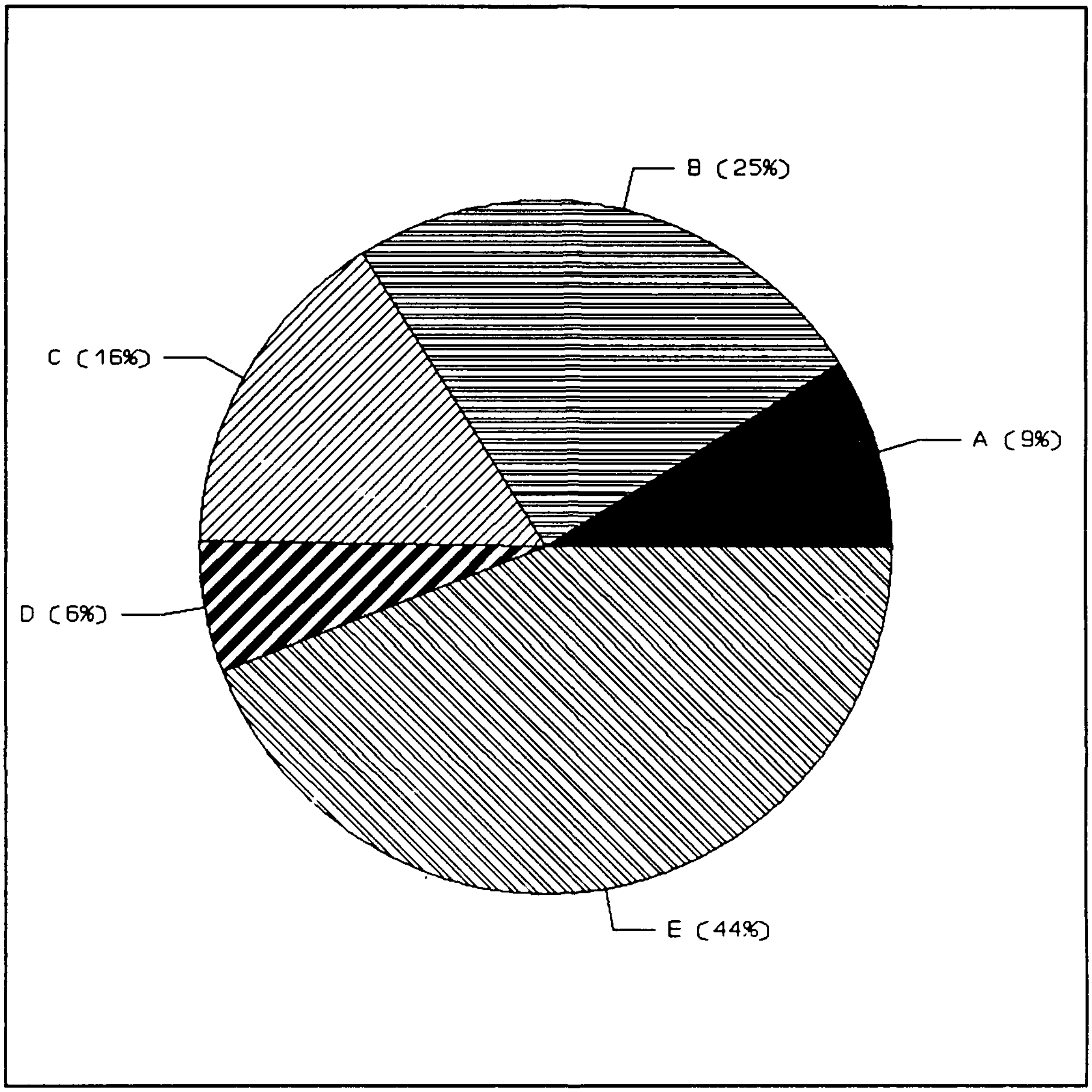

Figure D21: RESPONSE TO QUESTION 10, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

10. HQ/AFESC:

A(3/9.4%).	Excellent	C(5/15.6%).	Fair
B(8/25%).	Good	D(2/6.3%).	Poor

E(14/43.8%). Not Used/Not Applicable

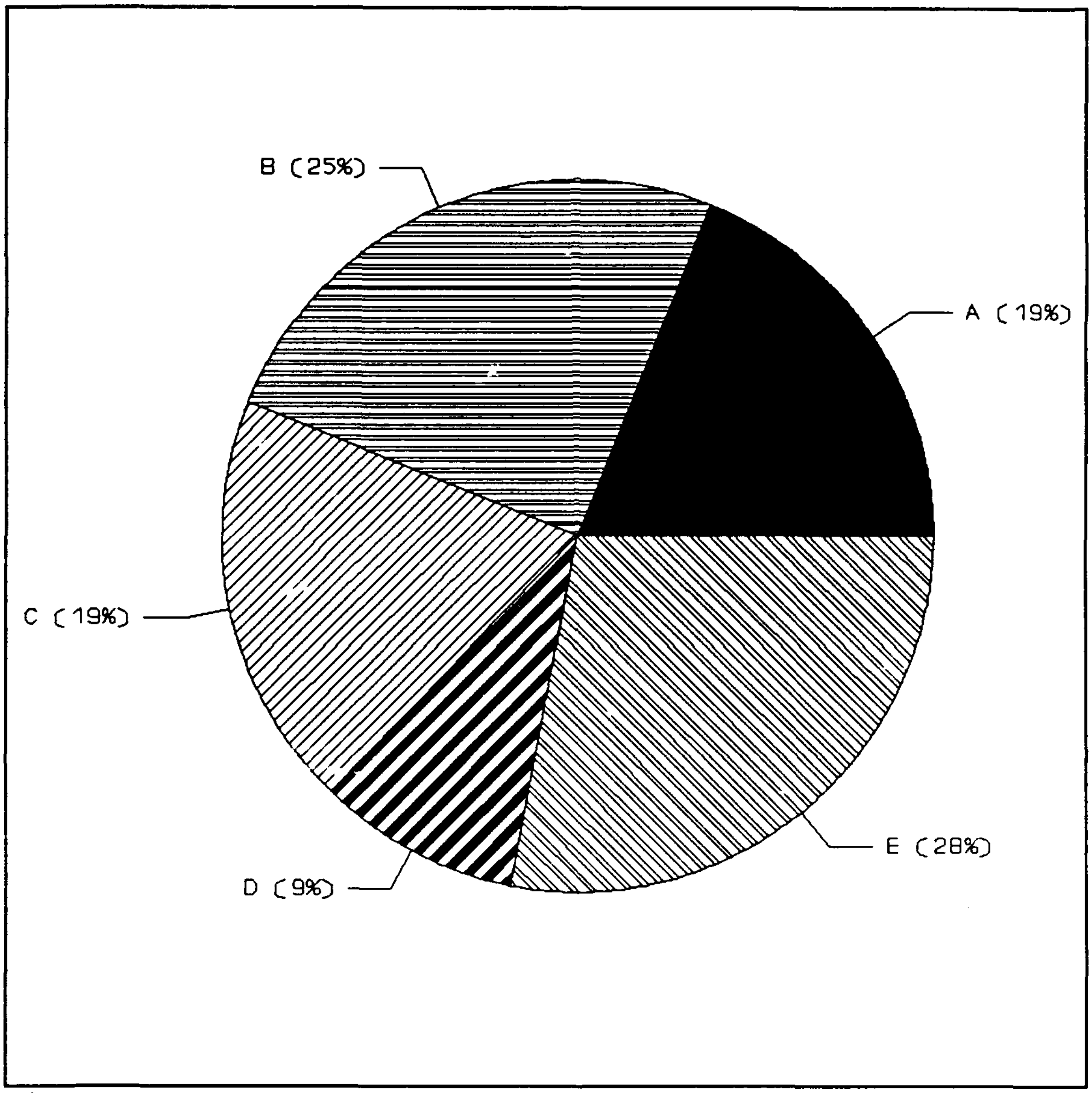

Figure D22: RESPONSE TO QUESTION 11, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

11. Your MAJCOM:

A(6/18.8%).	Excellent	C(6/18.8%).	Fair
B(8/25%).	Good	D(3/9.4%).	Poor

E(9/28.1%). Not Used/Not Applicable

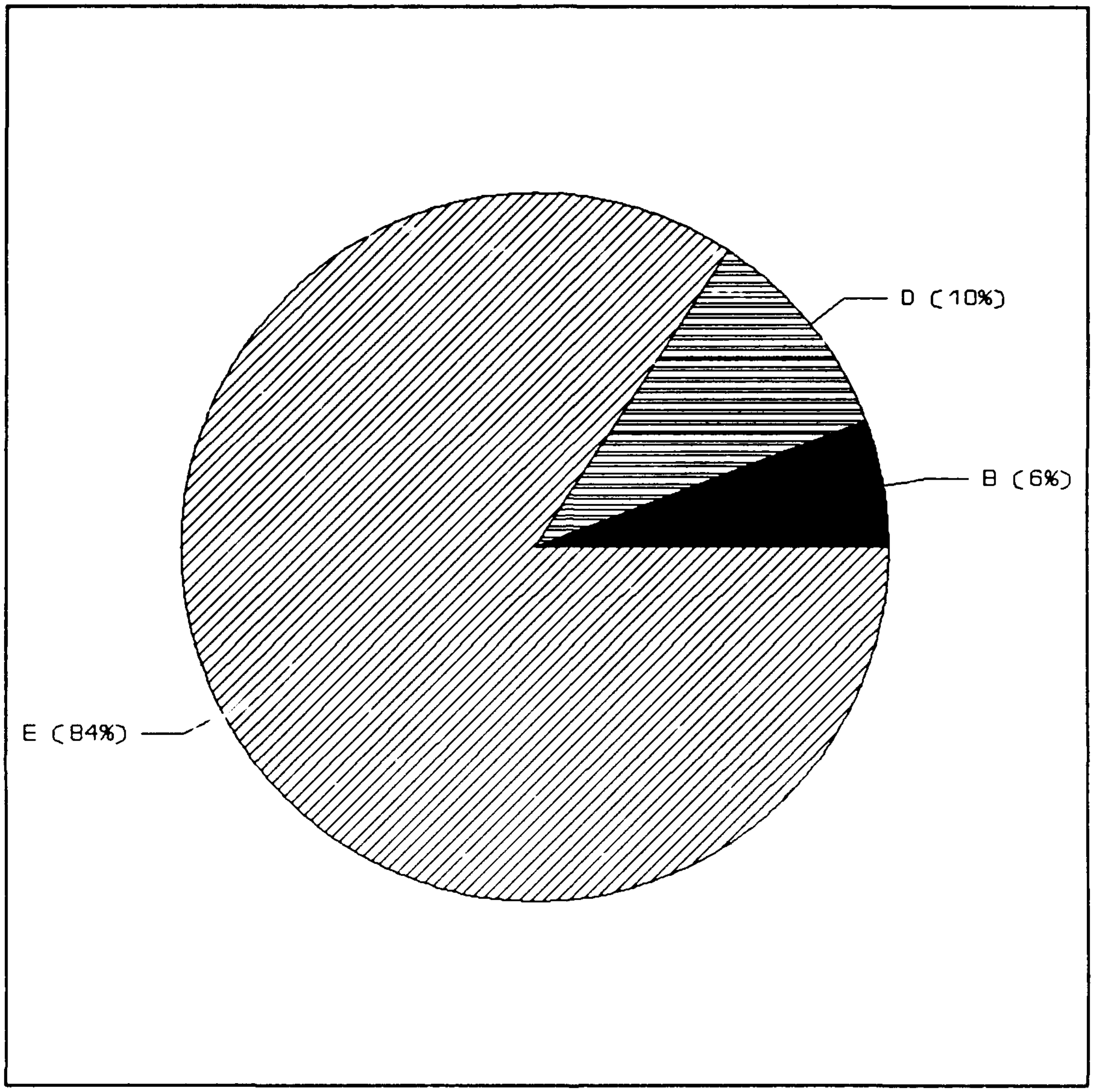

Figure D23: RESPONSE TO QUESTION 12, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

12. Other bases:

A(0/0%).	Excellent	C(0/0%).	Fair
B(2/6.3%).	Good	D(3/9.4%).	Poor

E(27/84.4%). Not Used/Not Applicable

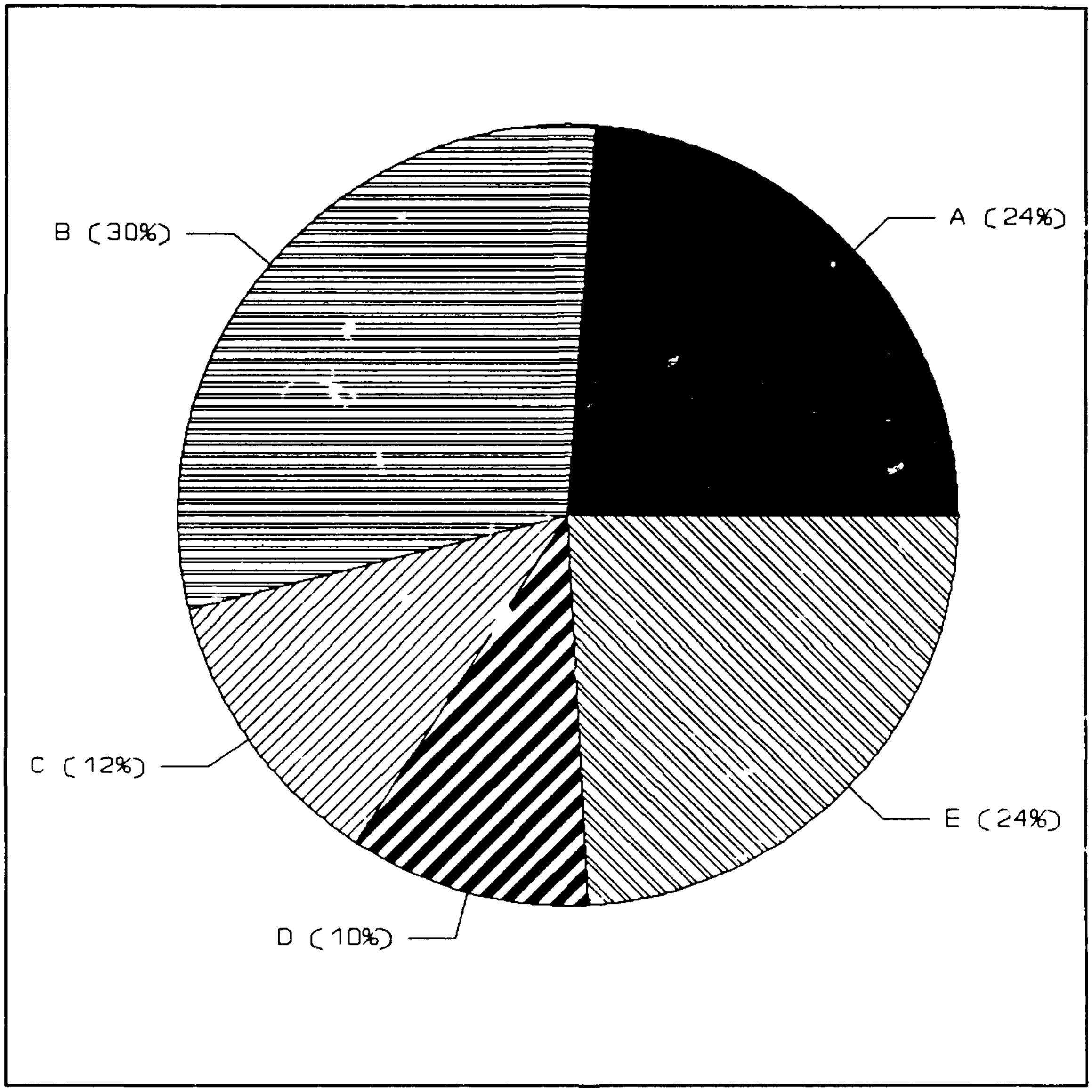

Figure D24: RESPONSE TO QUESTION 13, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

13. AFIT (Pavements Engineering short course):

A(8/24.2%).	Excellent	C(4/12.1%).	Fair
B(10/30.3%).	Good	D(3/9.9%).	Poor

E(8/24.2%). Not Used/Not Applicable

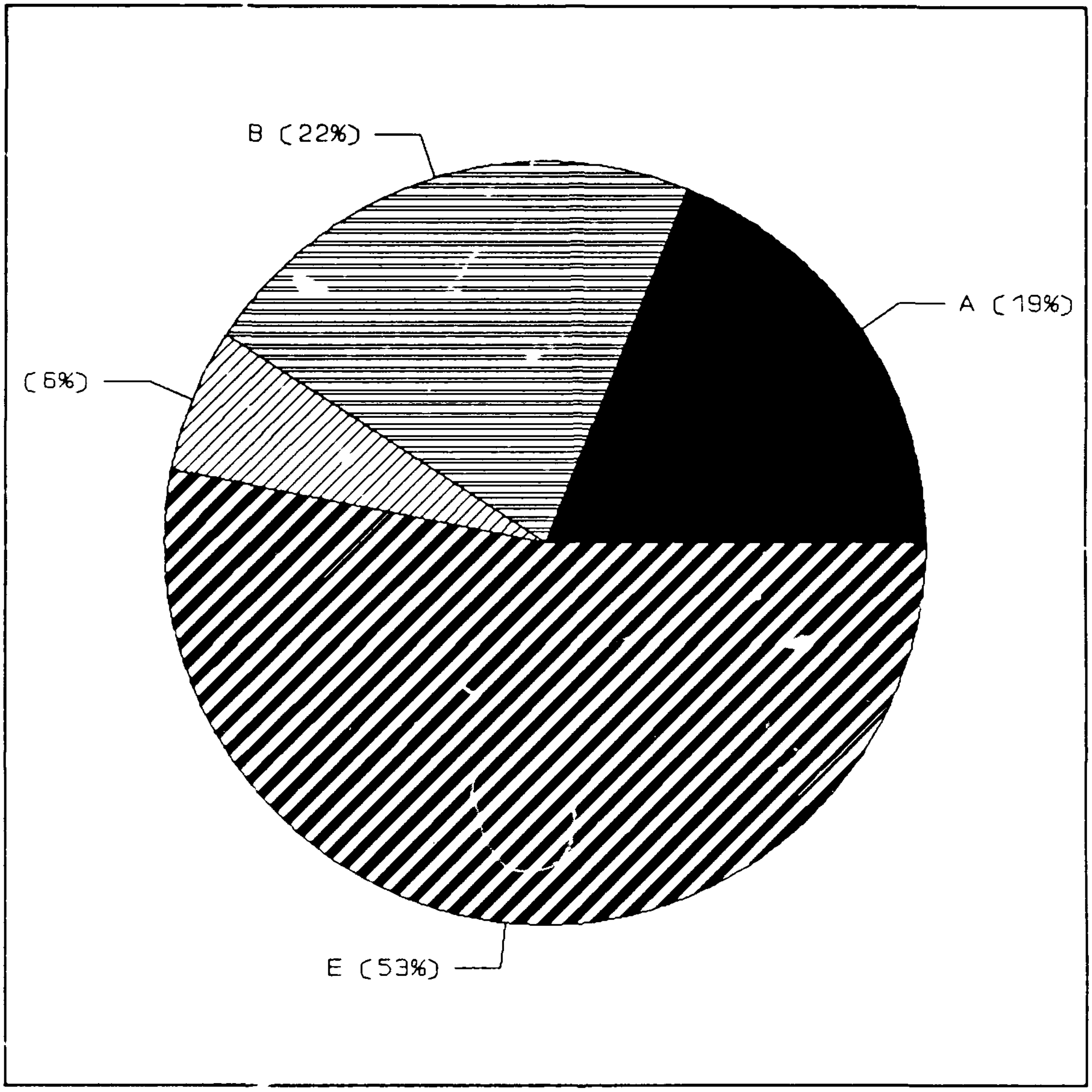

Figure D25: RESPONSE TO QUESTION 14, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

14. AFIT (PAVER short course):

A(6/18.8%). Excellent C(2/6.3%). Fair
B(7/21.9%). Good D(0/0%). Poor

E(17/53.1%). Not Used/Not Applicable

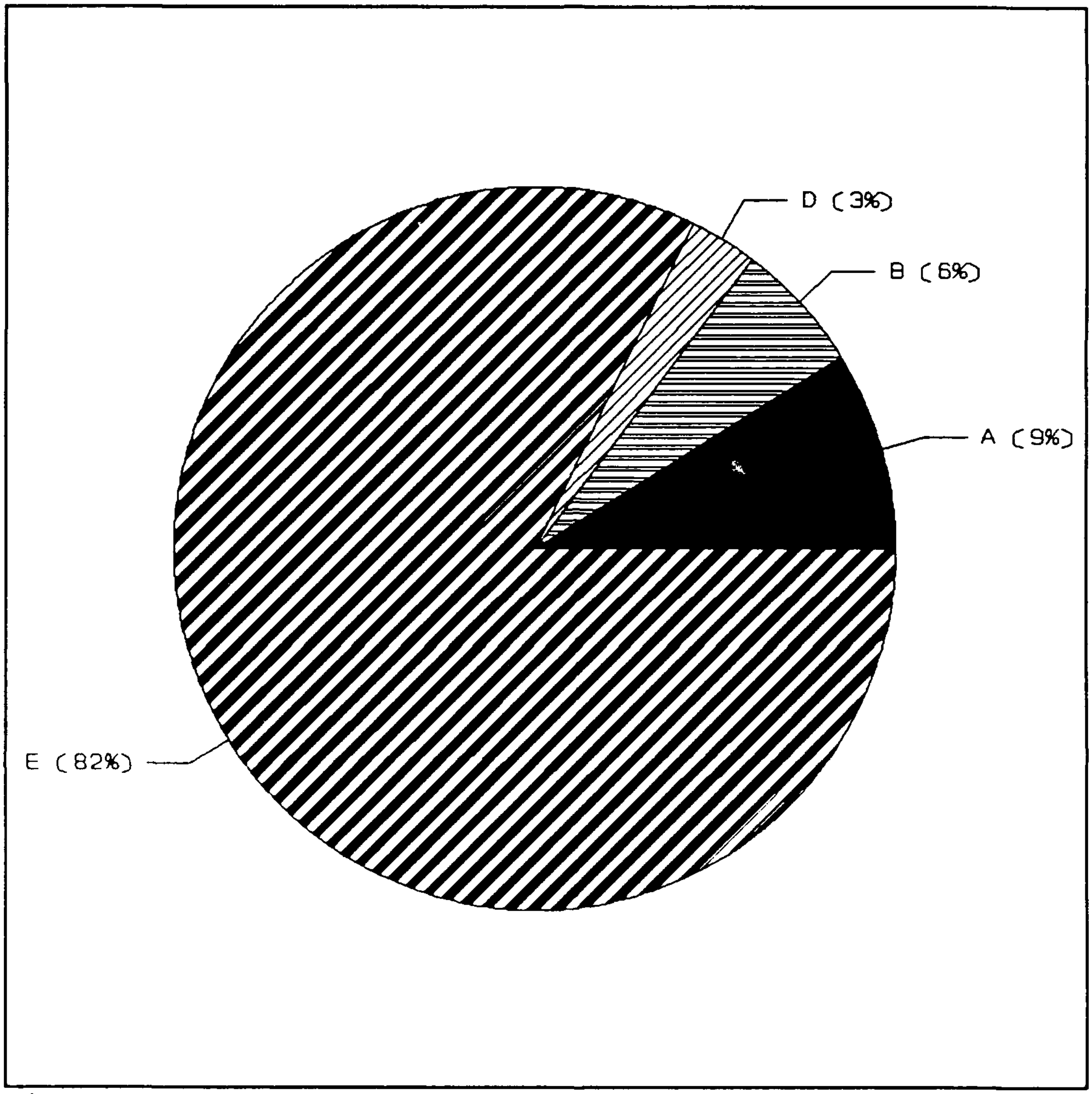

Figure D26: RESPONSE TO QUESTION 15, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

15. Univ. of Illinois (3-day short course, "The PAVER System: An Intensive Short Course"):

A(3/9.1%).	Excellent	C(0/0%).	Fair
B(2/6.1%).	Good	D(1/3%).	Poor

E(27/81.8%). Not Used/Not Applicable

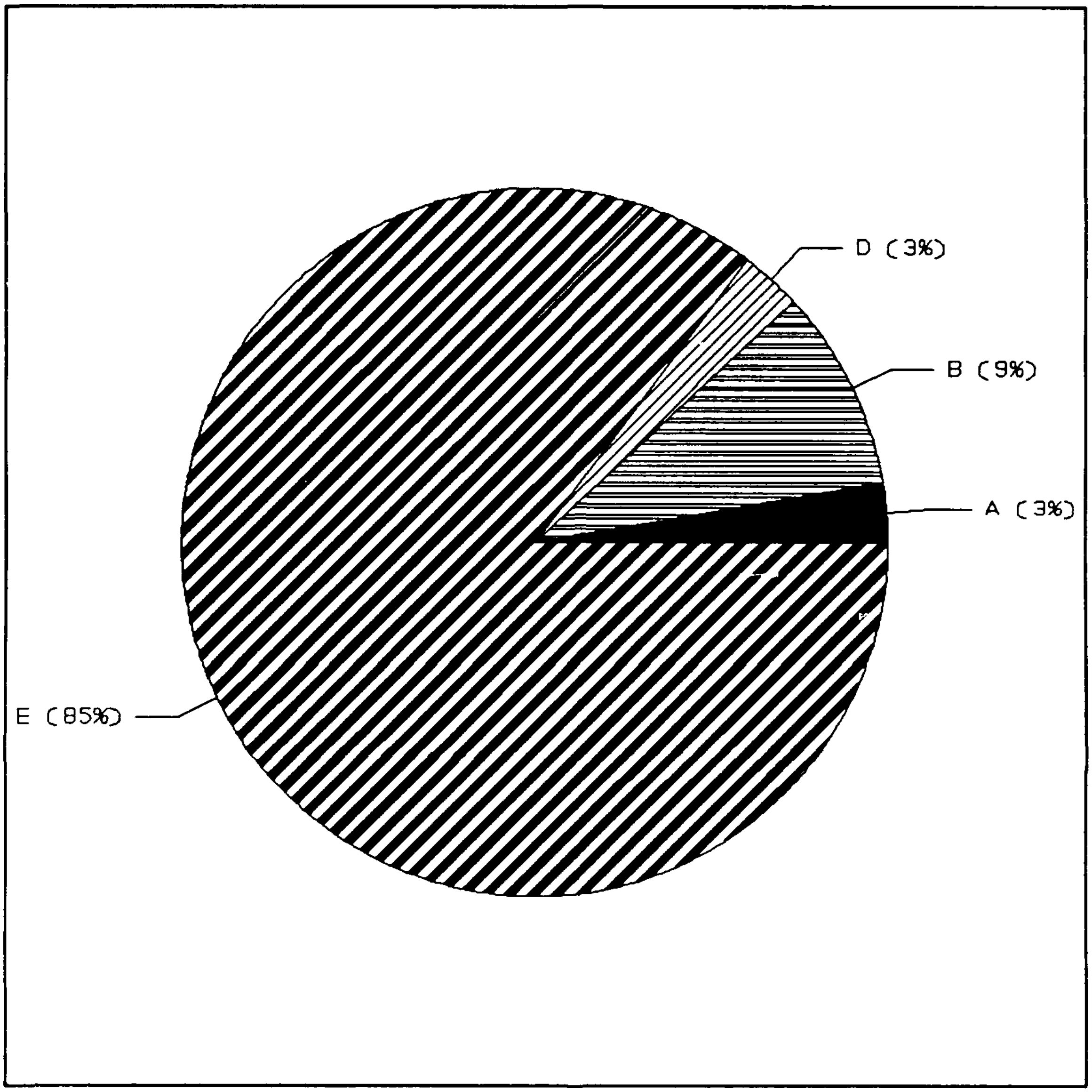

Figure D27: RESPONSE TO QUESTION 16, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

16. Construction Engineering Research Lab.:

A(1/3%).	Excellent	C(0/0%).	Fair
B(3/9.1%).	Good	D(1/3%).	Poor

E(28/84.8%). Not Used/Not Applicable

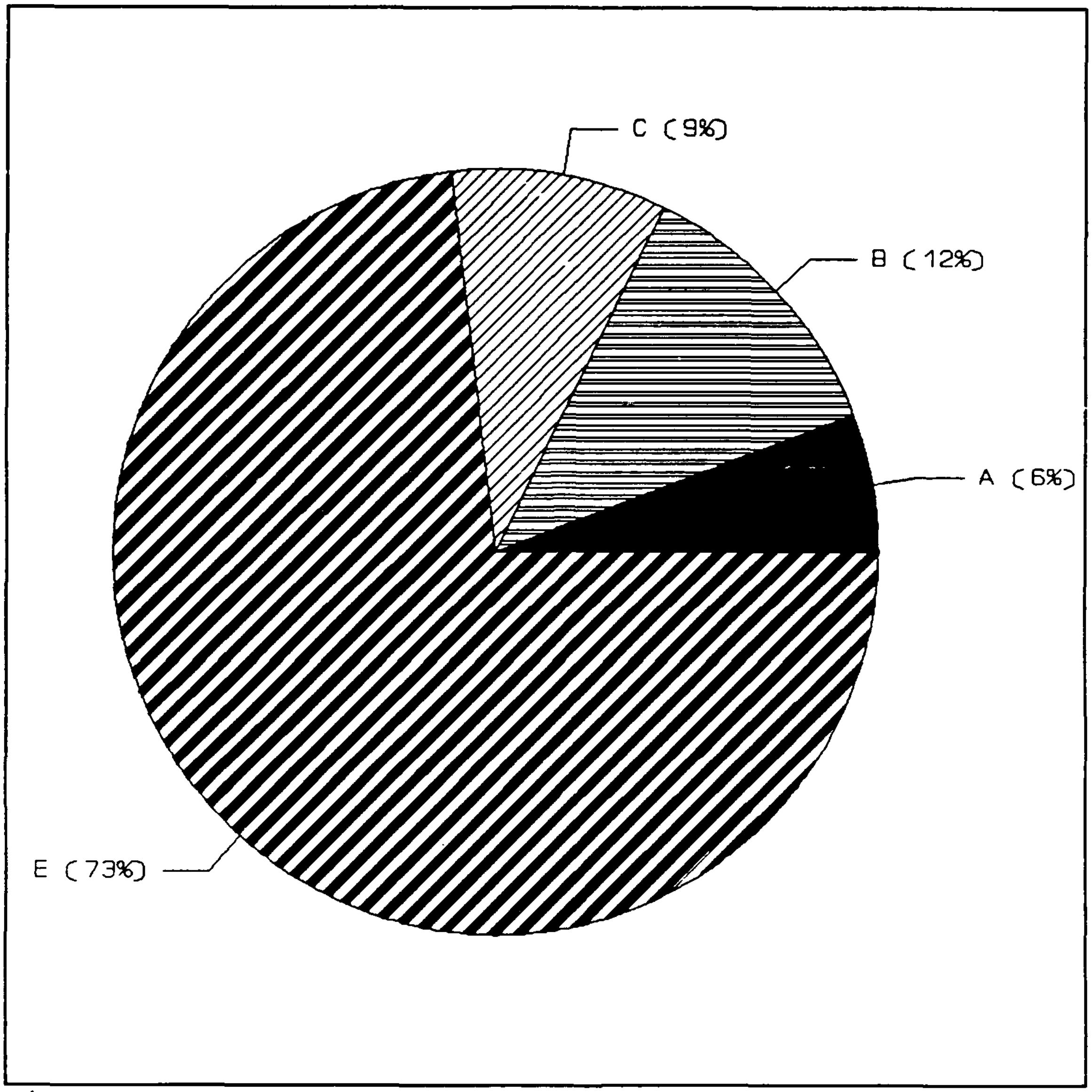

Figure D28: RESPONSE TO QUESTION 17, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

17. Command-Sponsored Workshops:

A(2/6.1%).	Excellent	C(3/9.1%).	Fair
B(4/12.1%).	Good	D(0/0%).	Poor

E(24/73%). Not Used/Not Applicable

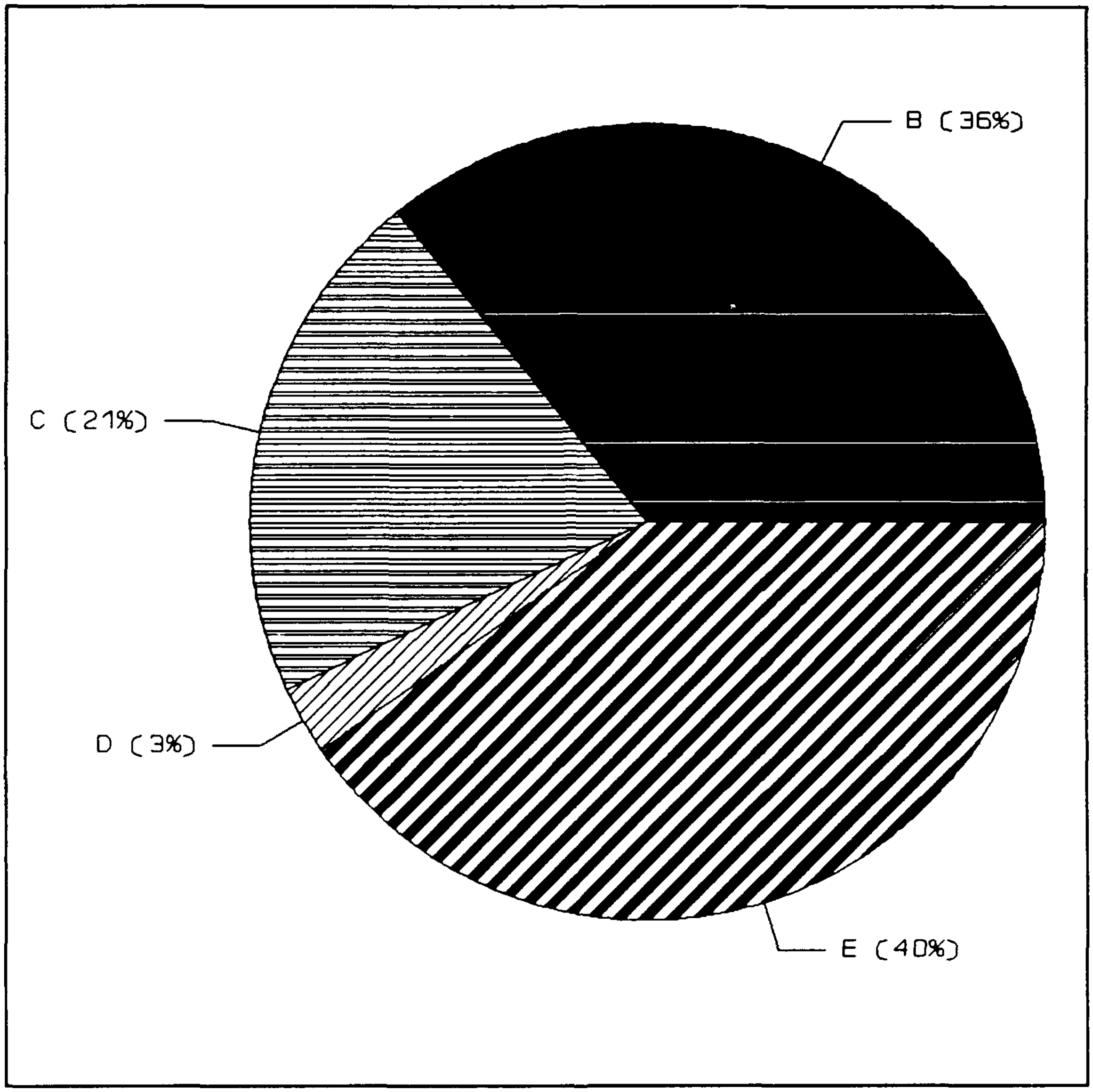

Figure D29: RESPONSE TO QUESTION 18, POPULATION CATEGORY I

During the implementation and use of PAVER at your base, how would you rate the training, assistance, or guidance received from:

18. PAVER Publications:

A(0/0%).	Excellent	C(7/21.2%).	Fair
B(12/36.4%).	Good	D(1/3%).	Poor

E(13/39.4%). Not Used/Not Applicable

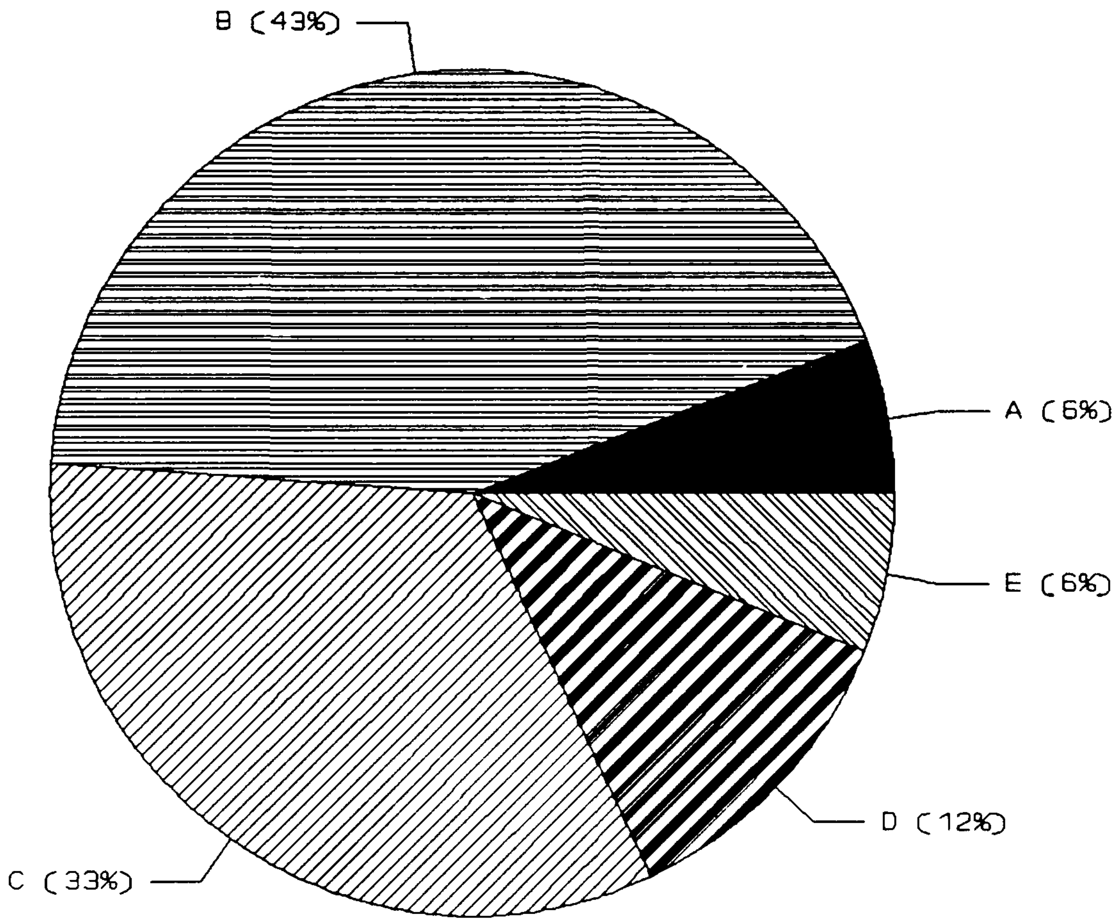

Figure D30: RESPONSE TO QUESTION 19, POPULATION CATEGORY I

19. How would you rate the adequacy of your training from all sources combined (questions 10 - 18) in preparing you to implement and use PAVER?

A(2/6.1%). Excellent
B(14/42.4). Good
C(11/33.3%). Fair
D(4/12.1). Poor
E(2/6.1). Very Poor

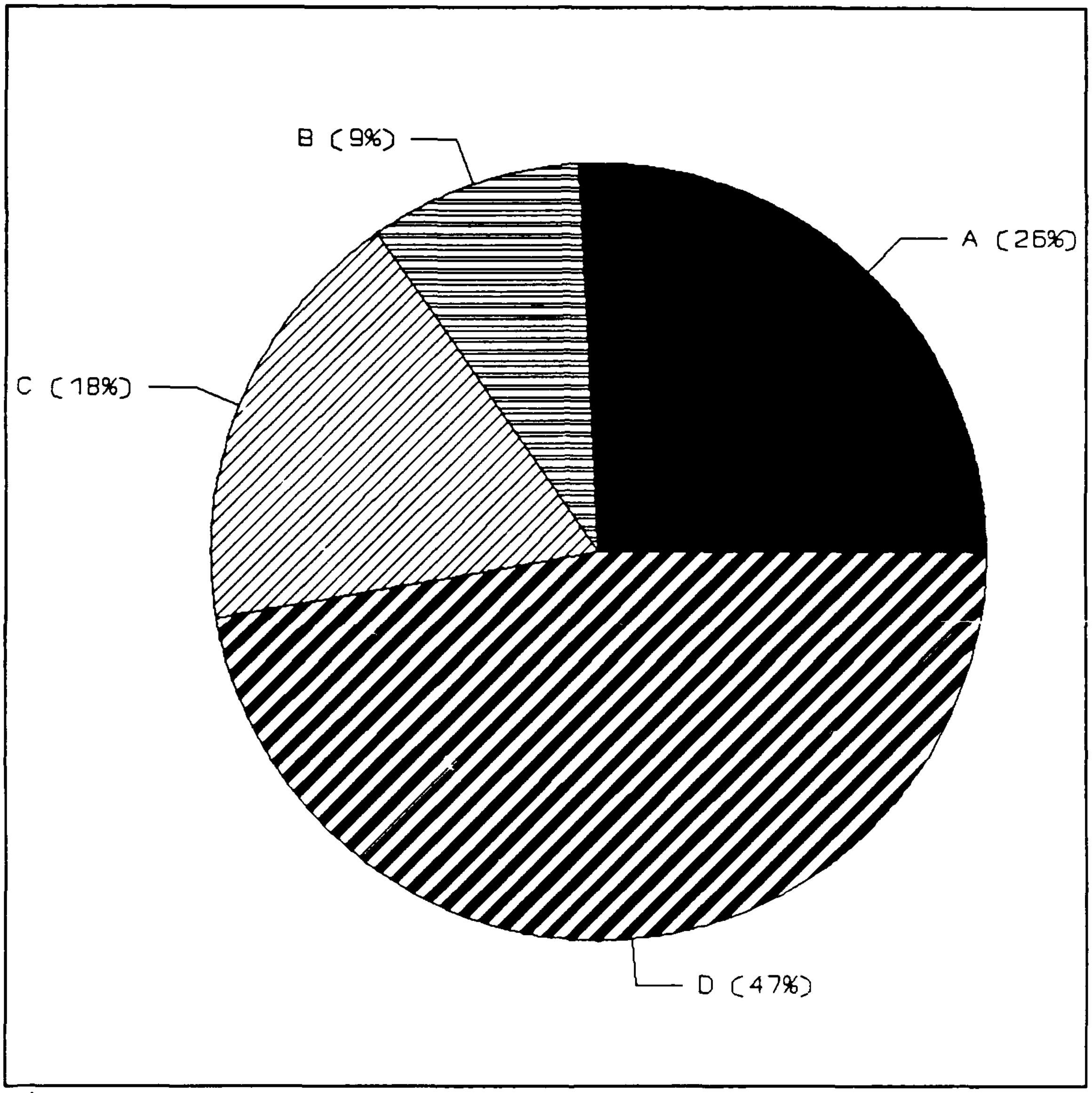

Figure D31: RESPONSE TO QUESTION 20, POPULATION CATEGORY I

20. Which of the following statements best describes the status of computer use for PAVER at your base?

A(9/26.5). We do not have the required computer equipment (hardware and/or software) and therefore must rely totally on manual analysis procedures.
B(3/8.8). We have the required computer equipment (hardware and software), but still prefer to operate PAVER manually.
C(6/17.6). We operate portions of PAVER manually, and operate other portions by computer.
D(16/47.1). We operate all applicable portions of PAVER on the computer.

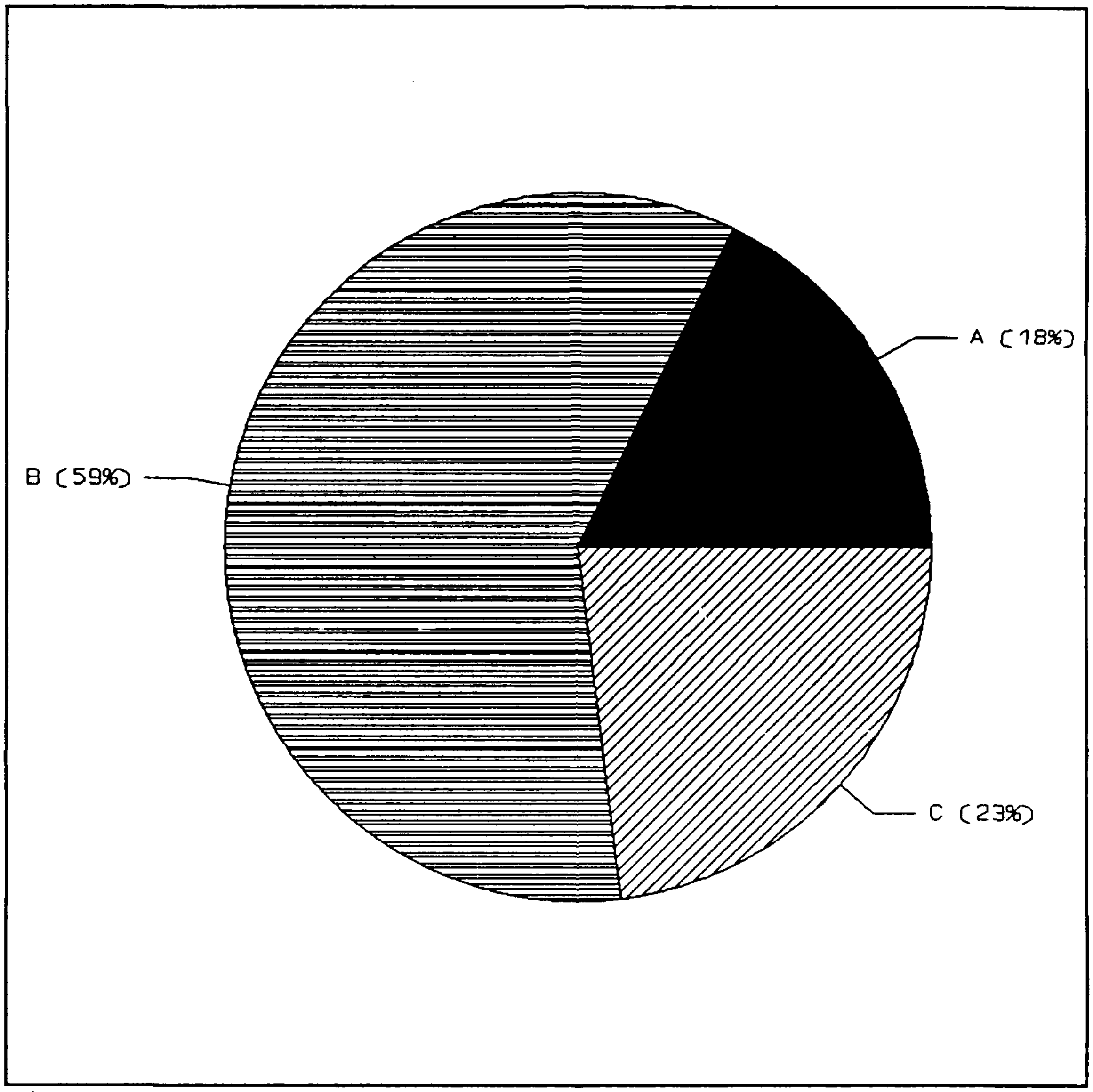

Figure D32: RESPONSE TO QUESTION 21, POPULATION CATEGORY I

21. If you operate all or portions of PAVER on the computer, please indicate which computer system you are using.

A(6/17.6%). Mainframe PAVER
B(20/58.8%). Micro PAVER
C(8/23.5%). Not Applicable; we use manual analysis procedures.

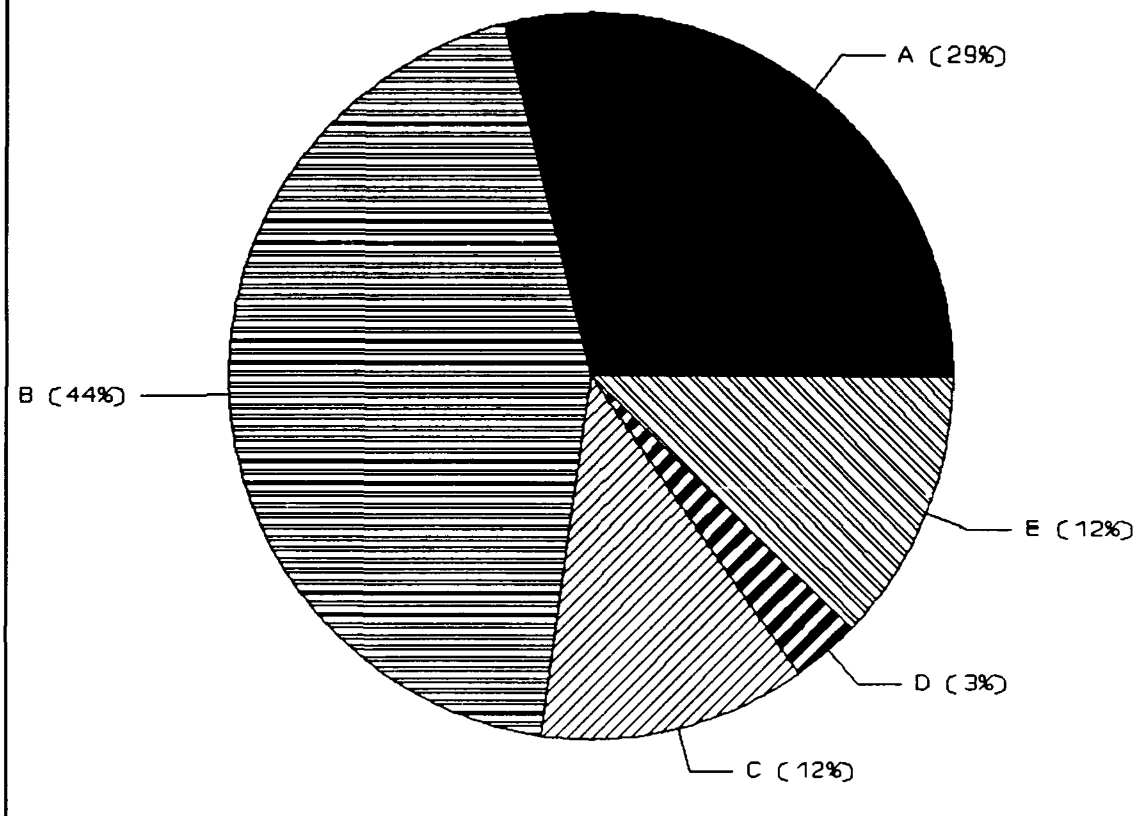

Figure D33: RESPONSE TO QUESTION 22, RESPONSE CATEGORY I

22. Which of the following statements best describes the status of available manpower to maintain the data base and use PAVER.

A(10/29.4%). We lack sufficient manpower to maintain and use PAVER.
B(15/44.1%). We have sufficient manpower to maintain and use PAVER but have higher priority uses for our manpower.
C(4/11.8%). We have sufficient manpower to maintain and use PAVER but are required to spend it satisfying the requirements of higher levels of management.
D(1/2.9%). We have sufficient manpower and use it to maintain and use PAVER.
E(4/11.8%). Other.

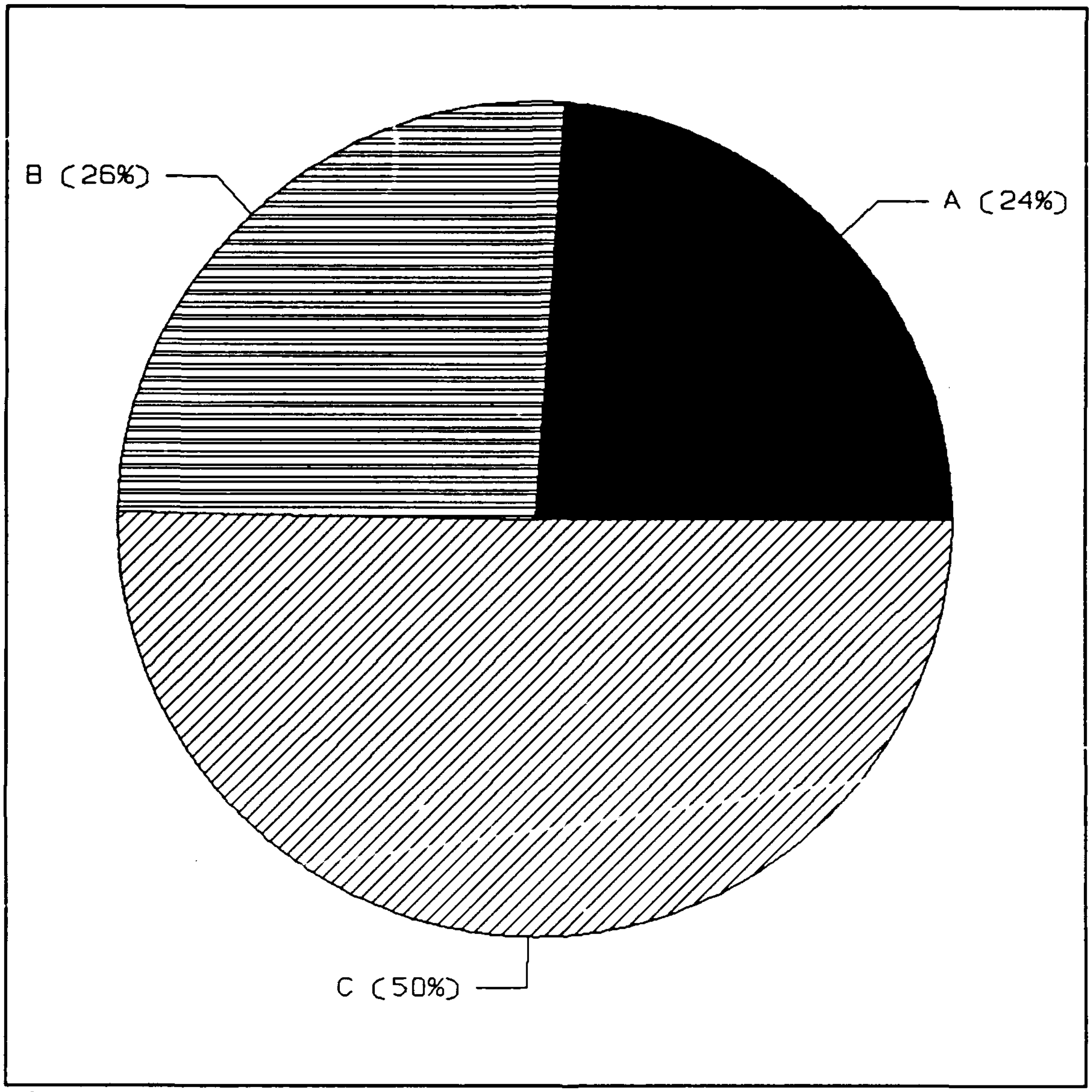

Figure D34: RESPONSE TO QUESTION 23, POPULATION CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

23. Lack of adequate training.

A(8/23.5%). Major contributing factor
B(9/26.5%). Minor contributing factor
C(17/50%). Not a contributing factor

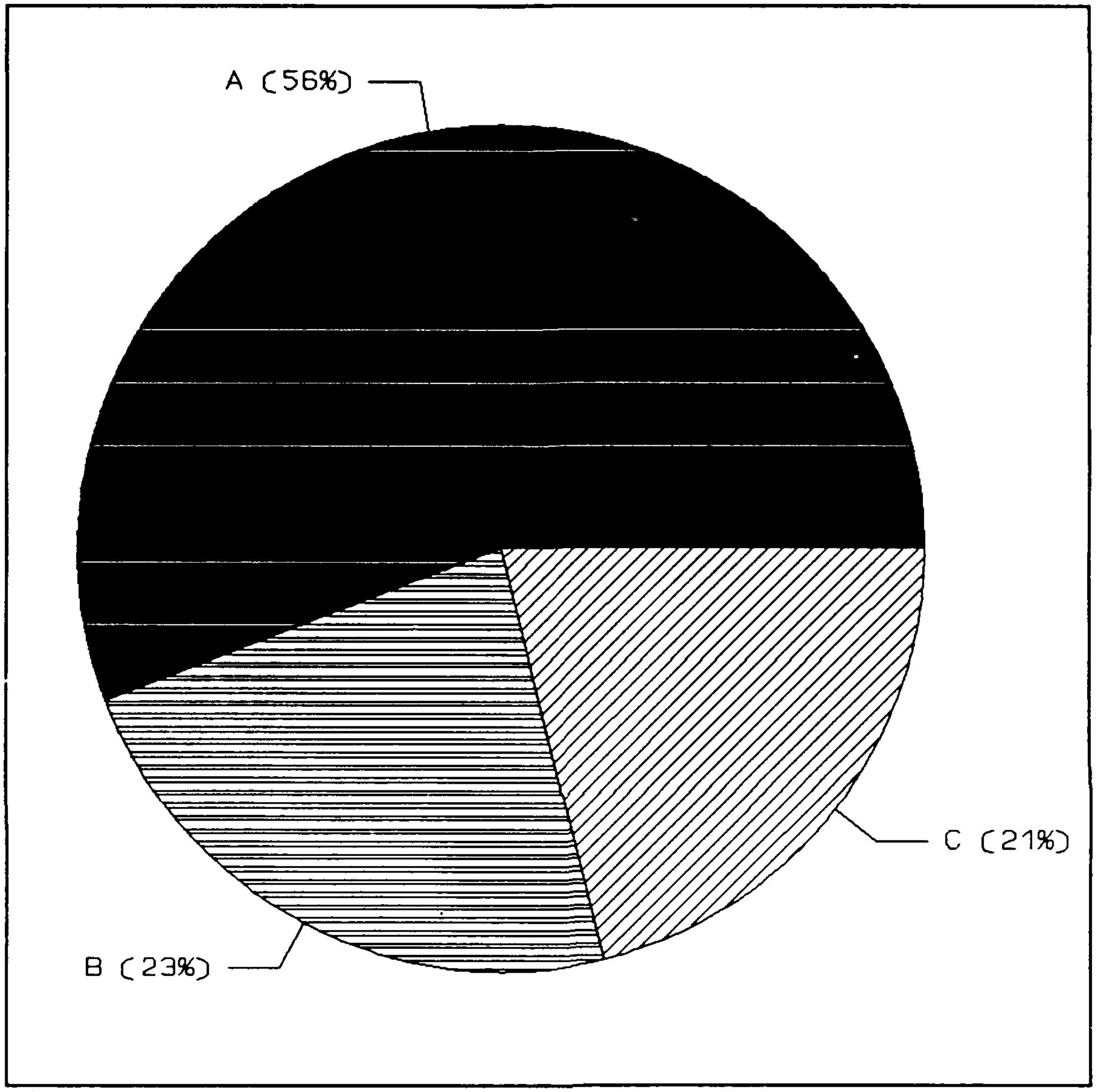

Figure D35: RESPONSE TO QUESTION 24, POPULATION CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

24. Lack of adequate manpower.

A(19/55.9%). Major contributing factor
B(8/23.5%). Minor contributing factor
C(7/20.6%). Not a contributing factor

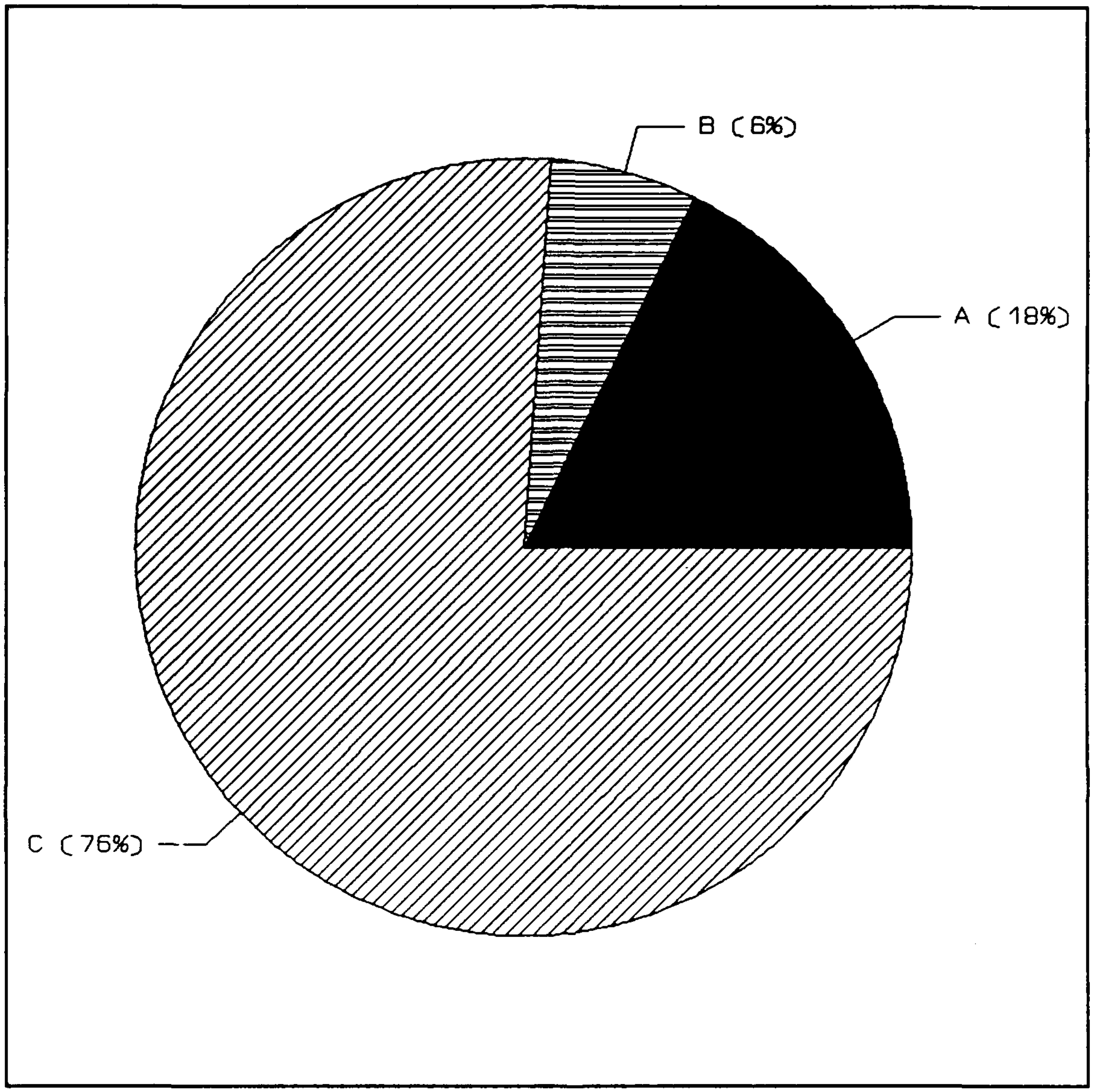

Figure D36: RESPONSE TO QUESTION 25, POPULATION CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

25. Lack of Micro PAVER computer program.

A(6/17.6%). Major contributing factor
B(2/5.9%). Minor contributing factor
C(26/76.5%). Not a contributing factor

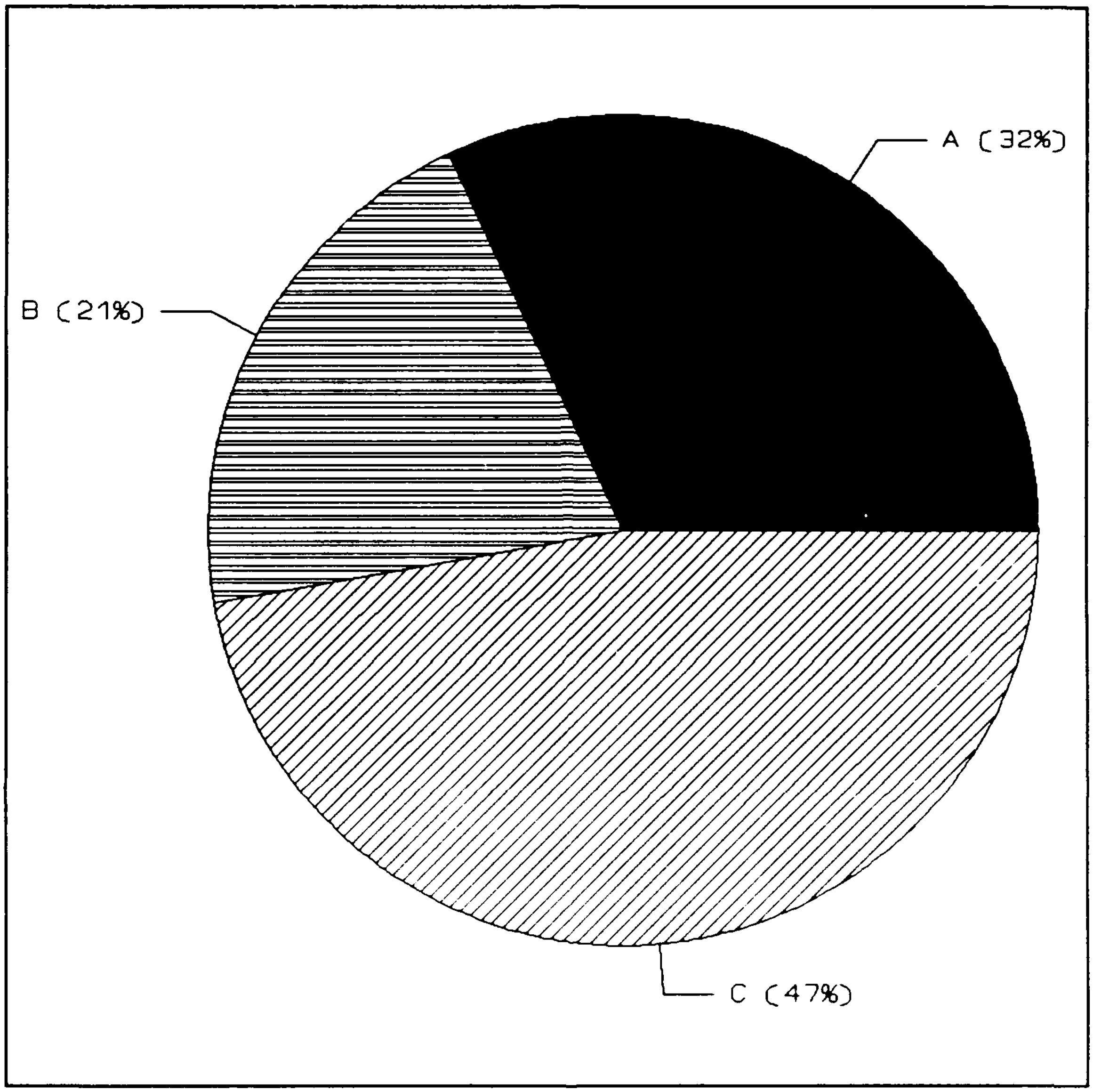

Figure D37: RESPONSE TO QUESTION 26, POPULATION CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

26. Lack of PAVER hardware.

A(11/32.4%). Major contributing factor
B(7/20.6%). Minor contributing factor
C(16/47.1%). Not a contributing factor

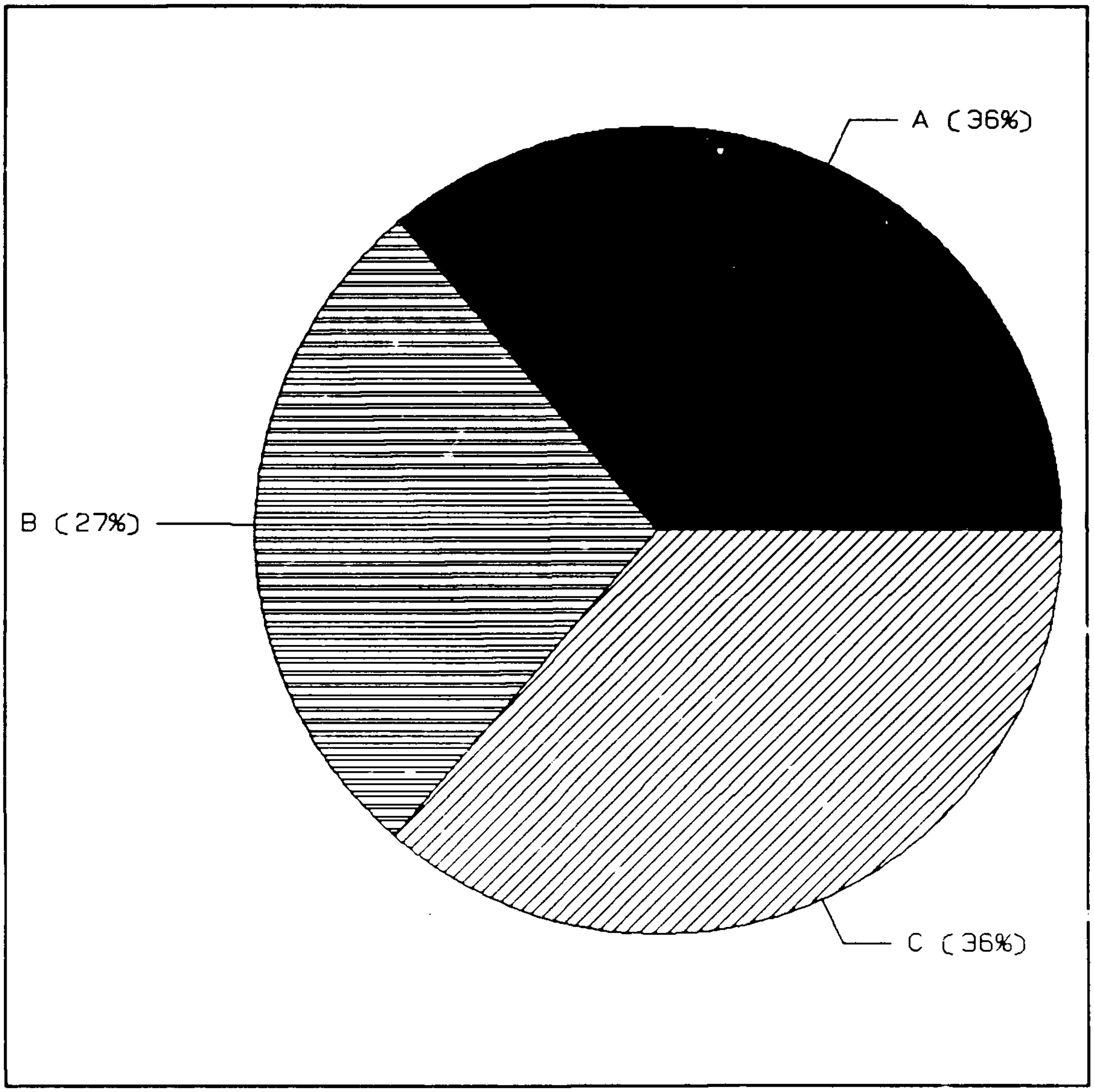

Figure D38: RESPONSE TO QUESTION 27, POPULATION CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

27. Lack of top management support.

A(12/36.4%). Major contributing factor
B(9/27.3%). Minor contributing factor
C(12/36.4%). Not a contributing factor

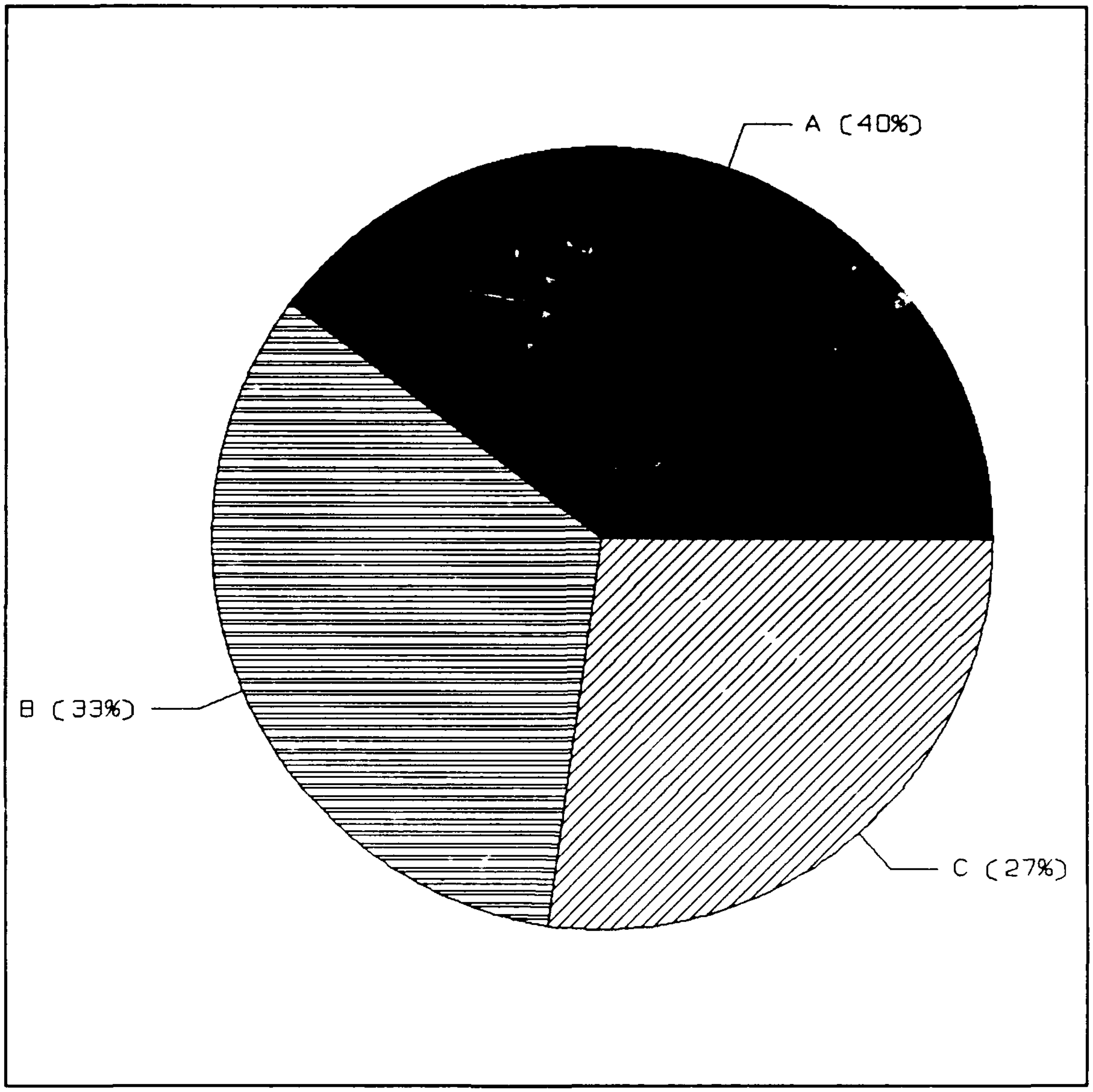

Figure D39: RESPONSE TO QUESTION 28, POPULATION CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

28. Difficulty of gathering pavement distress data.

A(13/39.3%). Major contributing factor
B(11/33.3%). Minor contributing factor
C(9/27.3%). Not a contributing factor

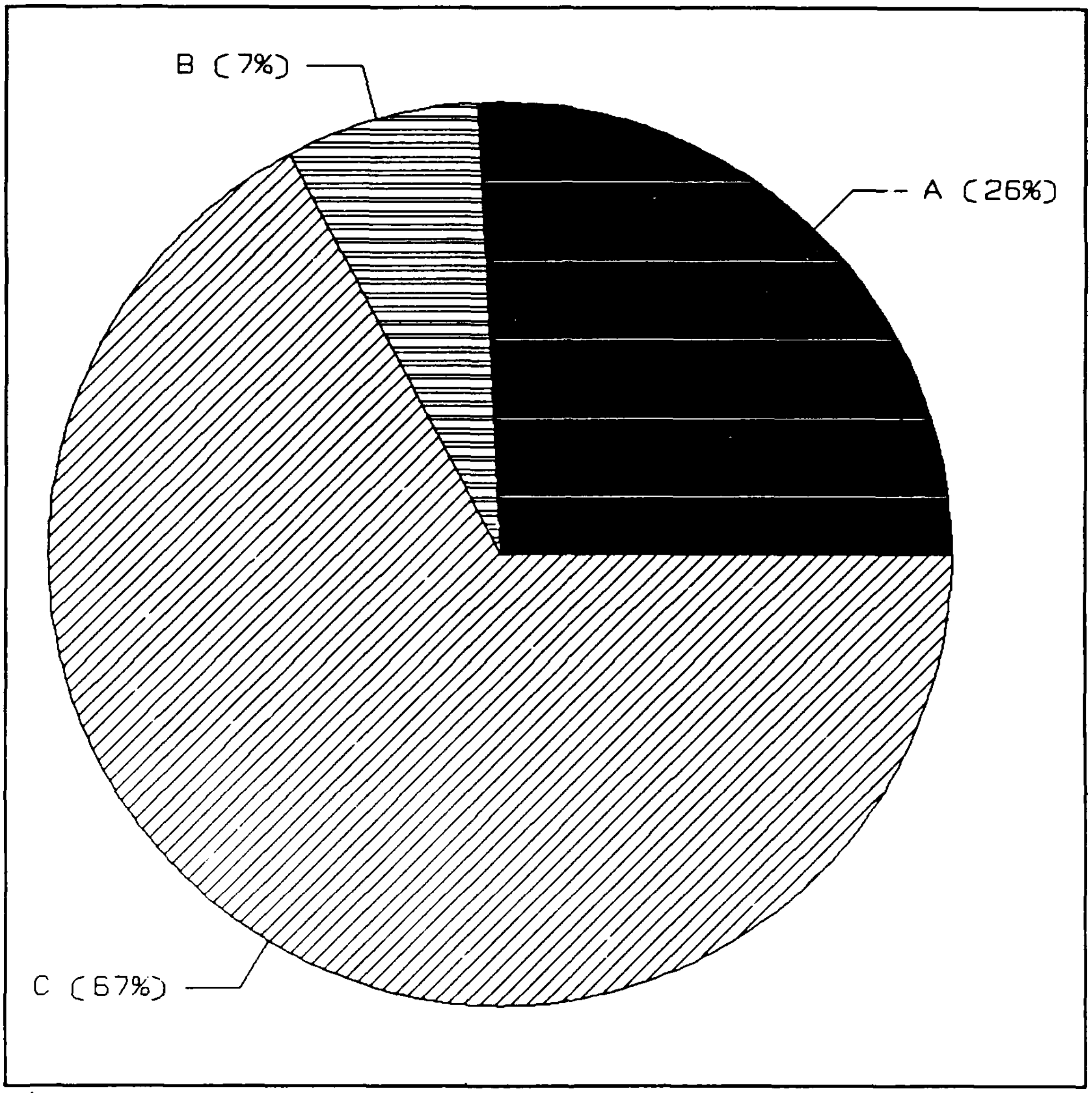

Figure D40: RESPONSE TO QUESTION 29, RESPONSE CATEGORY I

Rate the listed factor as an impediment to implementing and using PAVER on your base (A = major contributing factor; B = minor contributing factor; C = not a contributing factor).

29. Other.

A(4/26.7%). Major contributing factor
B(1/6.7%). Minor contributing factor
C(10/66.7%). Not a contributing factor

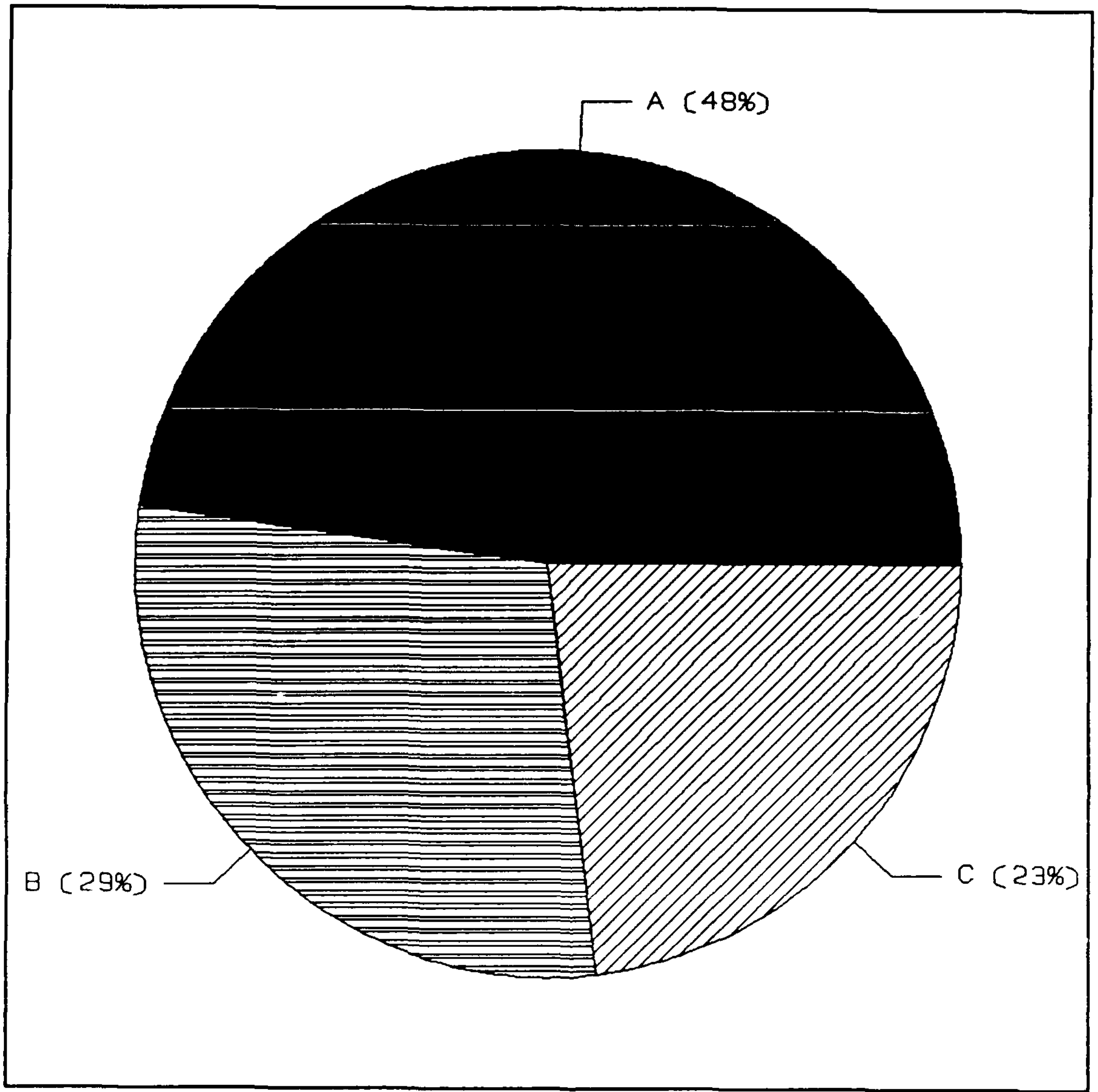

Figure D41: RESPONSE TO QUESTION 30, RESPONSE CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

30. Reduction in manhours to perform pavement management.

A(15/48.4%). Major benefit
B(9/29%). Minor benefit
C(7/22.6%). Not a benefit

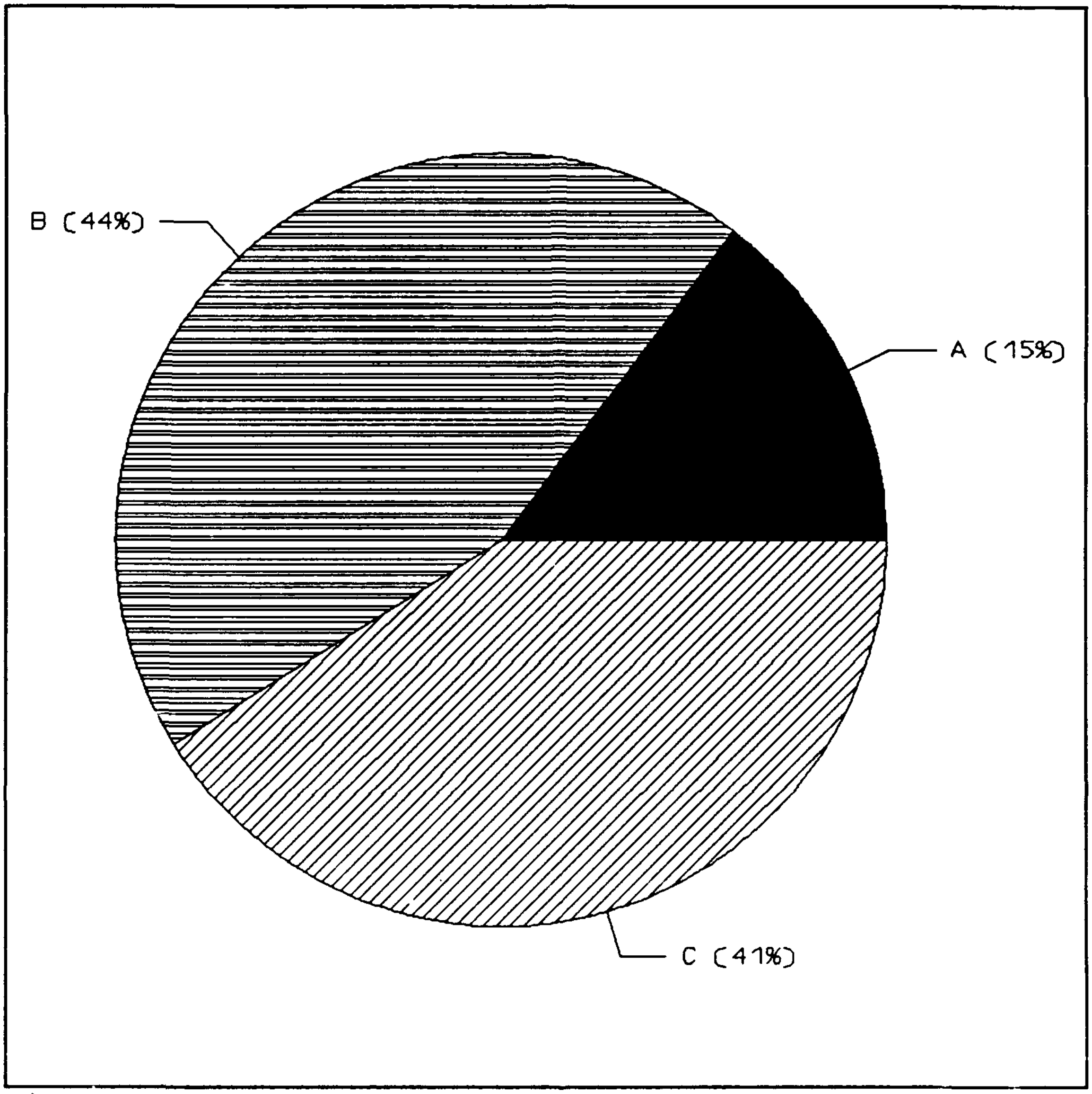

Figure D42: RESPONSE TO QUESTION 31, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

31. Project cost reduction.

A(5/15.6%). Major benefit
B(14/43.8%). Minor benefit
C(13/40.6%). Not a benefit

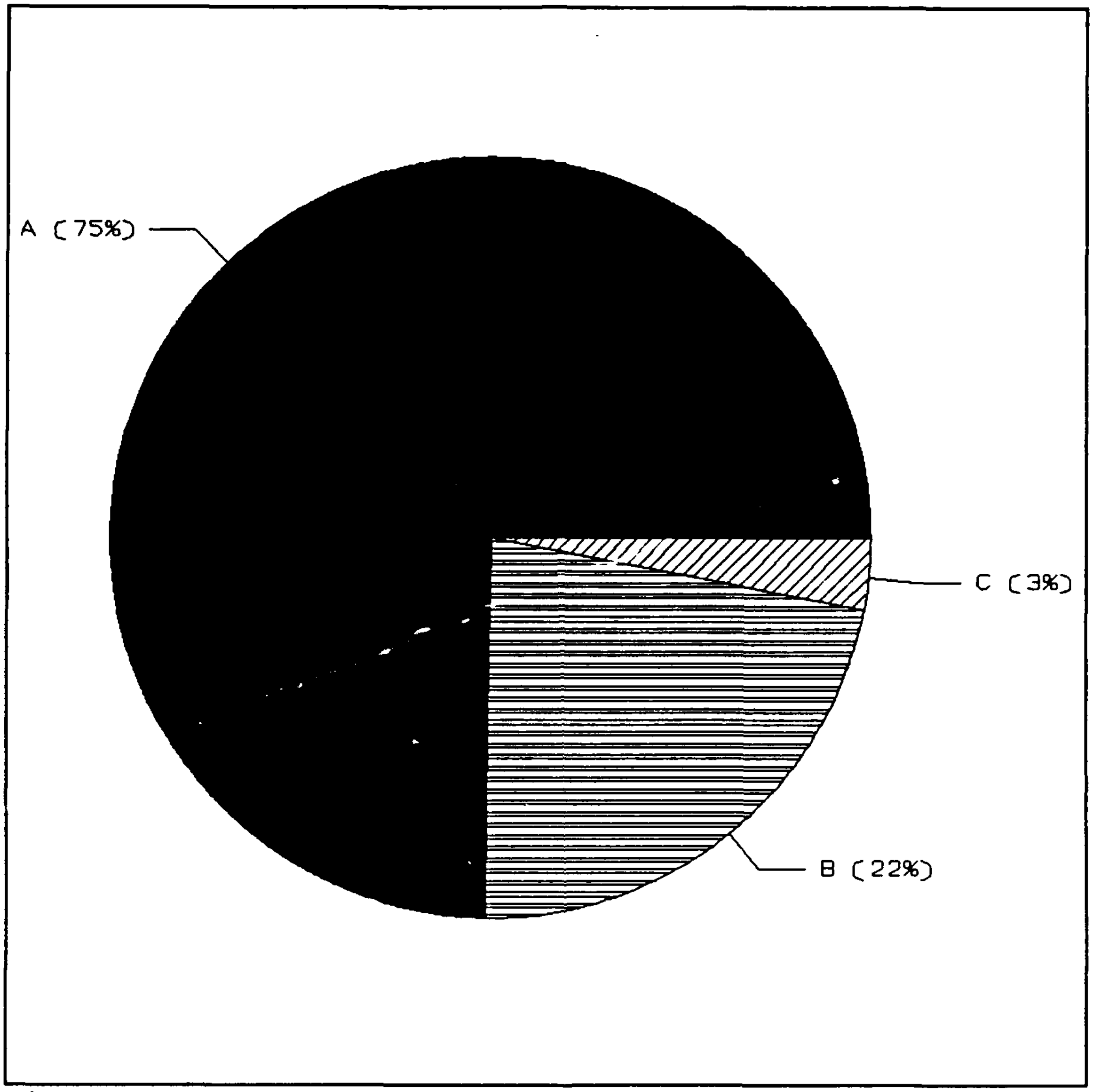

Figure D43: RESPONSE TO QUESTION 32, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

32. Improved project justification.

A(24/75%). Major benefit
B(7/21.9%). Minor benefit
C(1/3.1%). Not a benefit

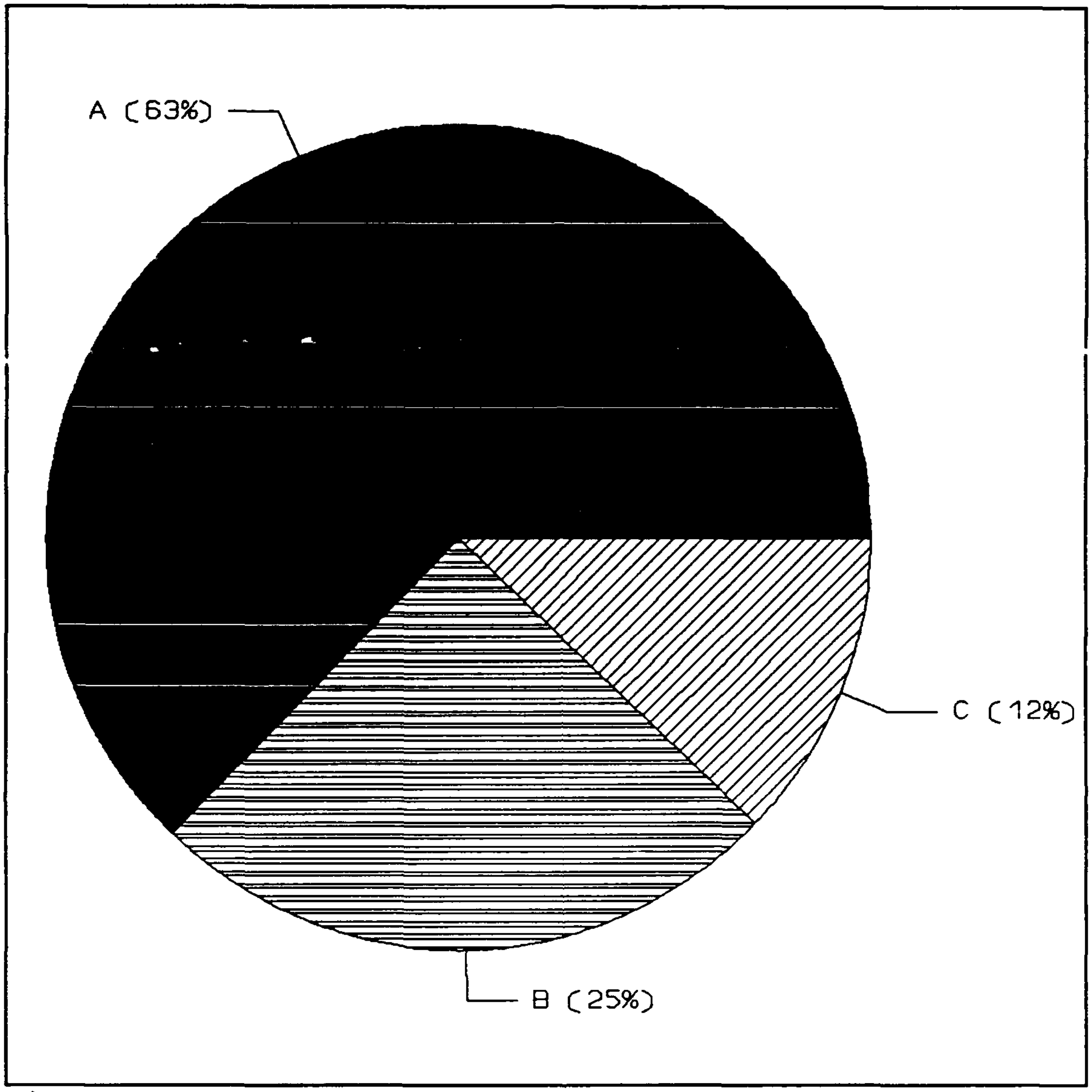

Figure D43: RESPONSE TO QUESTION 33, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

33. Elevation of project priority.

A(20/62.5%). Major benefit
B(8/25%). Minor benefit
C(4/12.5%). Not a benefit

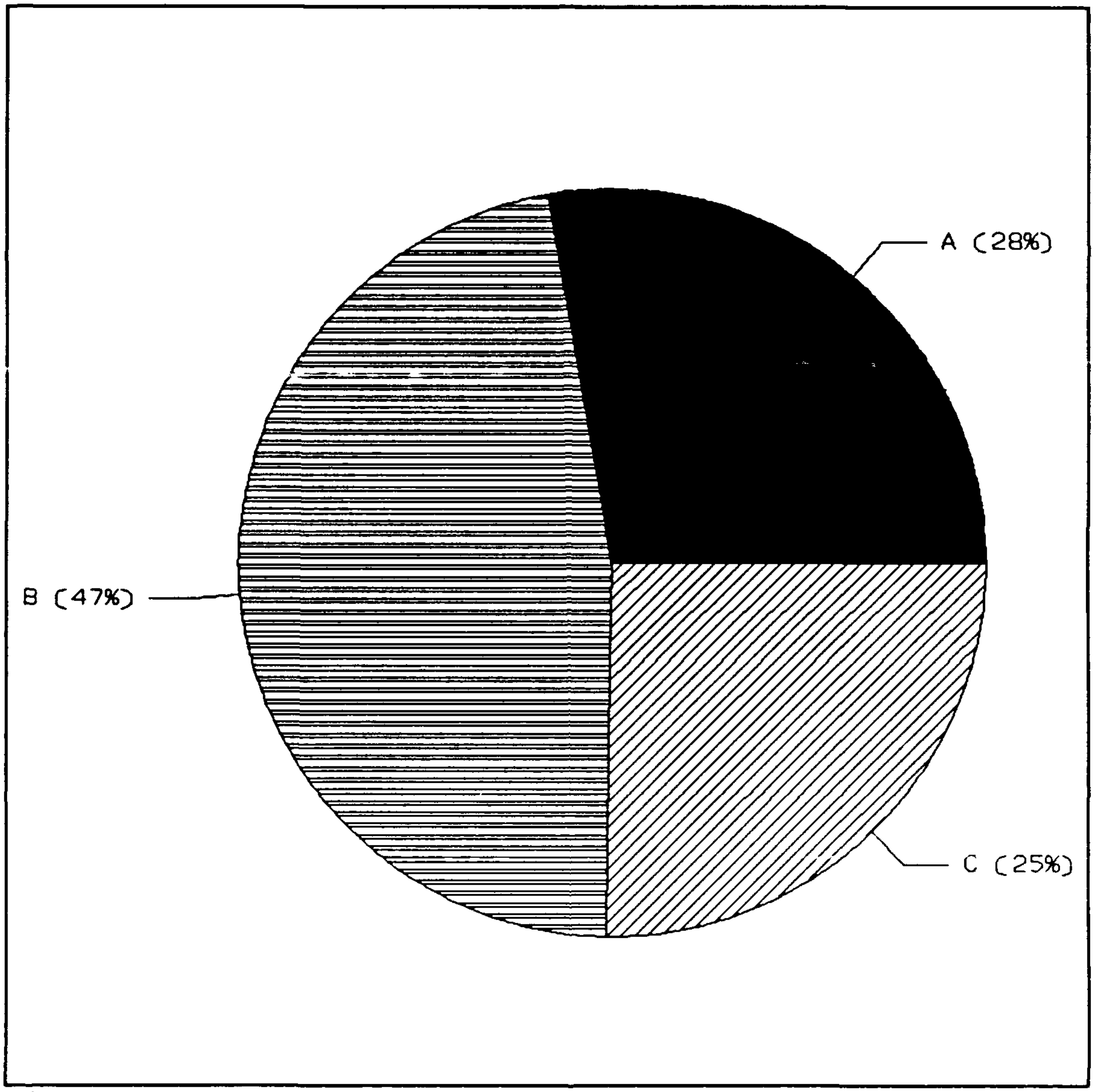

Figure D45: RESPONSE TO QUESTION 34, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

34. Increased funding for pavement projects.

A(9/28.1%). Major benefit
B(15/46.9%). Minor benefit
C(8/25%). Not a benefit

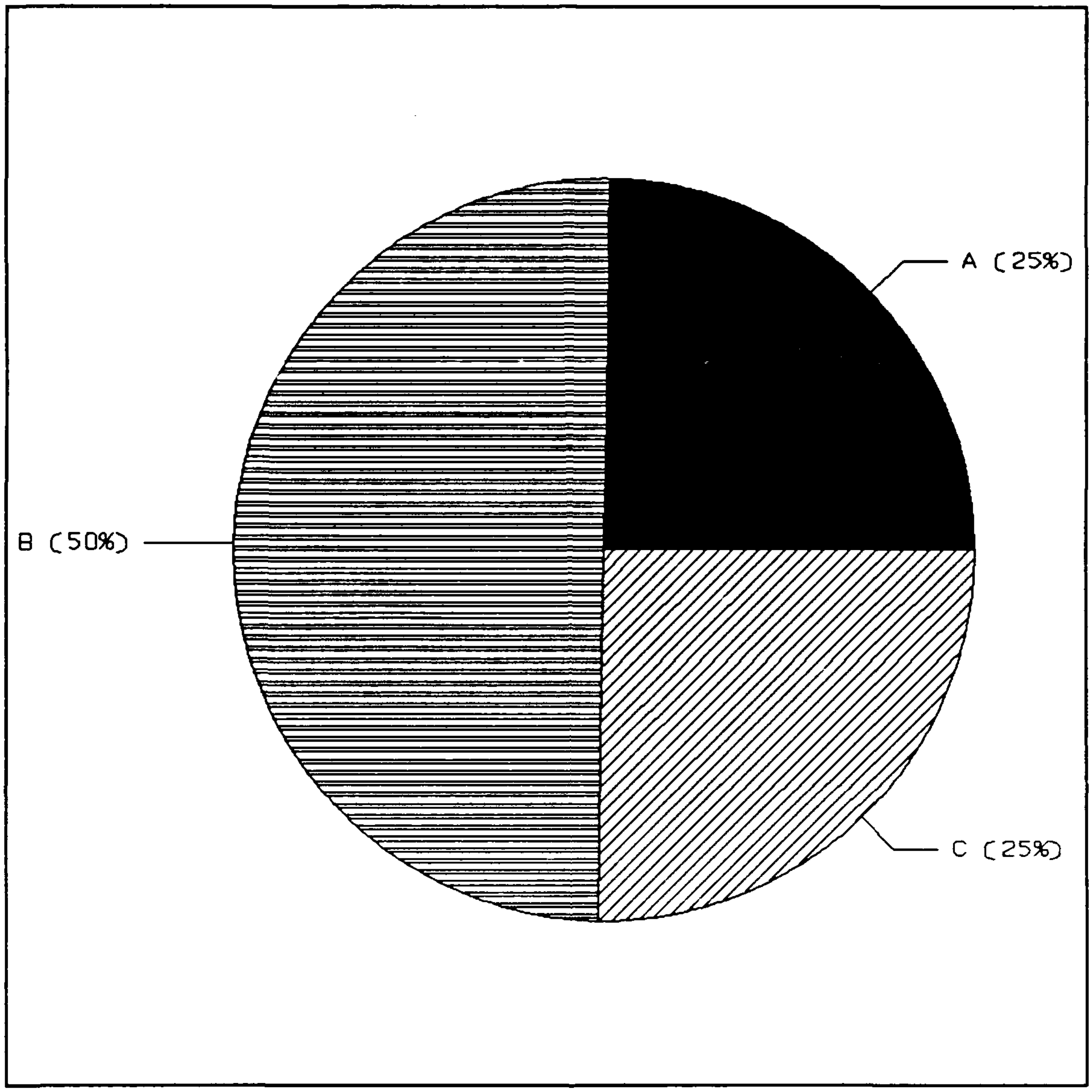

Figure D46: RESPONSE TO QUESTION 35, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

35. Elimination of projects due to improved preventive maintenance.

A(8/25%). Major benefit
B(16/50%). Minor benefit
C(8/25%). Not a benefit

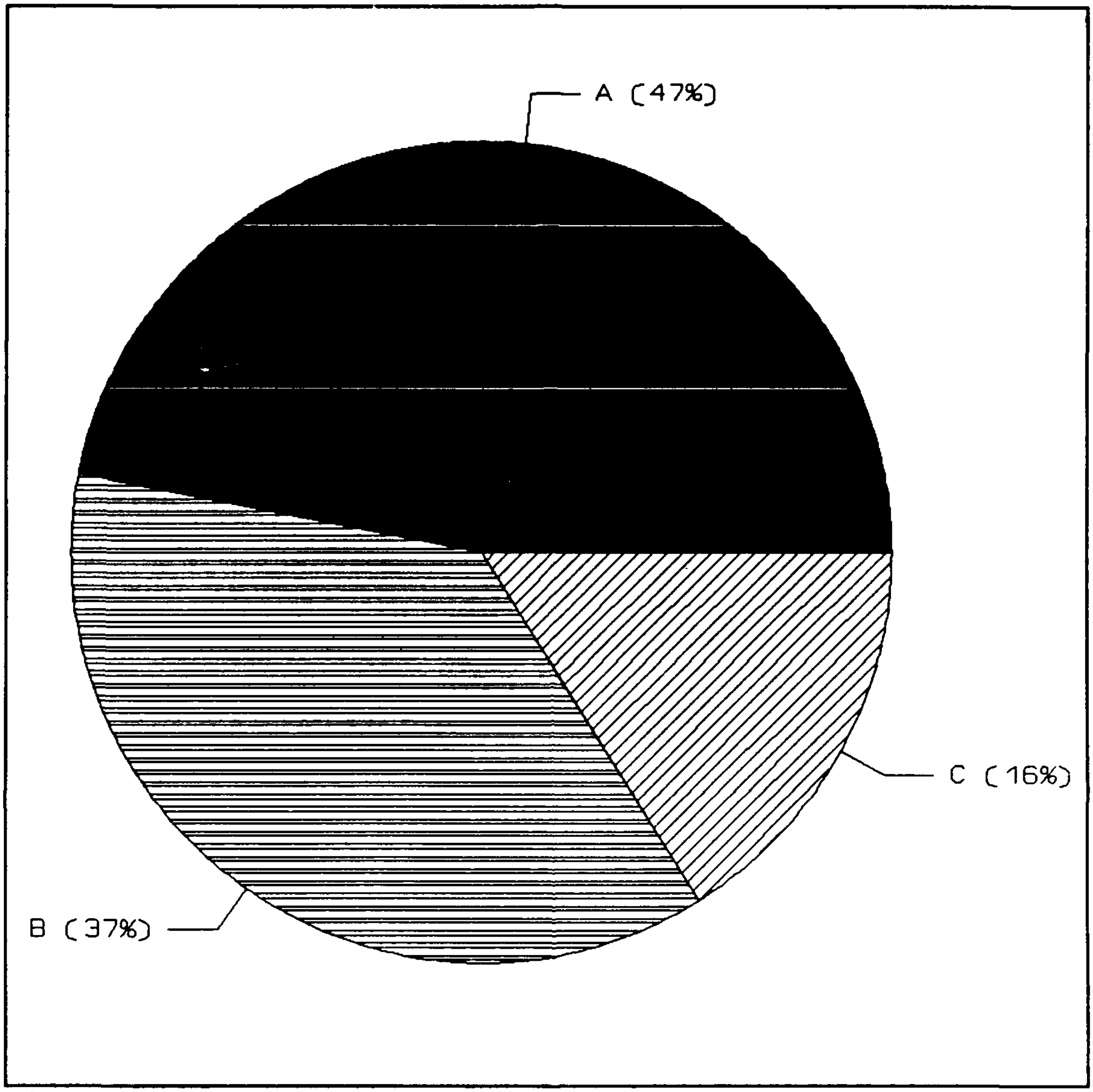

Figure D47: RESPONSE TO QUESTION 36, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

36. Improved decision making.

A(15/46.9%). Major benefit
B(12/37.5%). Minor benefit
C(5/15.6%). Not a benefit

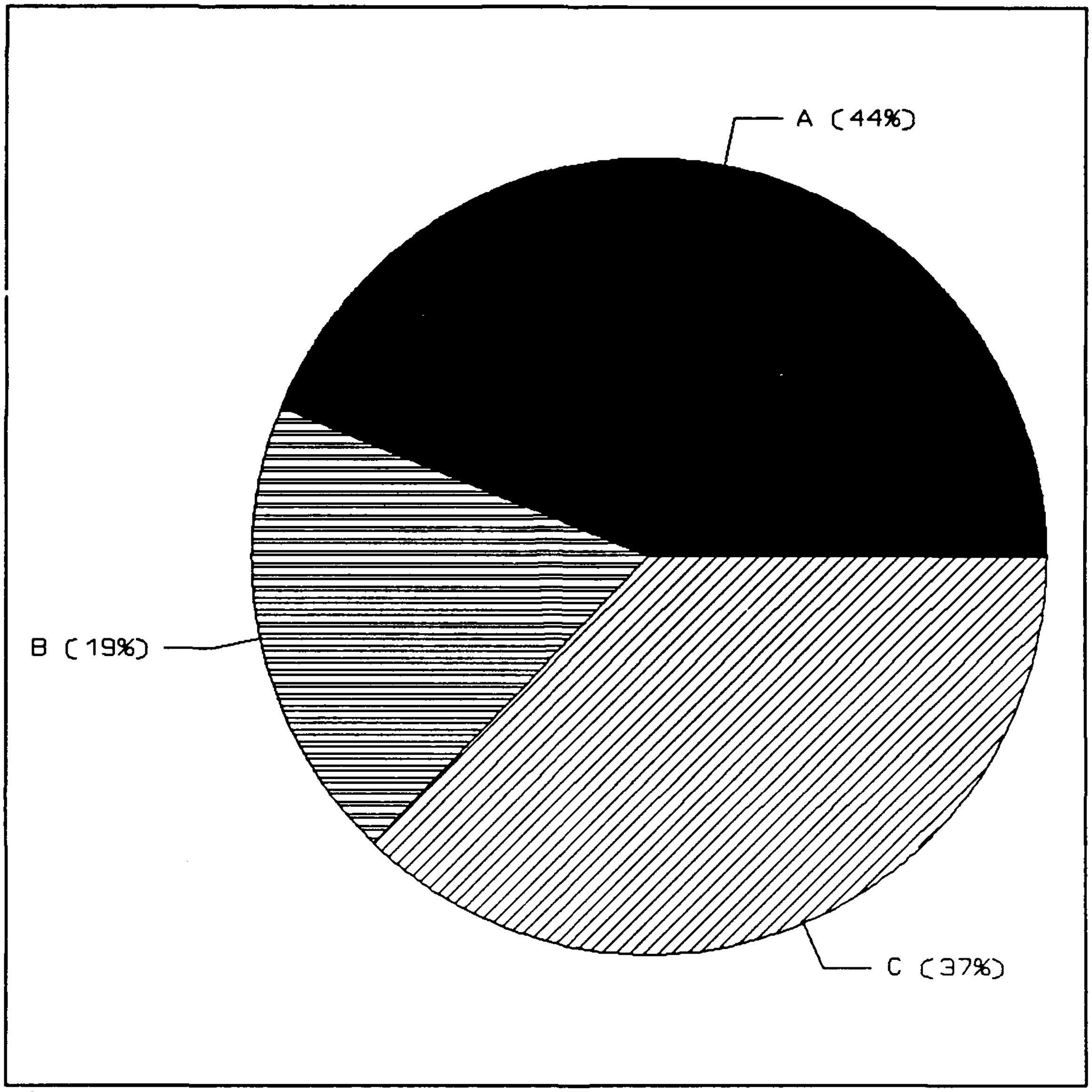

Figure D48: RESPONSE TO QUESTION 37, POPULATION CATEGORY I

Rate the listed factor as a benefit from the active use of PAVER at your base (A = major benefit; B = minor benefit; C = not a benefit).

37. Better communication among various levels in your organization.

A(14/43.8%). Major benefit
B(6/18.8%). Minor benefit
C(12/37.5%). Not a benefit

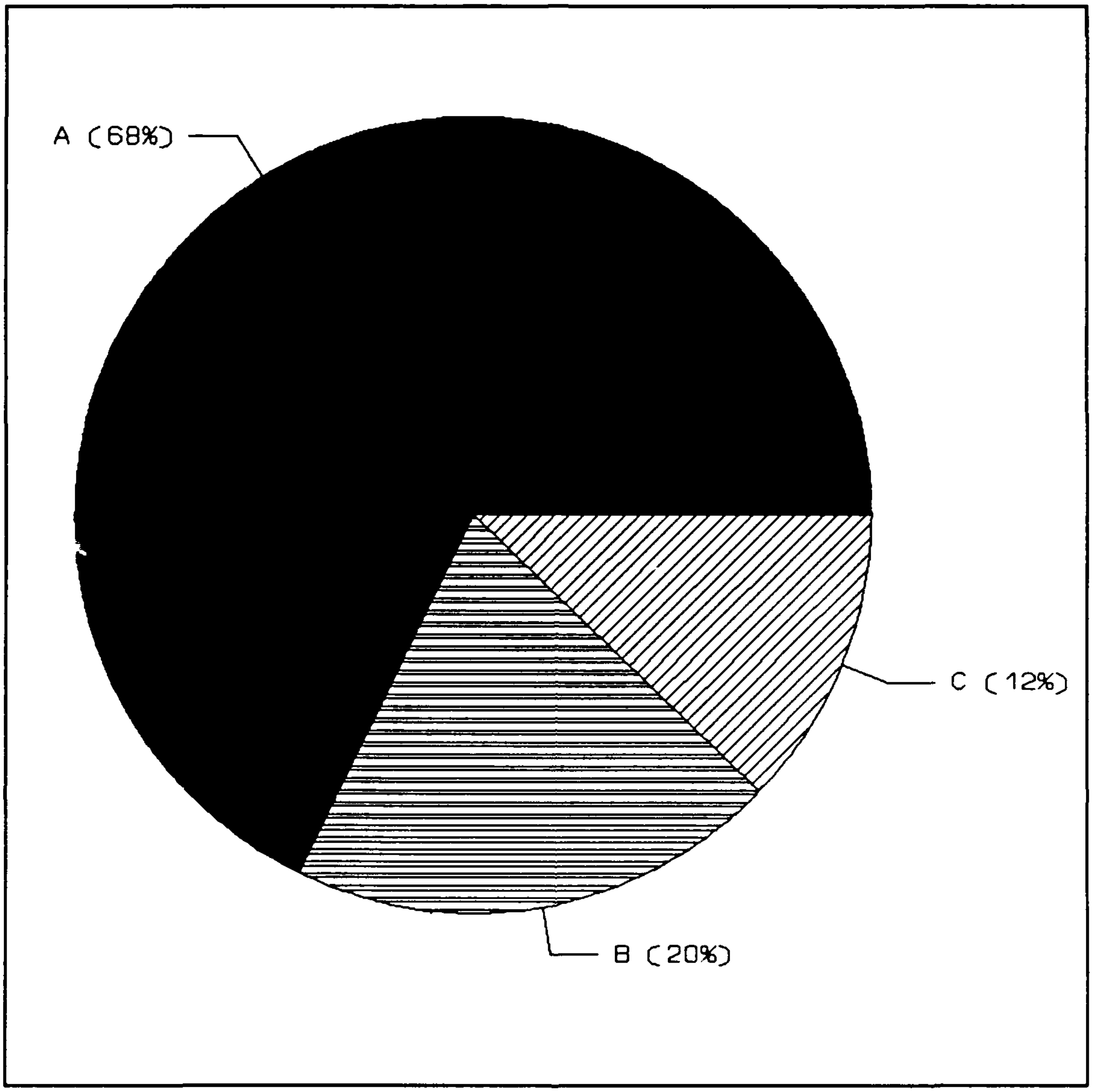

Figure D49: RESPONSE TO QUESTION 38, POPULATION CATEGORY I

38. Do you intend to add other pavement areas into your PAVER data base in the future (next 1-2 years)?

A(23/67.6%). Yes.
B(7/20.6%). No.
C(4/11.8%). Not applicable; we have fully implemented PAVER for all of our pavements.

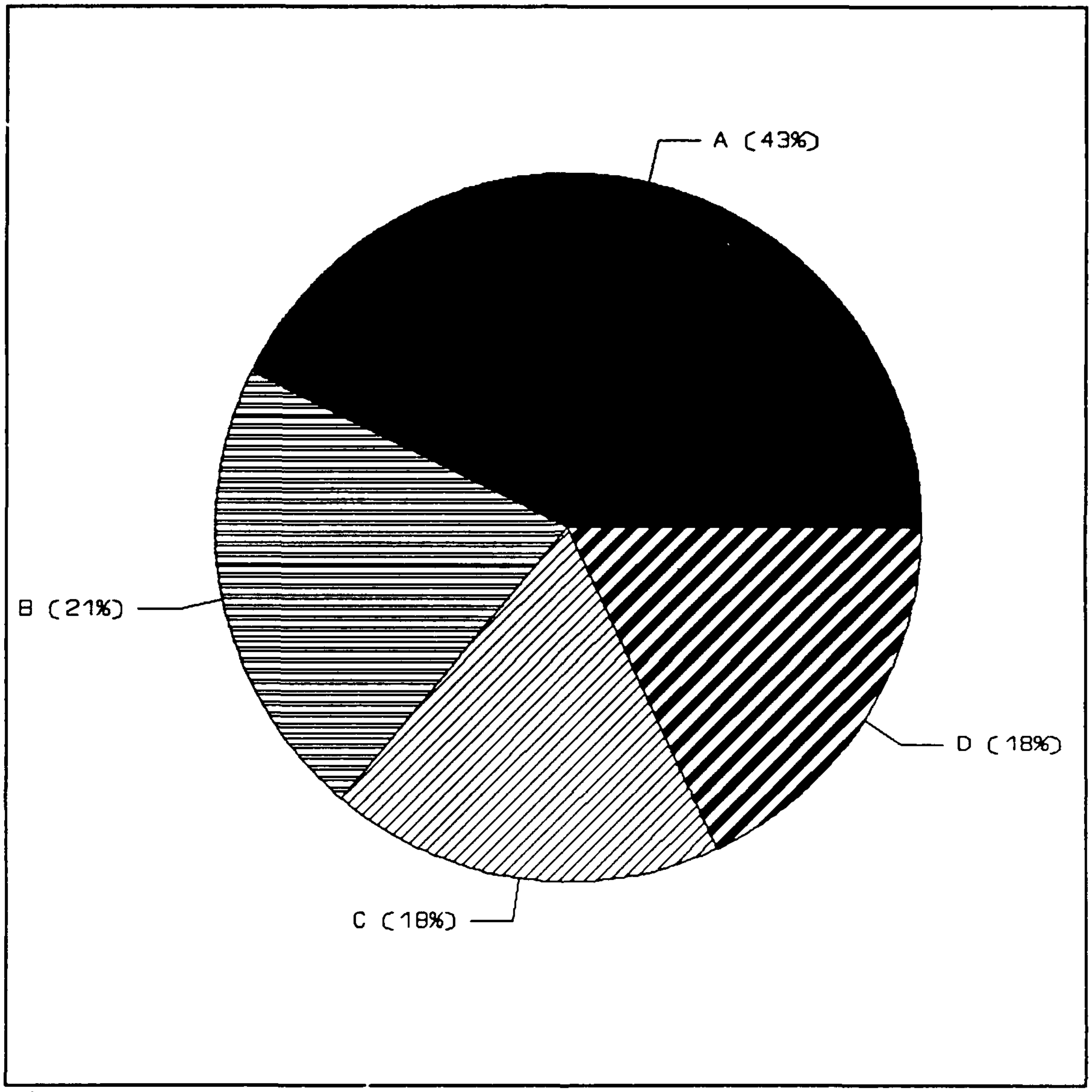

Figure D50: RESPONSE TO QUESTION 39, POPULATION CATEGORY I

39. Which of the following statements best describes your opinion of PAVER's pavement distress data gathering process?

A(14/42.2%). The data gathering process takes too long and is too manpower intensive.
B(7/21.2%). The data gathering process does not take too long and is not too manpower intensive.
C(6/18.2%). The data gathering process takes too long but is not too manpower intensive.
D(6/18.2%). The data gathering process does not take too long but is too manpower intensive.

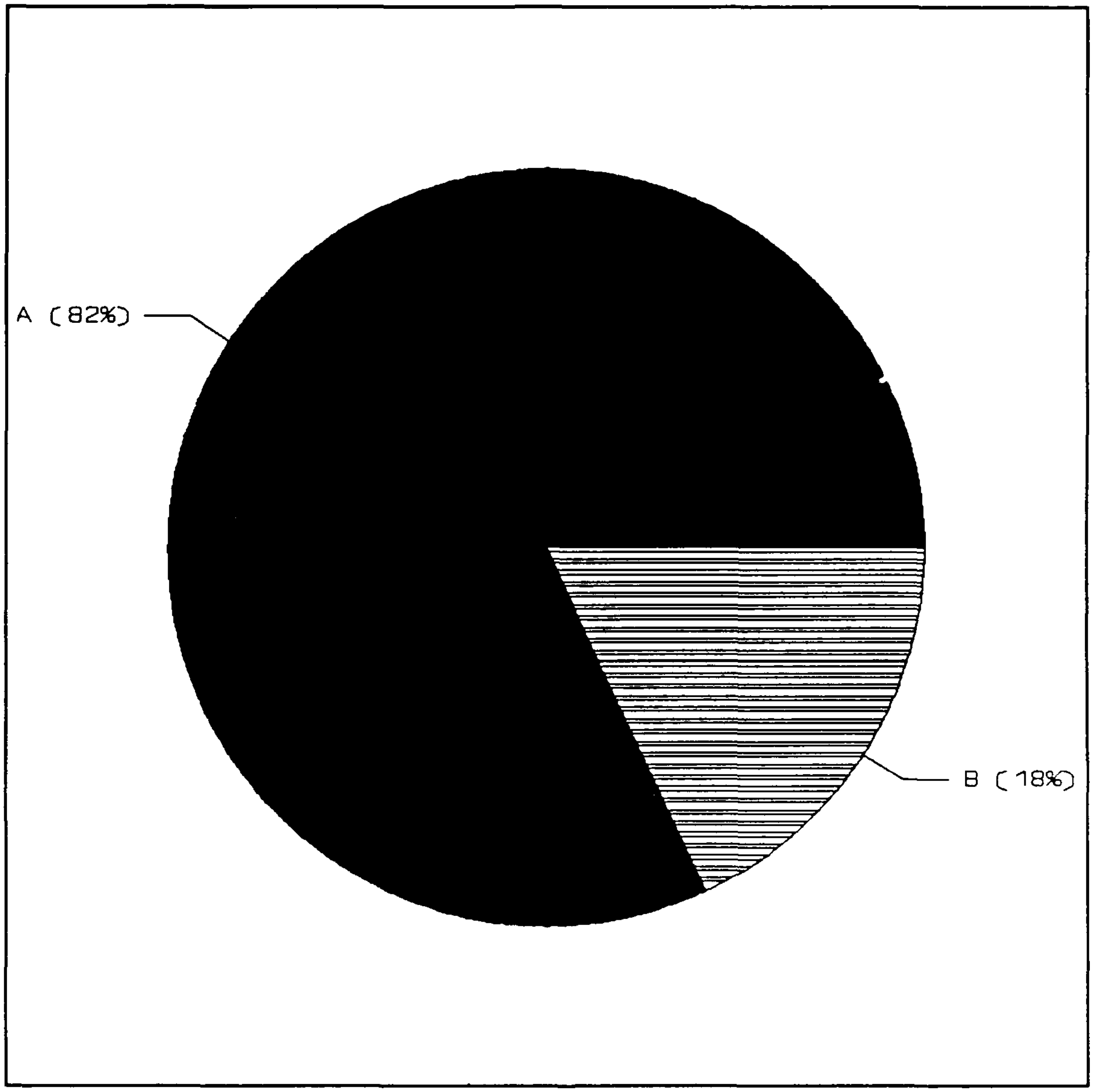

Figure D51: RESPONSE TO QUESTION 40, POPULATION CATEGORY I

40. Would you favor the introduction of more automation in the data gathering process?

A(27/81.8%). Yes. B(6/18.2%). No.

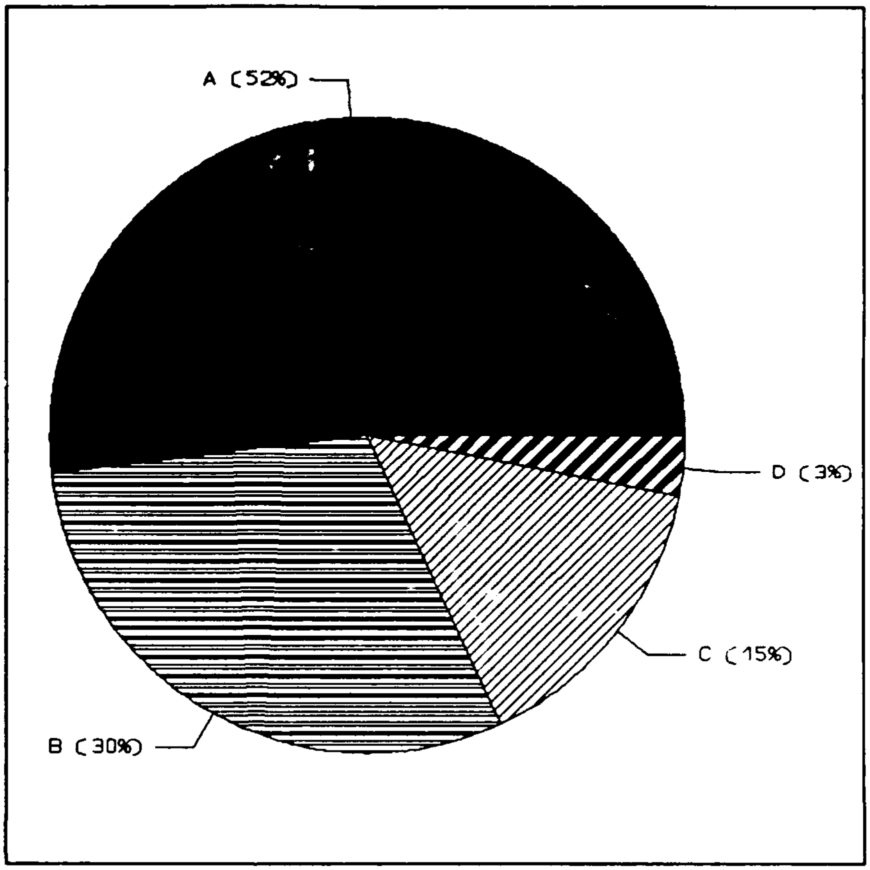

Figure D52: RESPONSE TO QUESTION 41, POPULATION CATEGORY I

41. A soon-to-be-released version of Micro PAVER will include certain changes, some of which are as follows:

(1) A graphics summary capability to produce histogram summaries of existing data.
(2) An automated annual work plan that will permit the quicker development of the pavements improvements plan as well as enable the user to determine changes to the work plan and consequences to network condition based on changing funding levels.
(3) Large data bases may be automatically broken down into smaller, more manageable data bases for quicker report generation. Individual data bases may also be combined into one large database for overall planning.
(4) Tables with default values that can be modified to meet local costs and conditions will be included.
(5) The family curve concept will be made an integral part of reports.

Please select the response which best reflects your opinion of these changes.

A(17/51.5%). These changes will enhance the usefulness of PAVER greatly.
B(10/30.3%). These changes will enhance the usefulness of PAVER somewhat.
C(5/15.2%). These changes will enhance the usefulness of PAVER a little.
D(1/3%). These changes will not enhance the usefulness of PAVER.
E(0/0%). These changes will detract from the usefulness of PAVER.

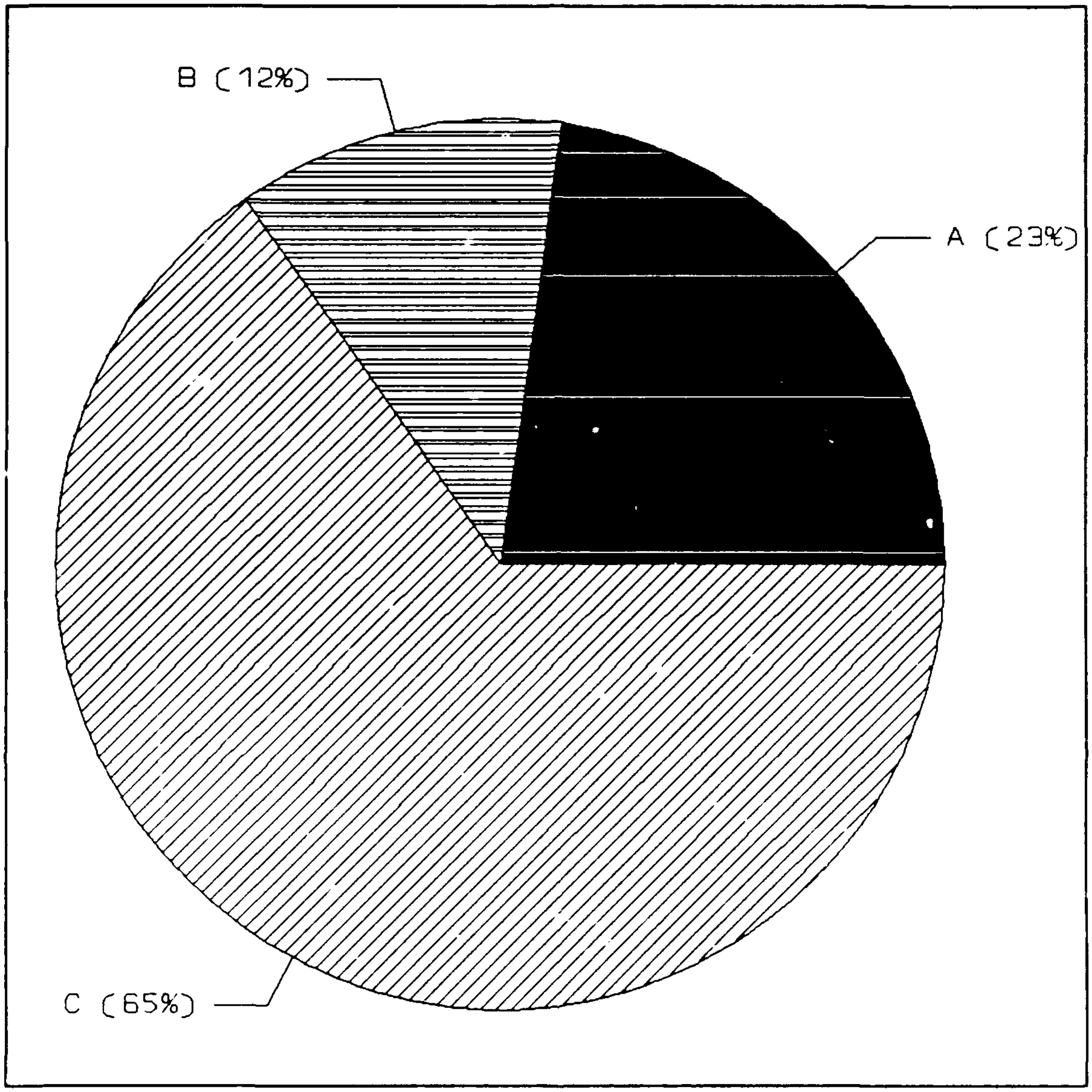

Figure D53: RESPONSE TO QUESTION 42, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

42. Training in PAVER has not been made available.

A(6/23.1%). Major contributing reason
B(3/11.5%). Minor contributing reason
C(17/65.4%). Not a contributing reason

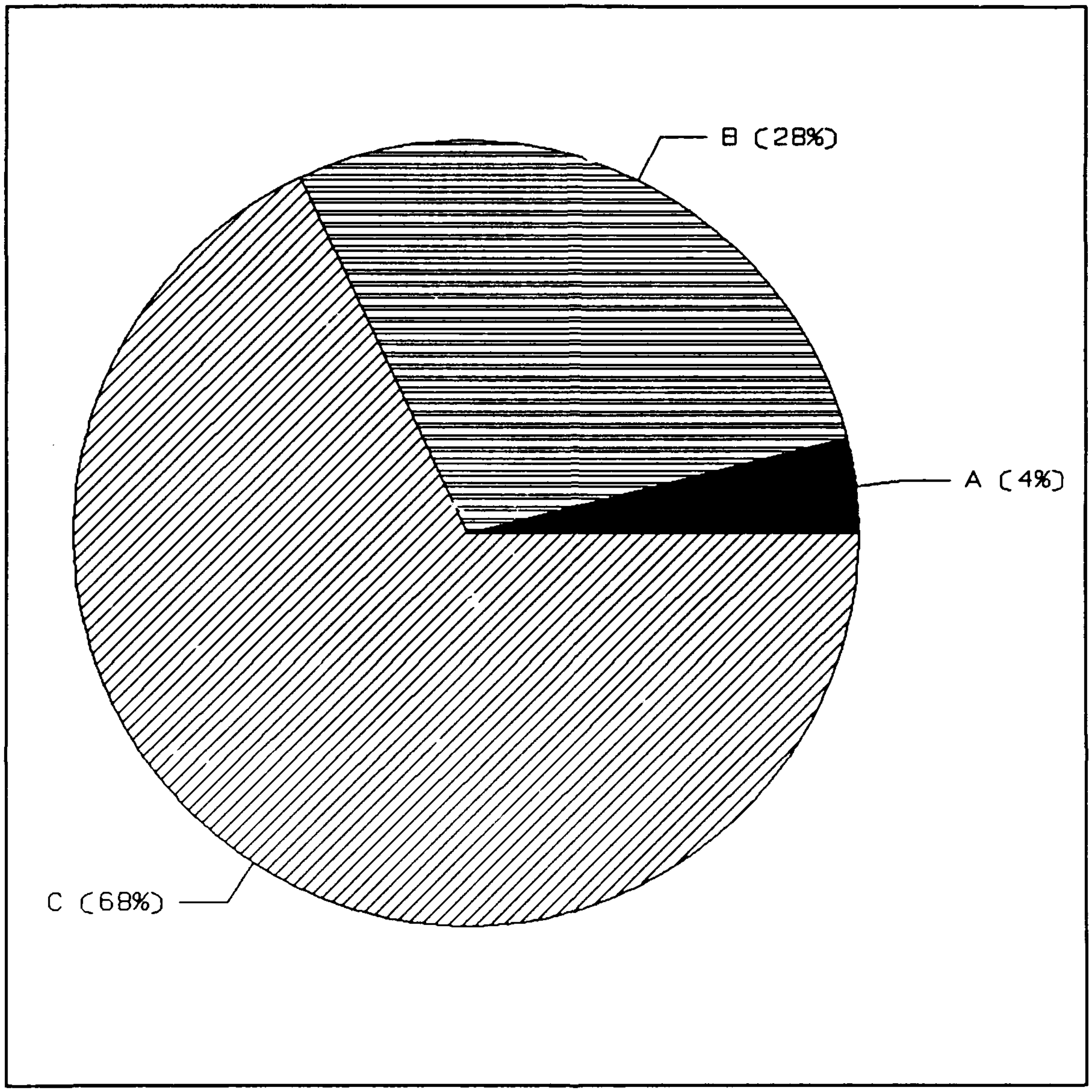

Figure D54: RESPONSE TO QUESTION 43, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

43. Training in PAVER has been made available but we cannot afford the manpower loss to participate in training.

A(1/4%). Major contributing reason
B(7/28%). Minor contributing reason
C(17/68%). Not a contributing reason

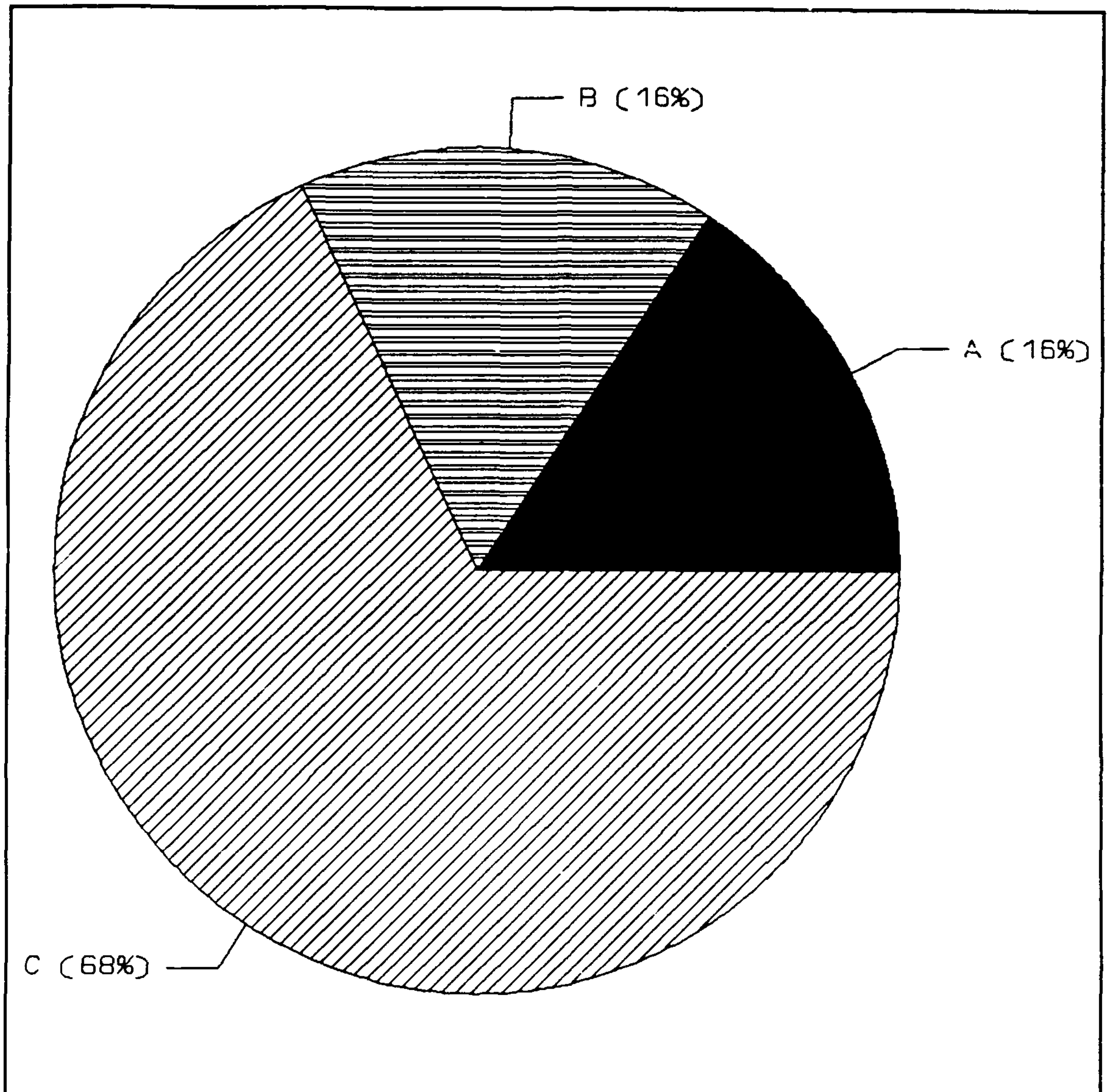

Figure D55: RESPONSE TO QUESTION 44, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

44. Training in PAVER has been made available but we do not have the funds to participate in training.

A(4/16%). Major contributing reason
B(4/16%). Minor contributing reason
C(17/68%). Not a contributing reason

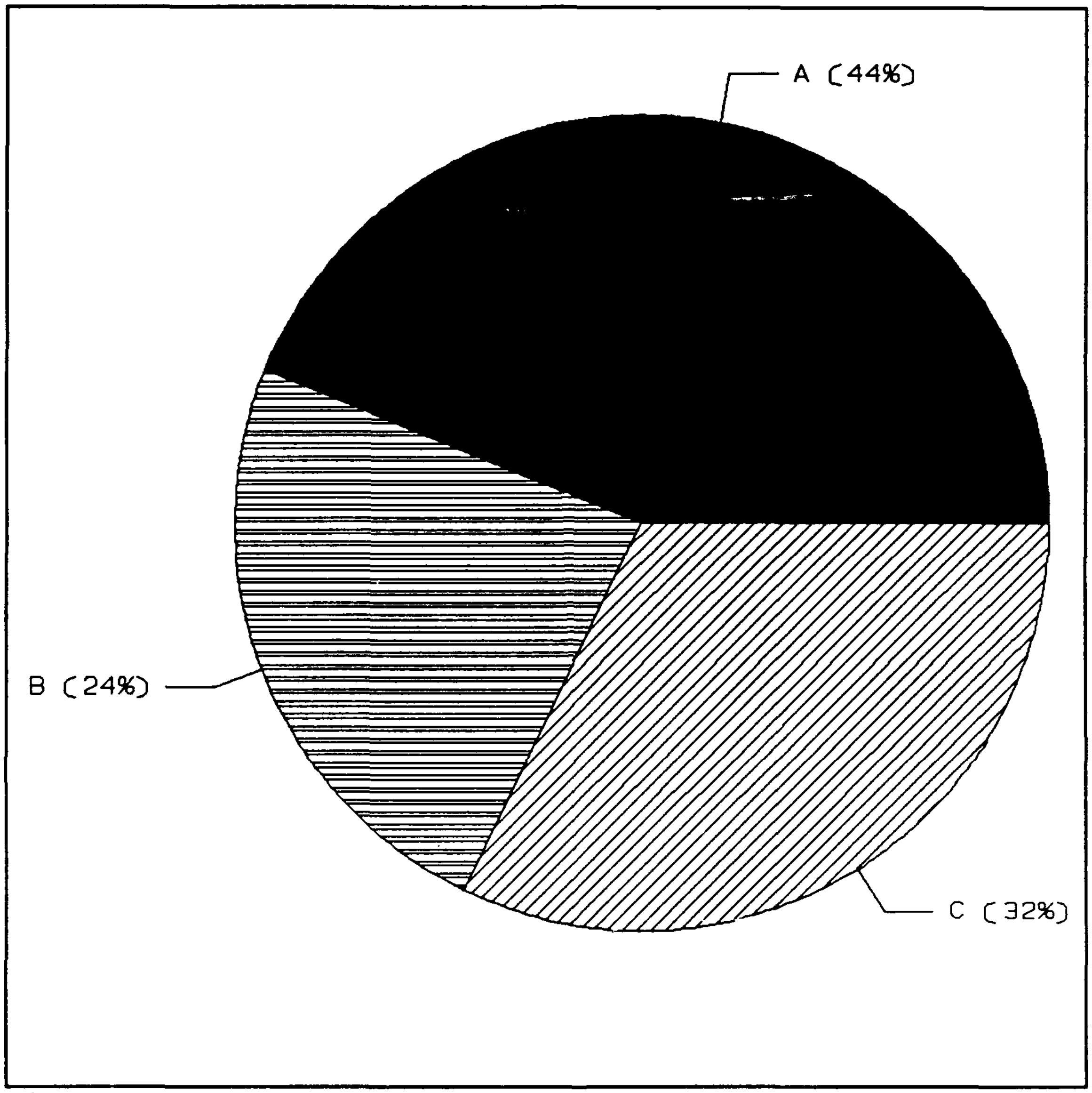

Figure D56: RESPONSE TO QUESTION 45, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

45. We lack sufficient manhours to implement PAVER.

A(11/44%). Major contributing reason
B(6/24%). Minor contributing reason
C(8/32%). Not a contributing reason

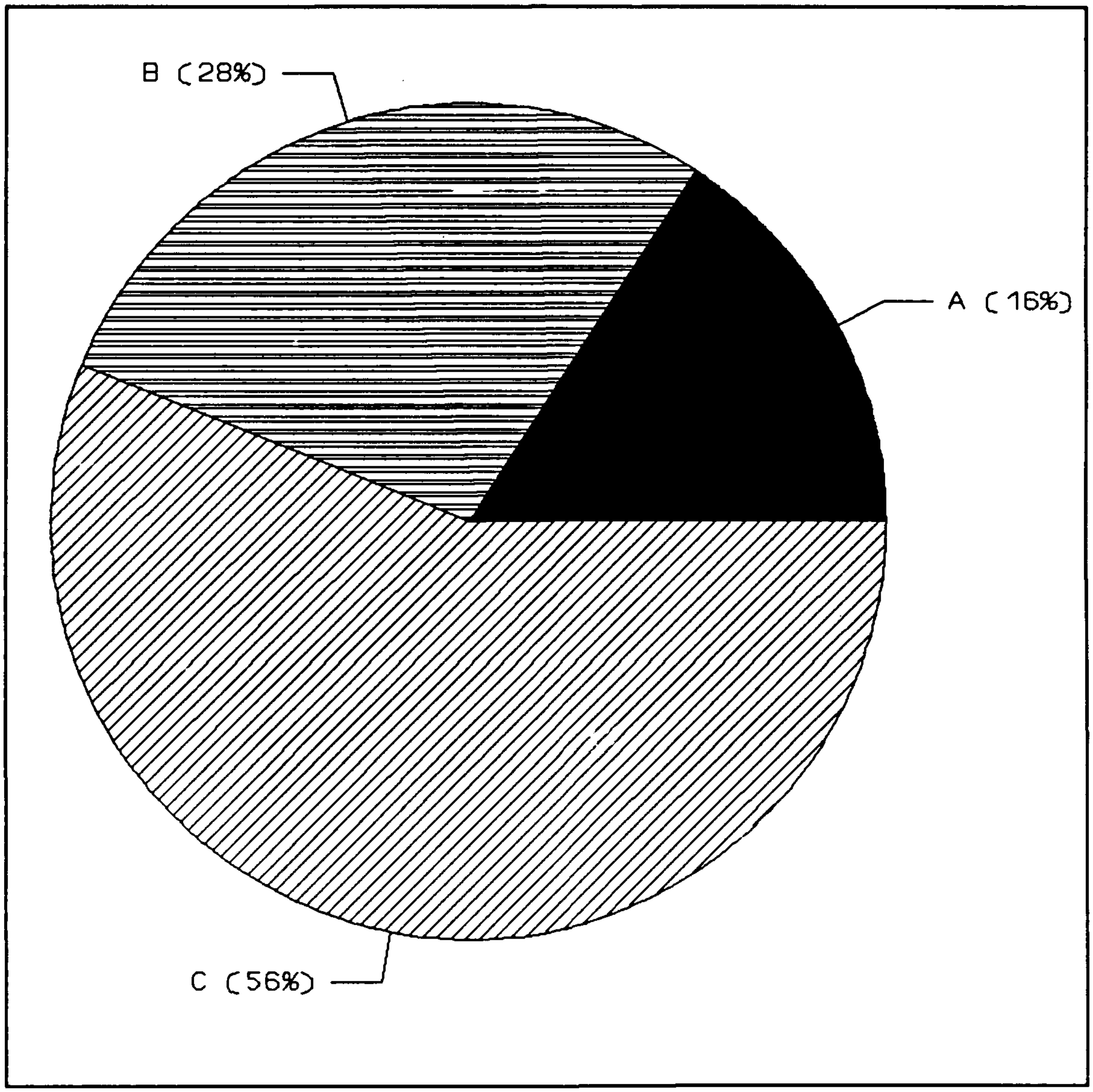

Figure D57: RESPONSE TO QUESTION 46, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

46. We have sufficient manhours but have higher priority uses for these manhours.

A(4/16%). Major contributing reason
B(7/28%). Minor contributing reason
C(14/56%). Not a contributing reason

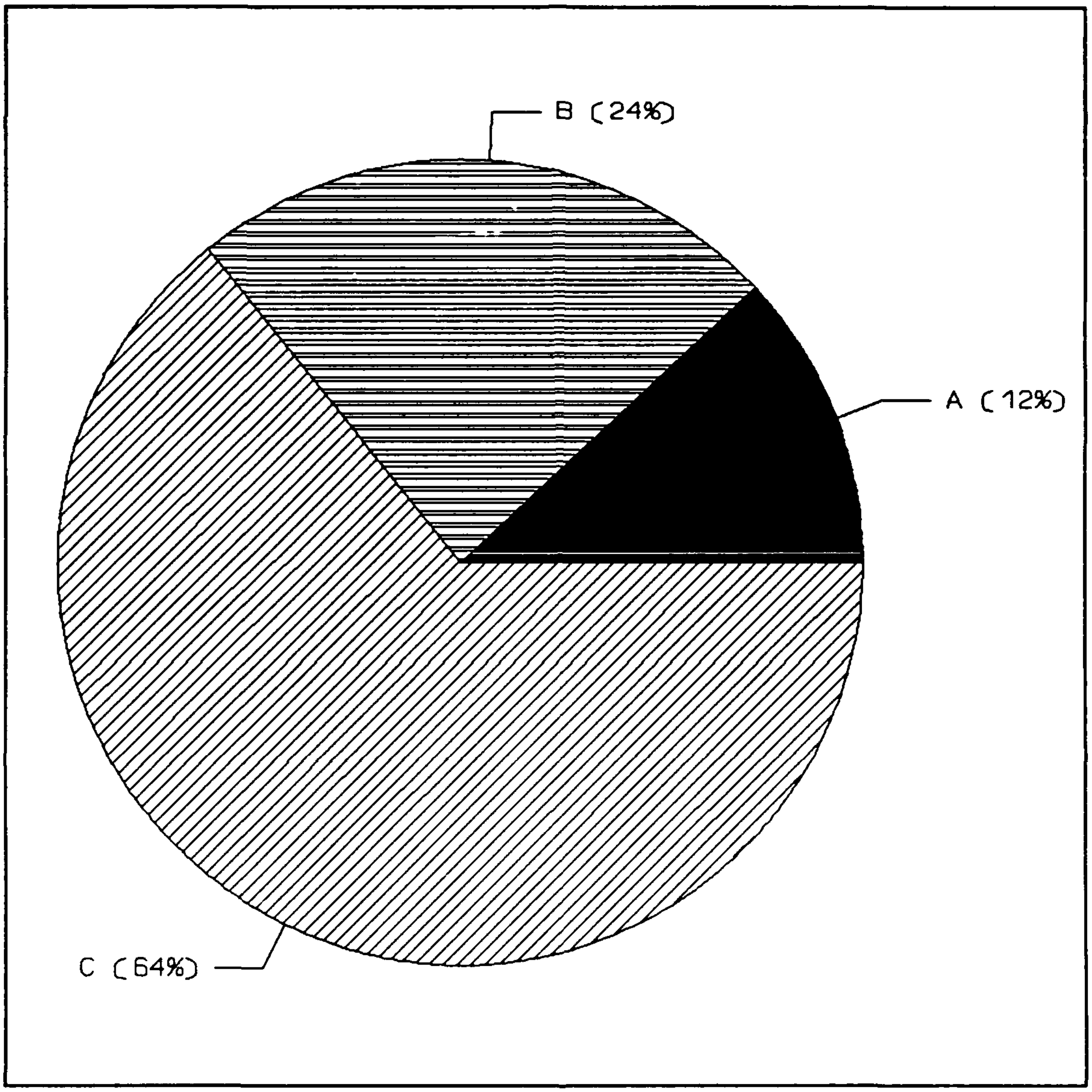

Figure D58: RESPONSE TO QUESTION 47, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

47. We have sufficient manhours but are required to spend them satisfying the requirements of higher levels of management.

A(3/12%). Major contributing reason
B(6/24%). Minor contributing reason
C(16/64%). Not a contributing reason

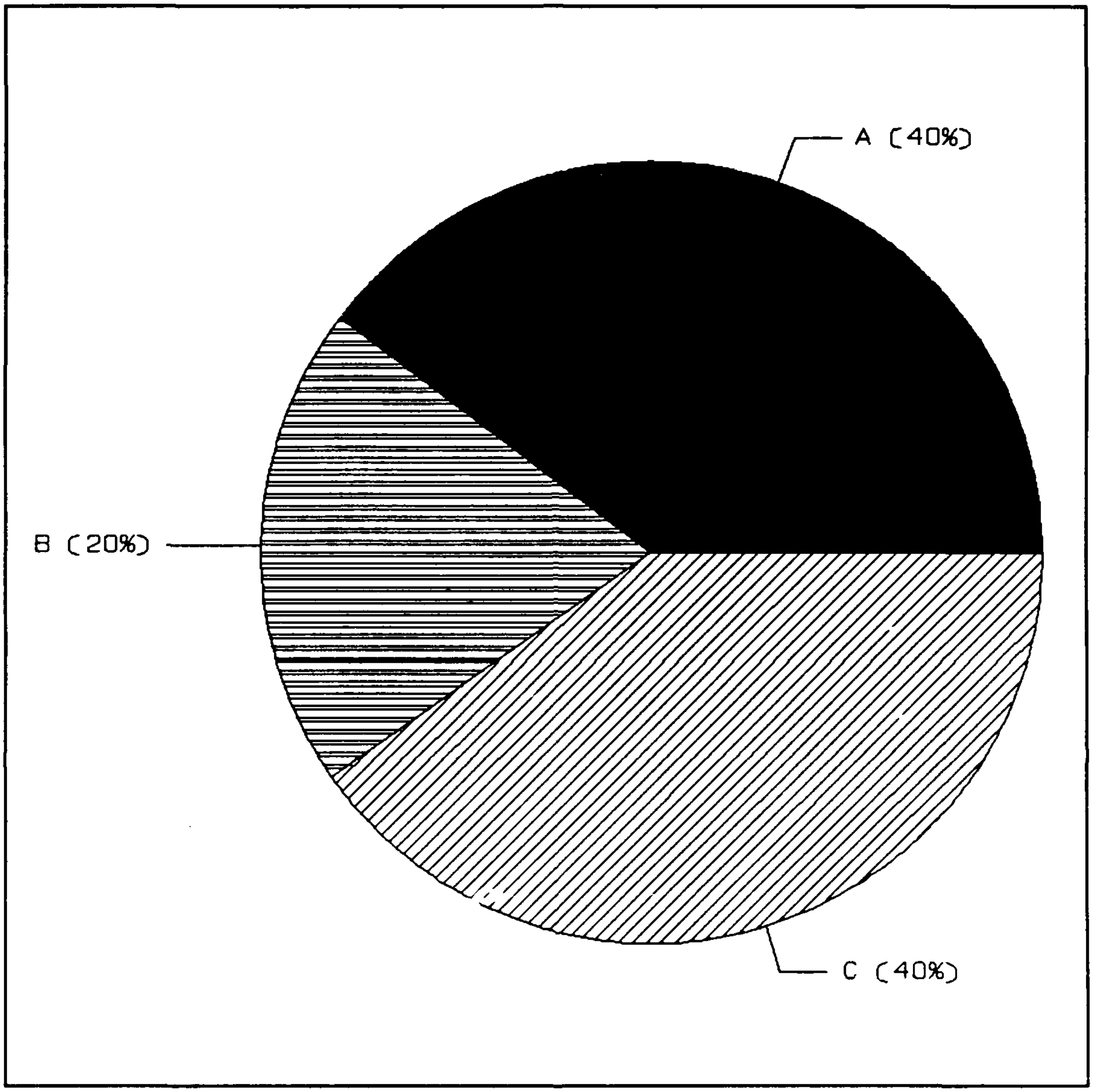

Figure D58: RESPONSE TO QUESTION 48, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

48. We lack the Micro PAVER computer program.

A(10/40%). Major contributing reason
B(5/20%). Minor contributing reason
C(10/40%). Not a contributing reason

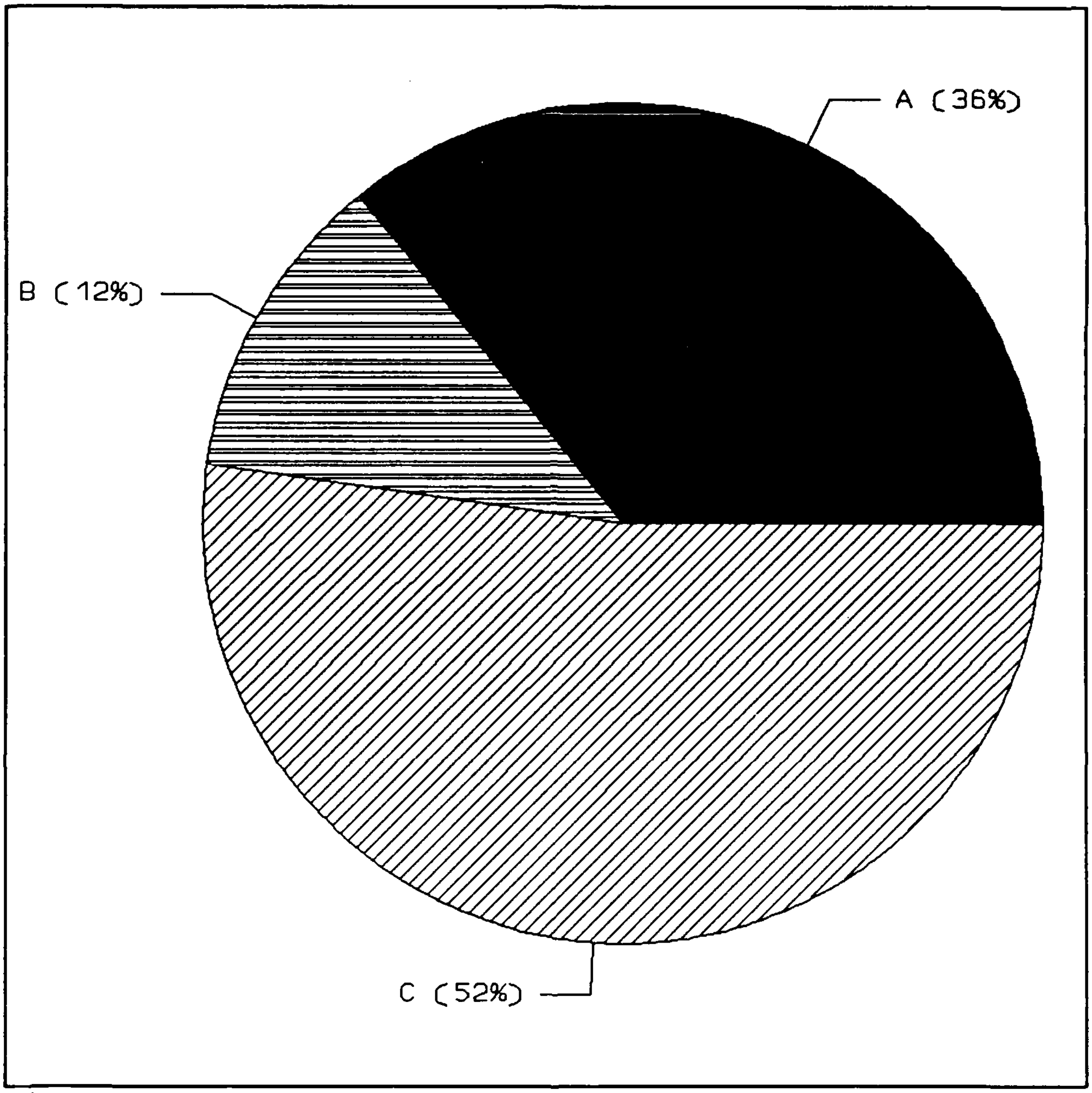

Figure D59: RESPONSE TO QUESTION 49, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

49. We lack the hardware for PAVER.

A(9/36%). Major contributing reason
B(3/12%). Minor contributing reason
C(13/52%). Not a contributing reason

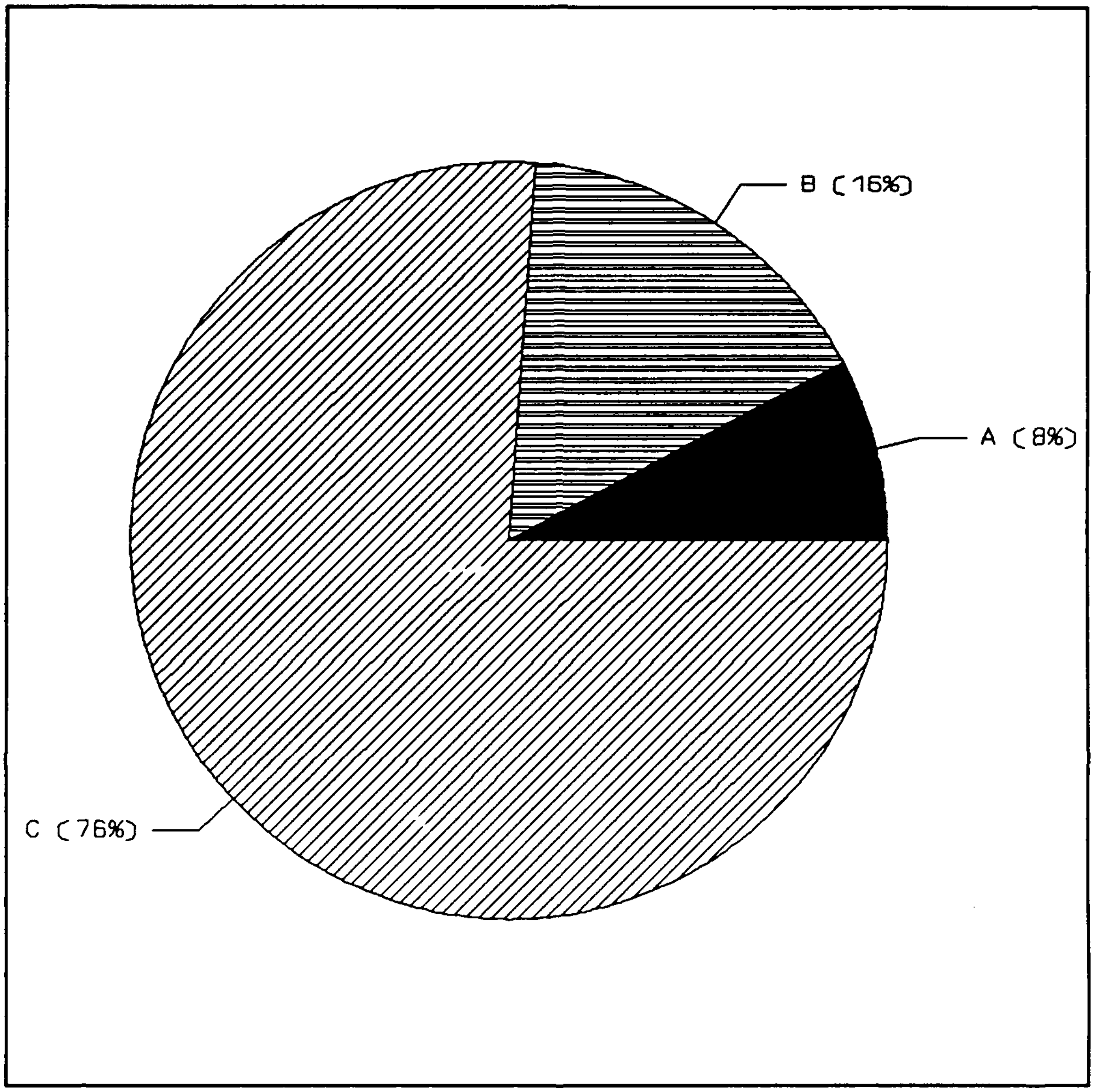

Figure D60: RESPONSE TO QUESTION 50, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

50. We are not aware of the benefits of using PAVER.

A(2/8%). Major contributing reason
B(4/16%). Minor contributing reason
C(19/76%). Not a contributing reason

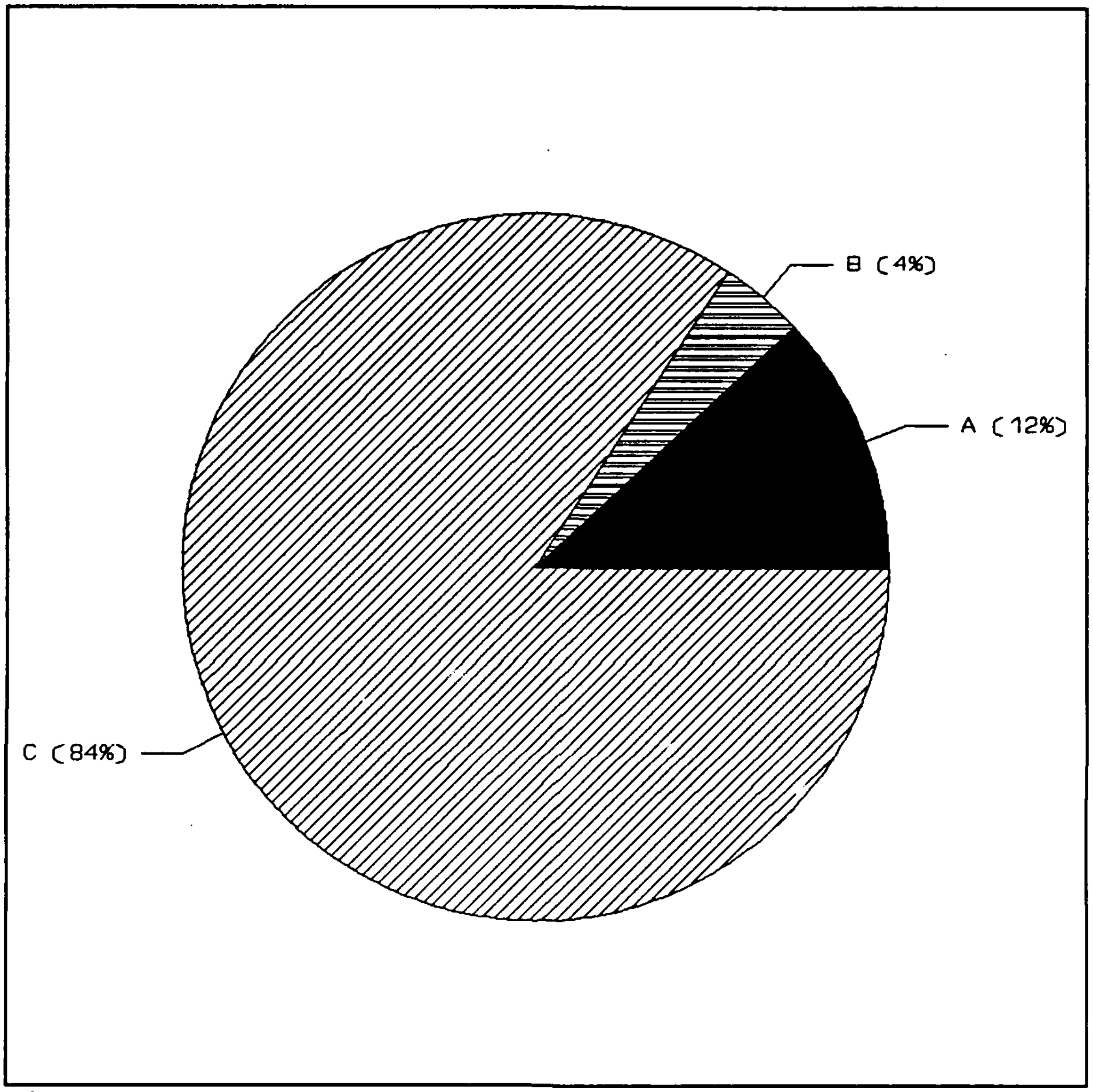

Figure D61: RESPONSE TO QUESTION 51, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

51. We do not think PAVER can solve our pavement management problems.

A(3/12%). Major contributing reason
B(1/4%). Minor contributing reason
C(21/84%). Not a contributing reason

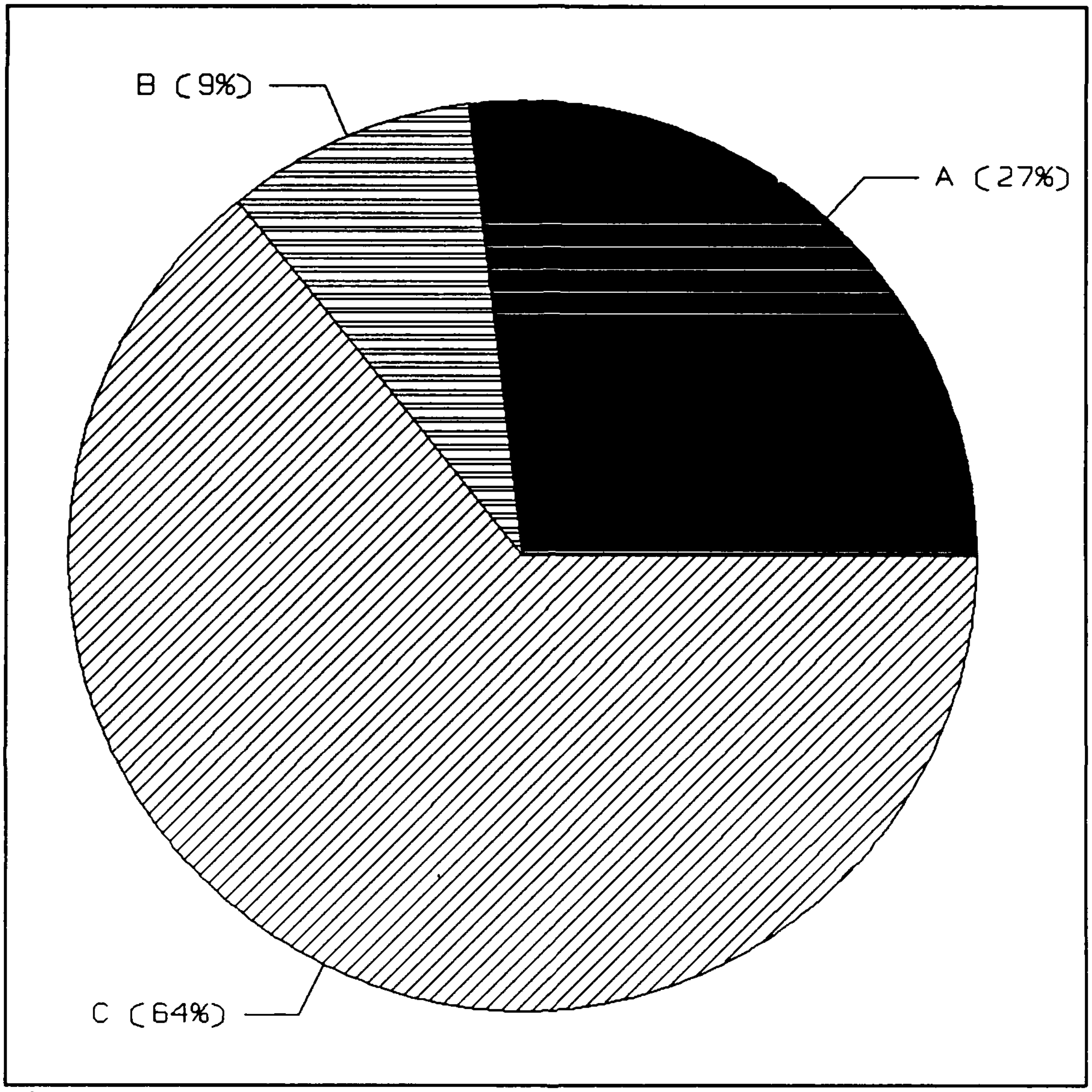

Figure D62: RESPONSE TO QUESTION 52, POPULATION CATEGORY NI

Rate the following item as a contributing reason explaining why your base has not implemented PAVER (A = major contributing reason; B = minor contributing reason; C = not a contributing reason):

52. Other.

A(3/27.3%). Major contributing reason
B(1/9.1%). Minor contributing reason
C(7/63.6%). Not a contributing reason

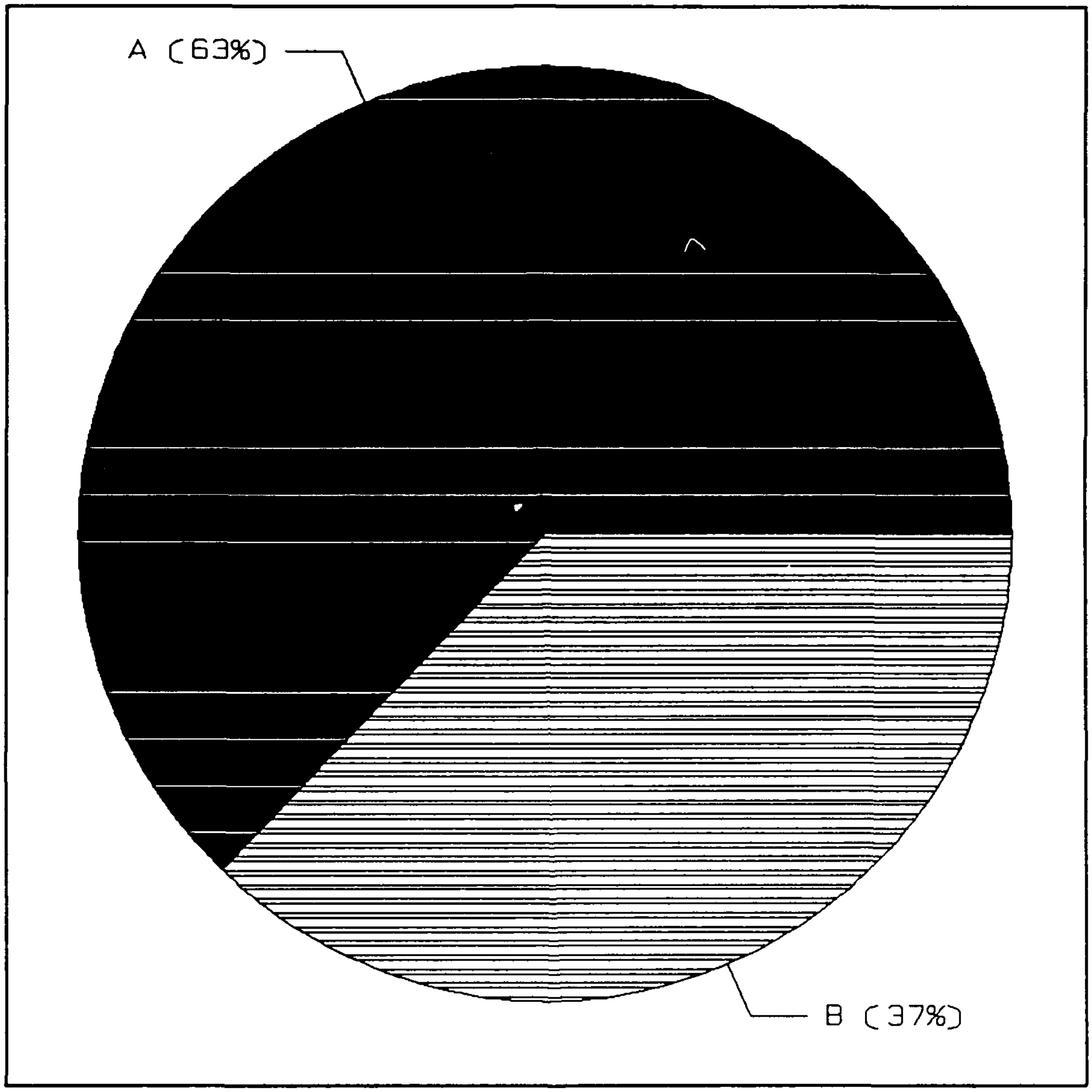

Figure D63: RESPONSE TO QUESTION 53, POPULATION CATEGORY NI

53. Do you plan to implement PAVER in the future (next 1-2 years)?

A(15/62.5%). Yes
B(9/37.5%). No

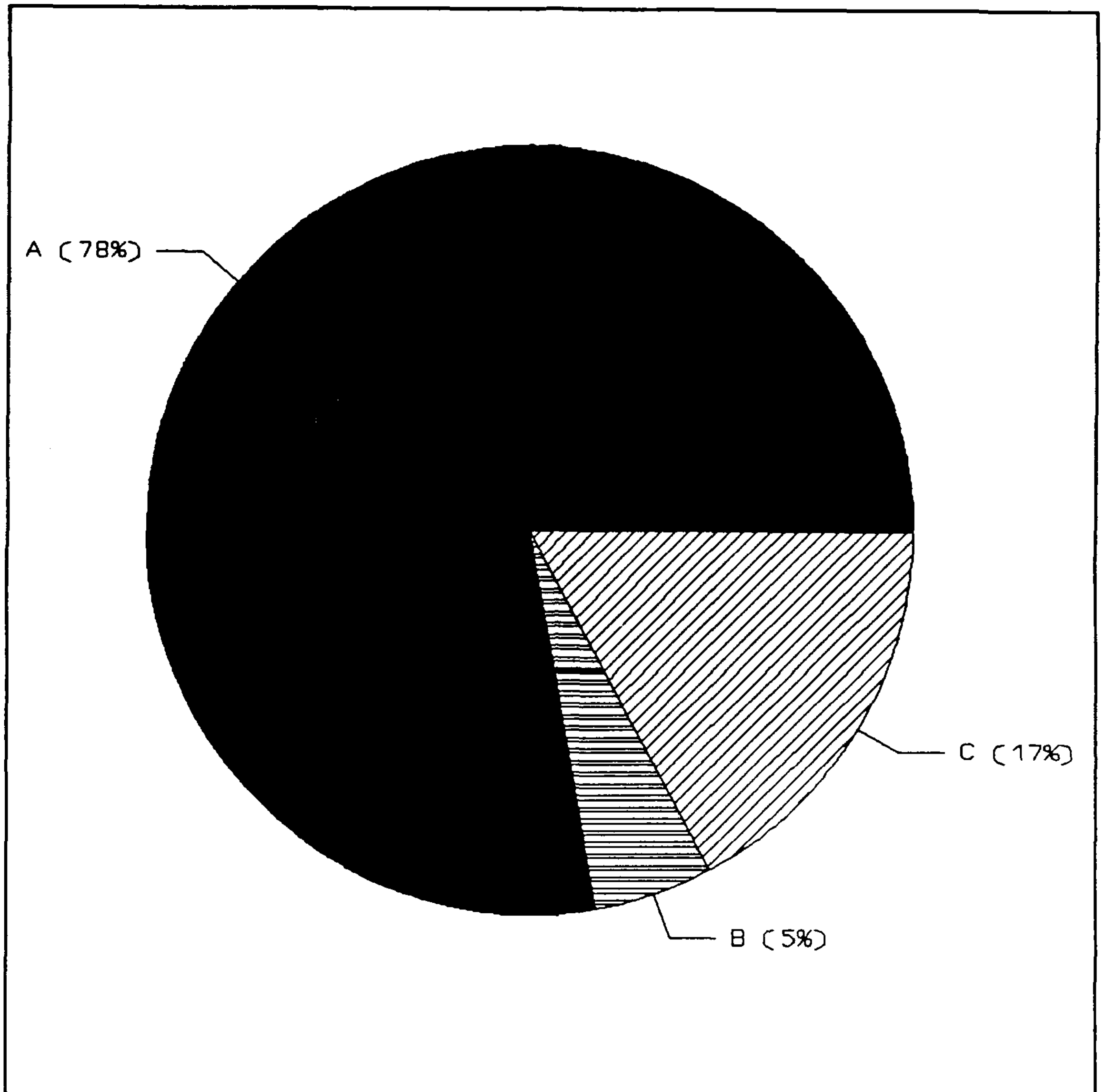

Figure D64: RESPONSE TO QUESTION 54, POPULATION CATEGORY A

54. Do you perceive PAVER as an innovation to be an improvement over previously used methods of pavement management?

A(45/77.6%). Yes.
B(3/5.2%). No.
C(10/17.2%). Not applicable; I am insufficiently familiar with PAVER or previous pavement mgt. methods.

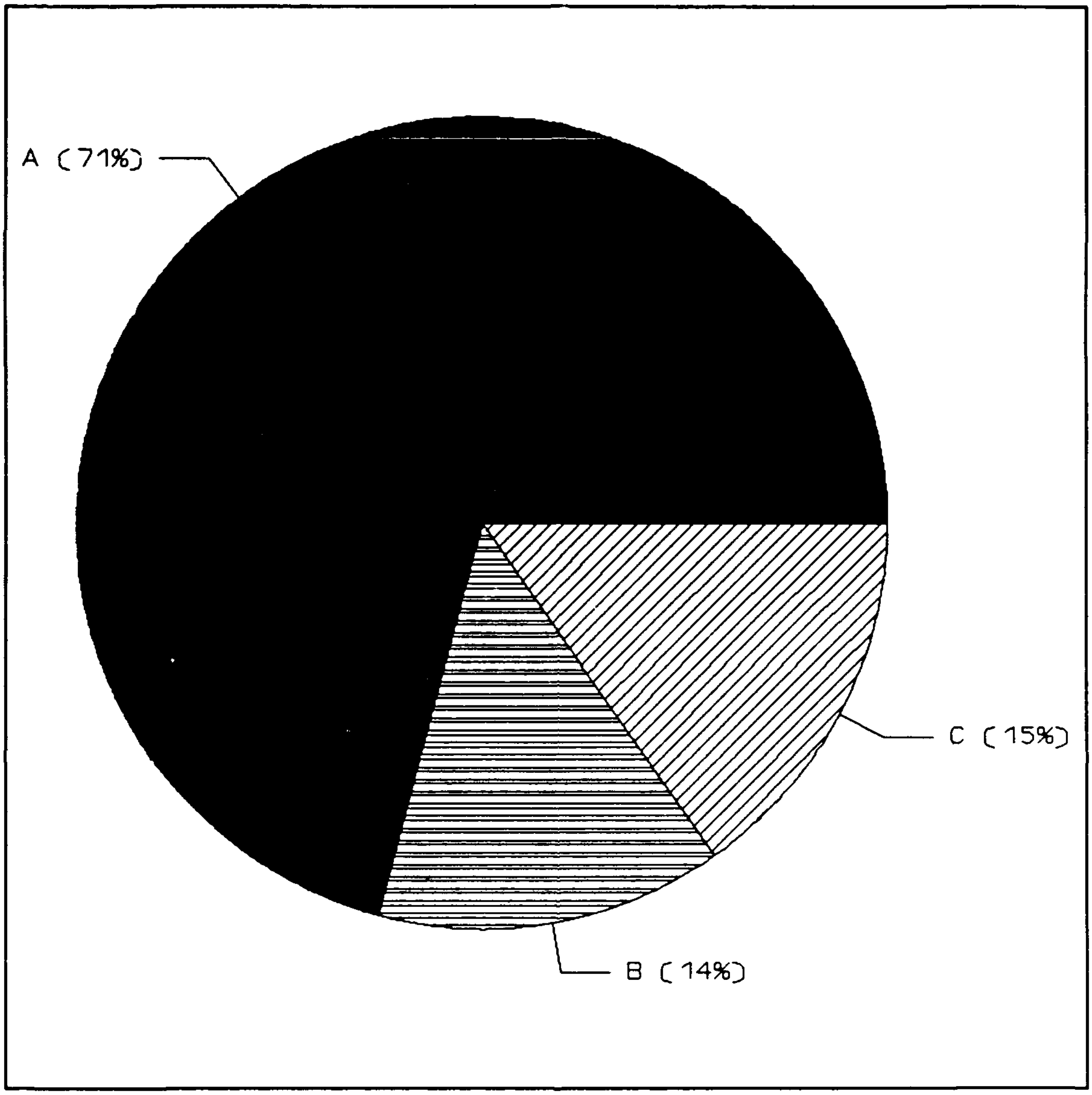

Figure D65: RESPONSE TO QUESTION 55, POPULATION CATEGORY A

55. Do you perceive PAVER to be compatible with existing management methods in your organization?

A(42/71.2%). Yes.
B(8/13.6%). No.
C(9/15.3%). Not applicable; I am insufficiently familiar with PAVER to judge.

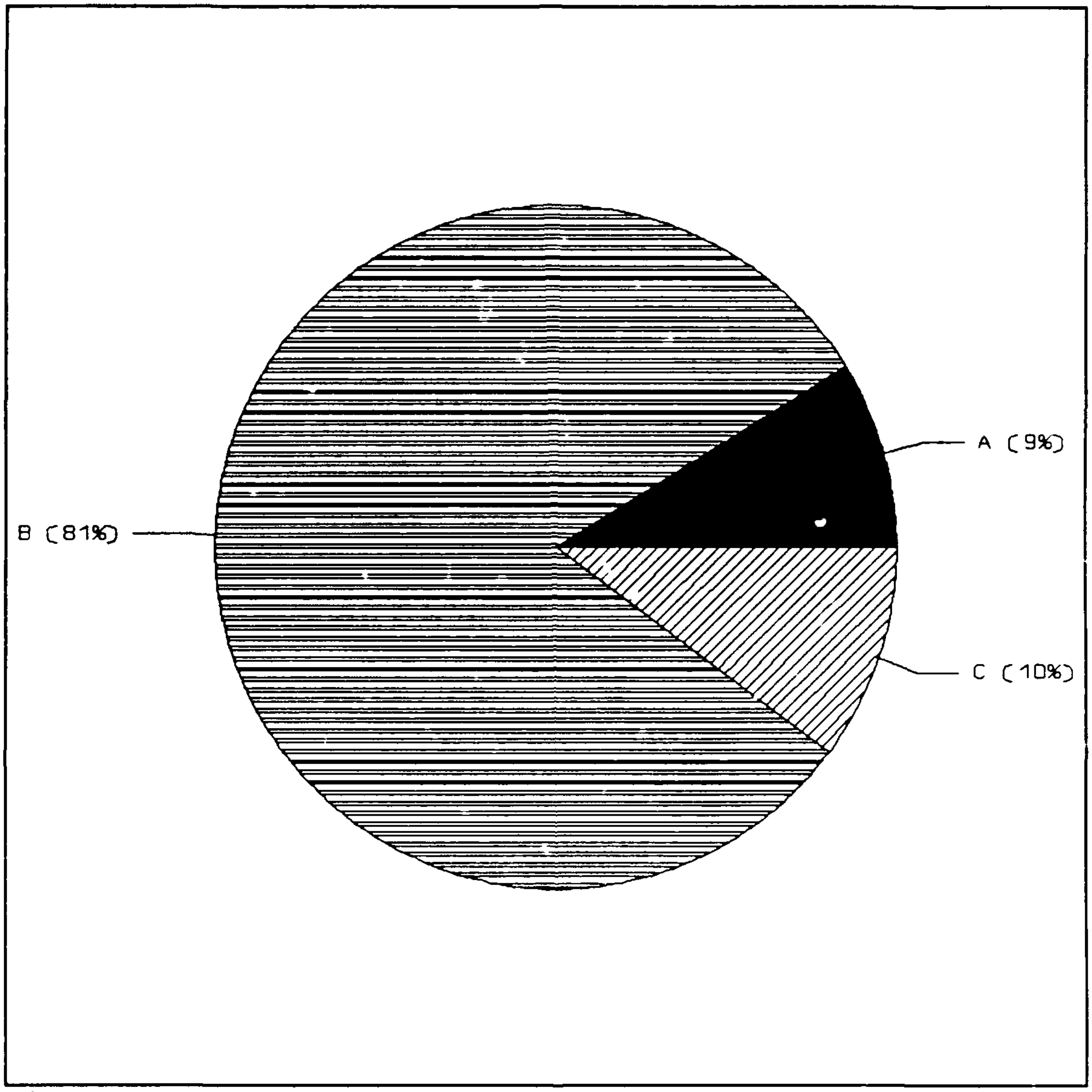

Figure D66: RESPONSE TO QUESTION 56, POPULATION CATEGORY A

56. Do you perceive PAVER to be too complex, that is, too difficult to understand and use?

A(5/8.5%). Yes.
B(48/81.4%). No.
C(6/10.2%). Not applicable; I am insufficiently familiar with PAVER to judge.

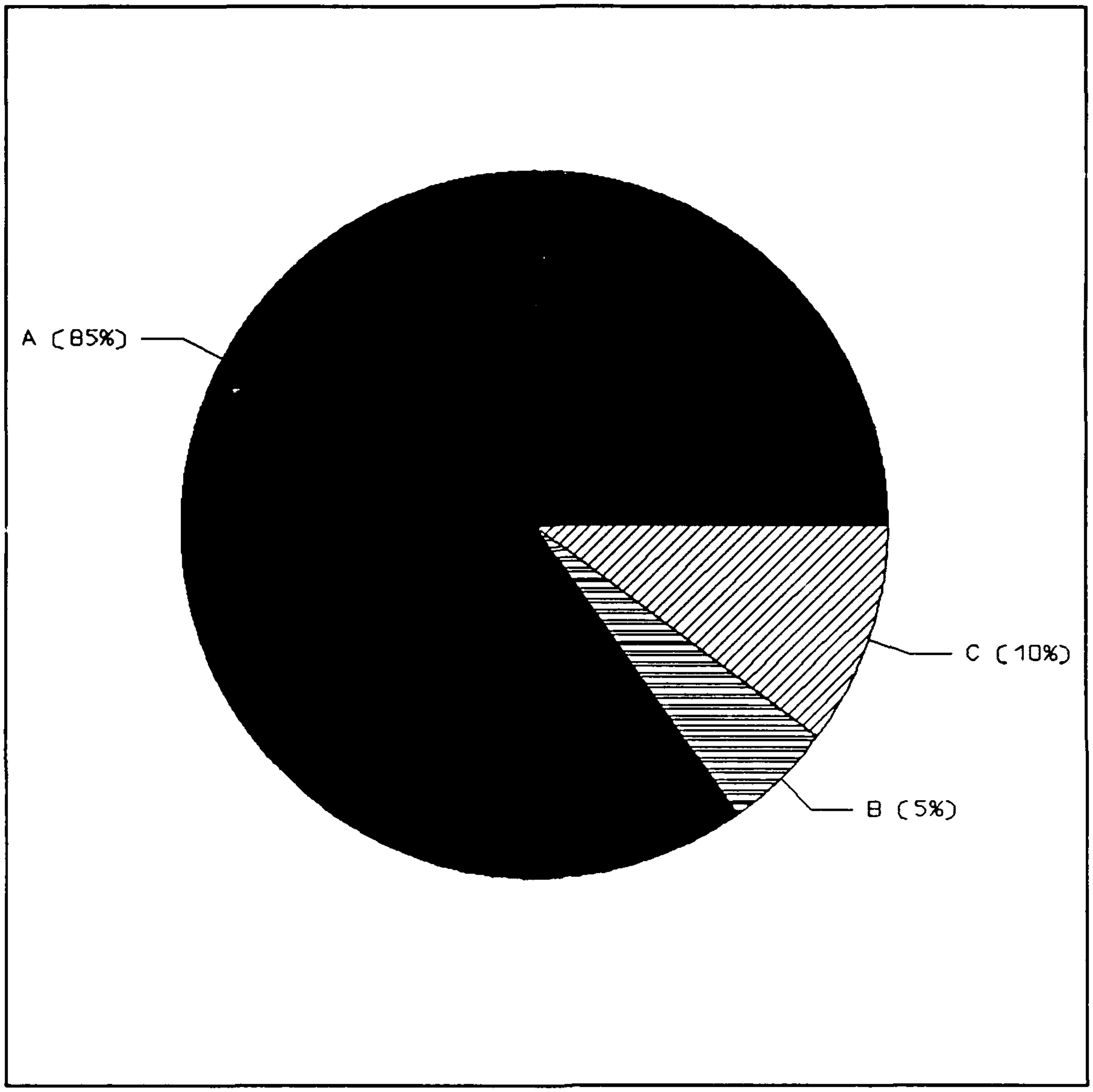

Figure D67: RESPONSE TO QUESTION 58, POPULATION CATEGORY A

57. Do you perceive PAVER to provide you with results which you can relate to peers and higher management?

A(50/84.7%). Yes.
B(3/5.1%). No.
C(6/10.2%). Not applicable; I am insufficiently familiar with PAVER to judge.

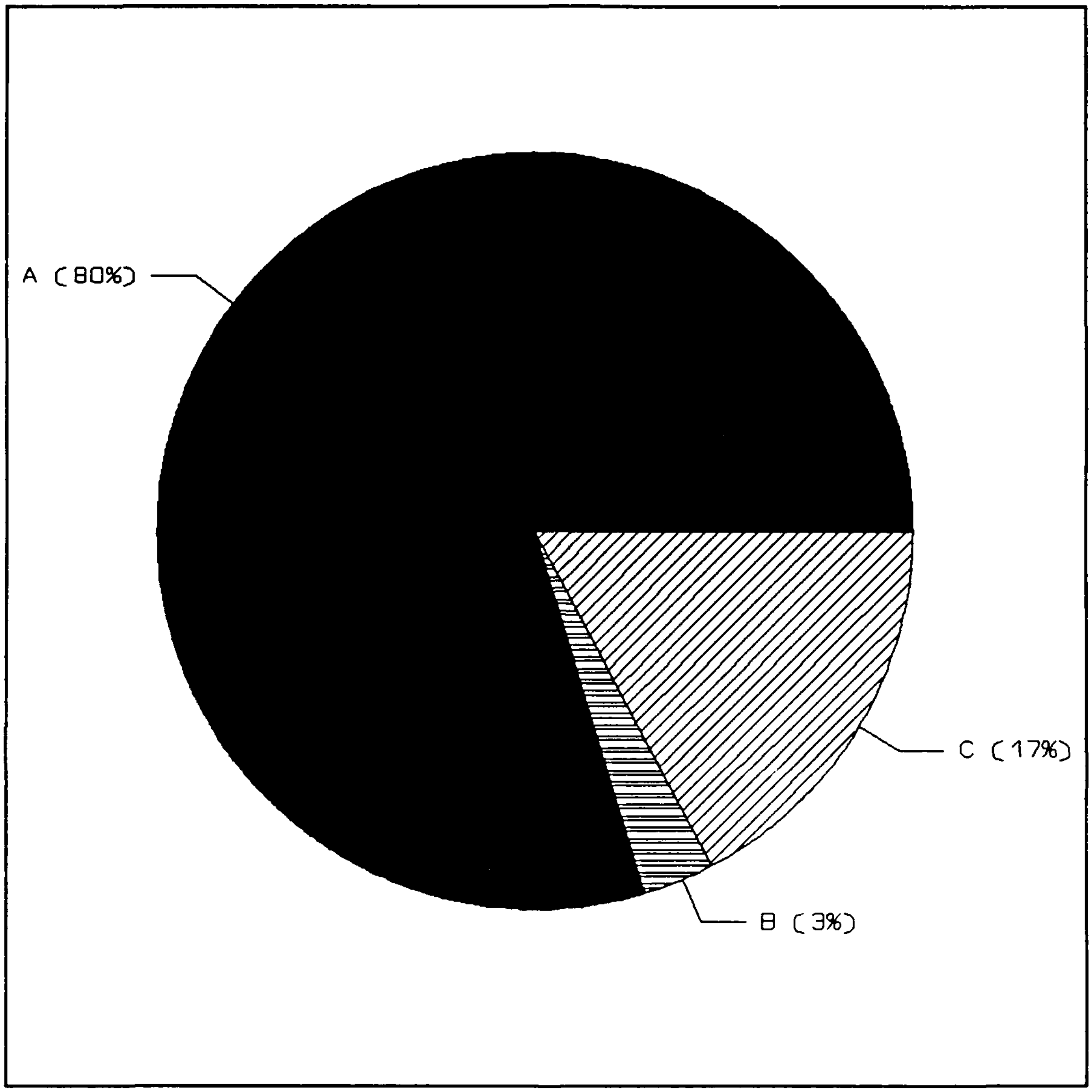

Figure D68: RESPONSE TO QUESTION 58, POPULATION CATEGORY A

58. Do you perceive PAVER to be adaptable, that is, able to be modified to be useful for your base's particular needs?

A(47/79.7%). Yes.
B(2/3.4%). No.
C(10/16.9%). Not applicable; I am insufficiently familiar with PAVER to judge.

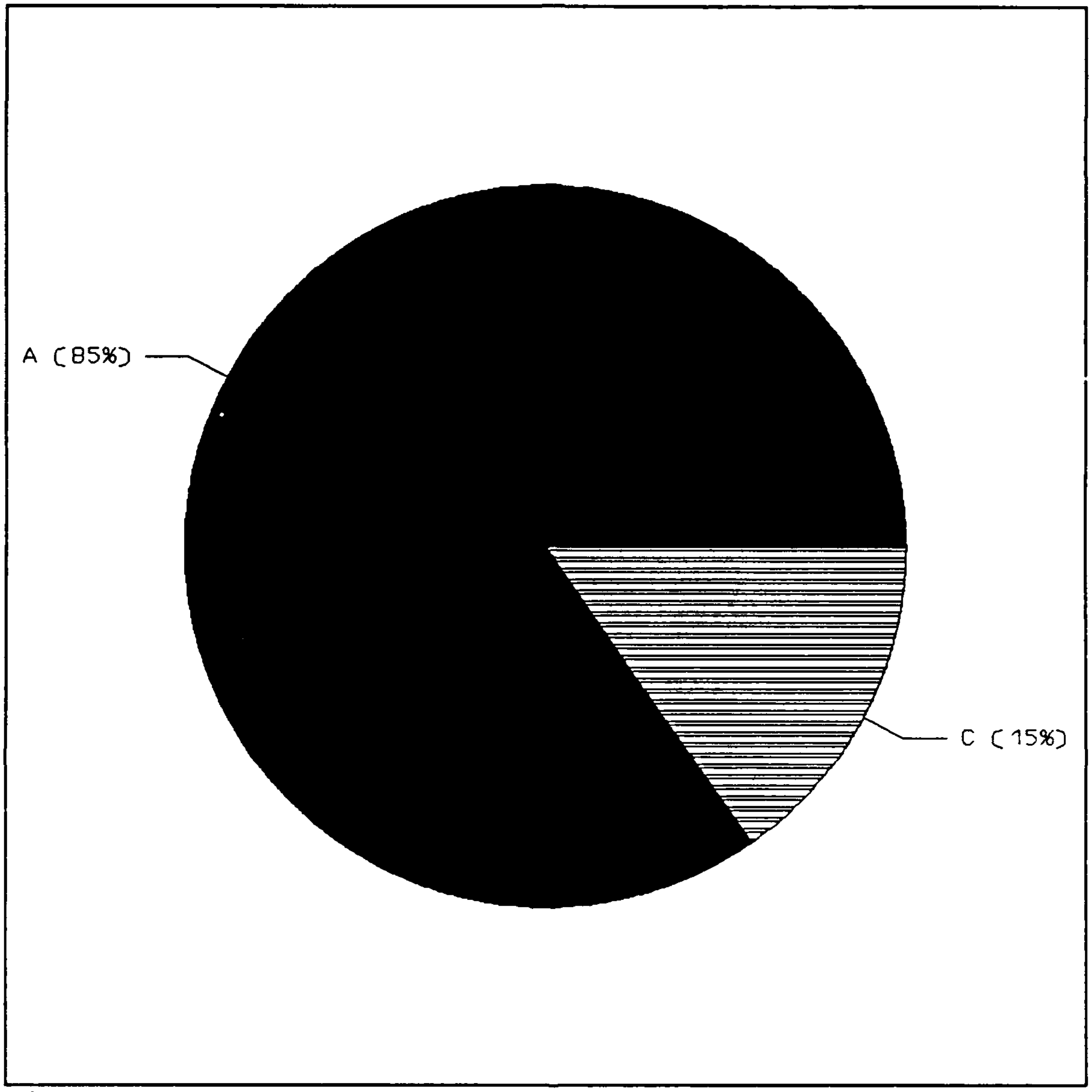

Figure D69: RESPONSE TO QUESTION 59, POPULATION CATEGORY A

59. Do you perceive PAVER to be credible, that is, soundly based on technical content?

A(50/84.7%). Yes.
B(0/0%). No.
C(9/15.3%). Not applicable; I am insufficiently familiar with PAVER to judge.

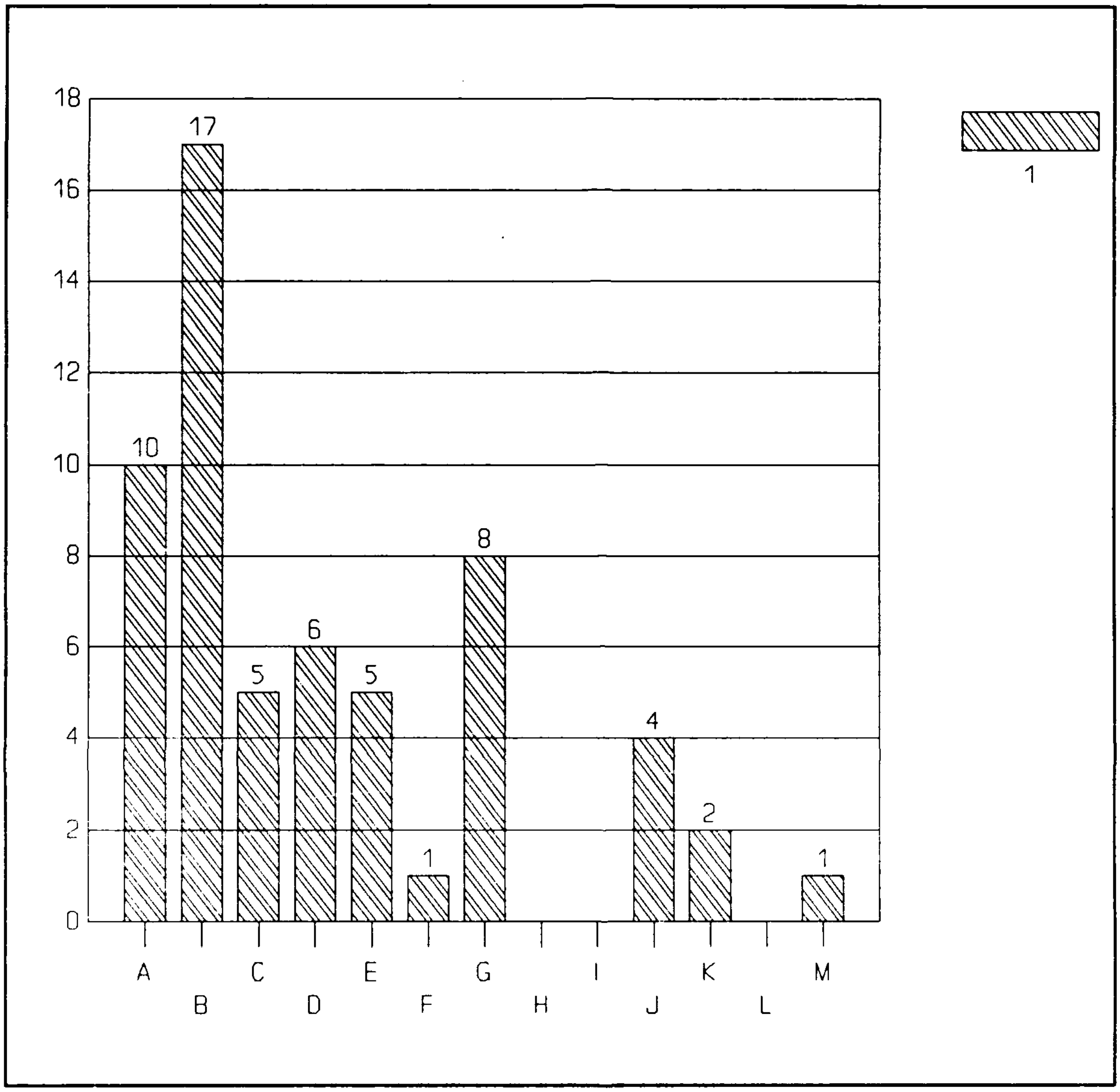

Figure D60: RESPONSE TO QUESTIONS 60-63, POPULATION CATEGORY A

60-63. What is your MAJCOM or SOA?

A(10).	TAC	E(5).	ATC	H(0).	AFSPACECOM	K(2).	AFSC
B(17).	SAC	F(1).	AAC	I(0).	AFDW	L(0).	AU
C(5).	PACAF	G(8).	MAC	J(4).	AFLC	M(1).	USAFA
D(6).	USAFE						

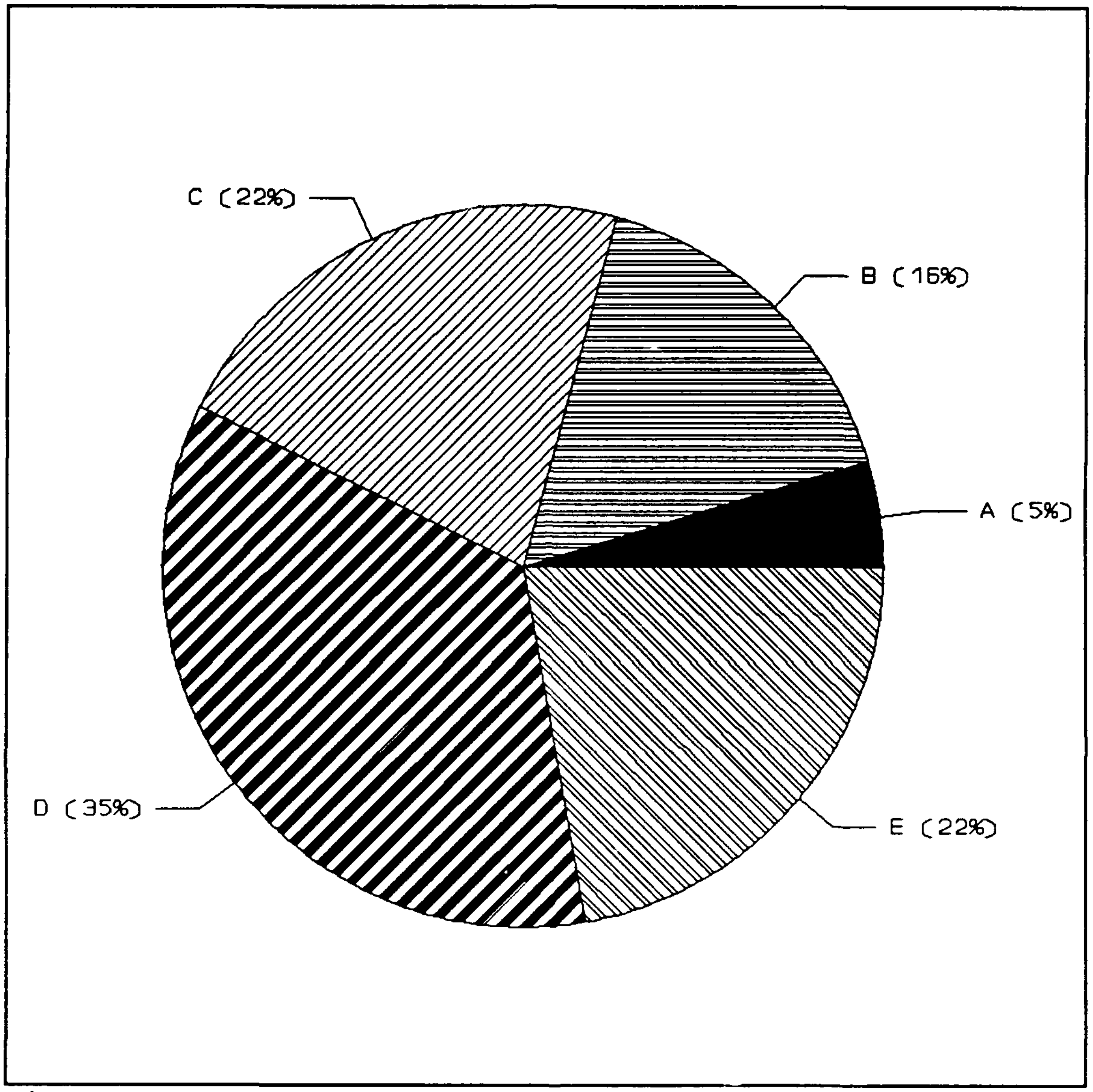

Figure D71: RESPONSE TO QUESTION 64, POPULATION CATEGORY A

64. How many years have you been engaged in the engineering profession?

A(3/5.2%). 0-2
B(9/15.5%). 3-5
C(13/22.4%). 6-10
D(20/34.5%). 11-20
E(13/22.4%). More than 20

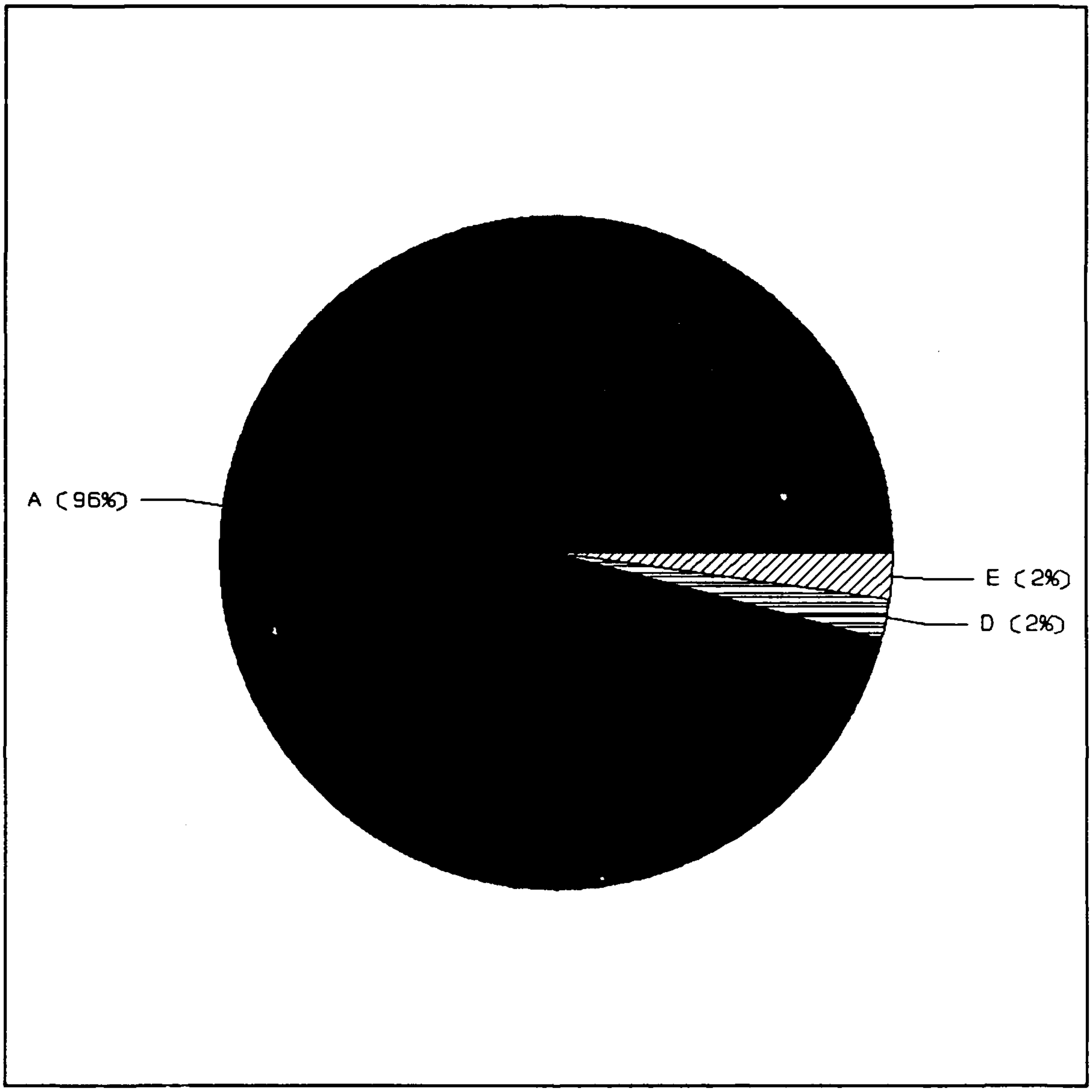

Figure D72: RESPONSE TO QUESTION 65, POPULATION CATEGORY A

65. What is your engineering discipline?

A(56/96.6%). Civil
B(0/0%). Mechanical
C(0/0%). Electrical
D(1/1.7%). Architectural
E(1/1.7%). Other

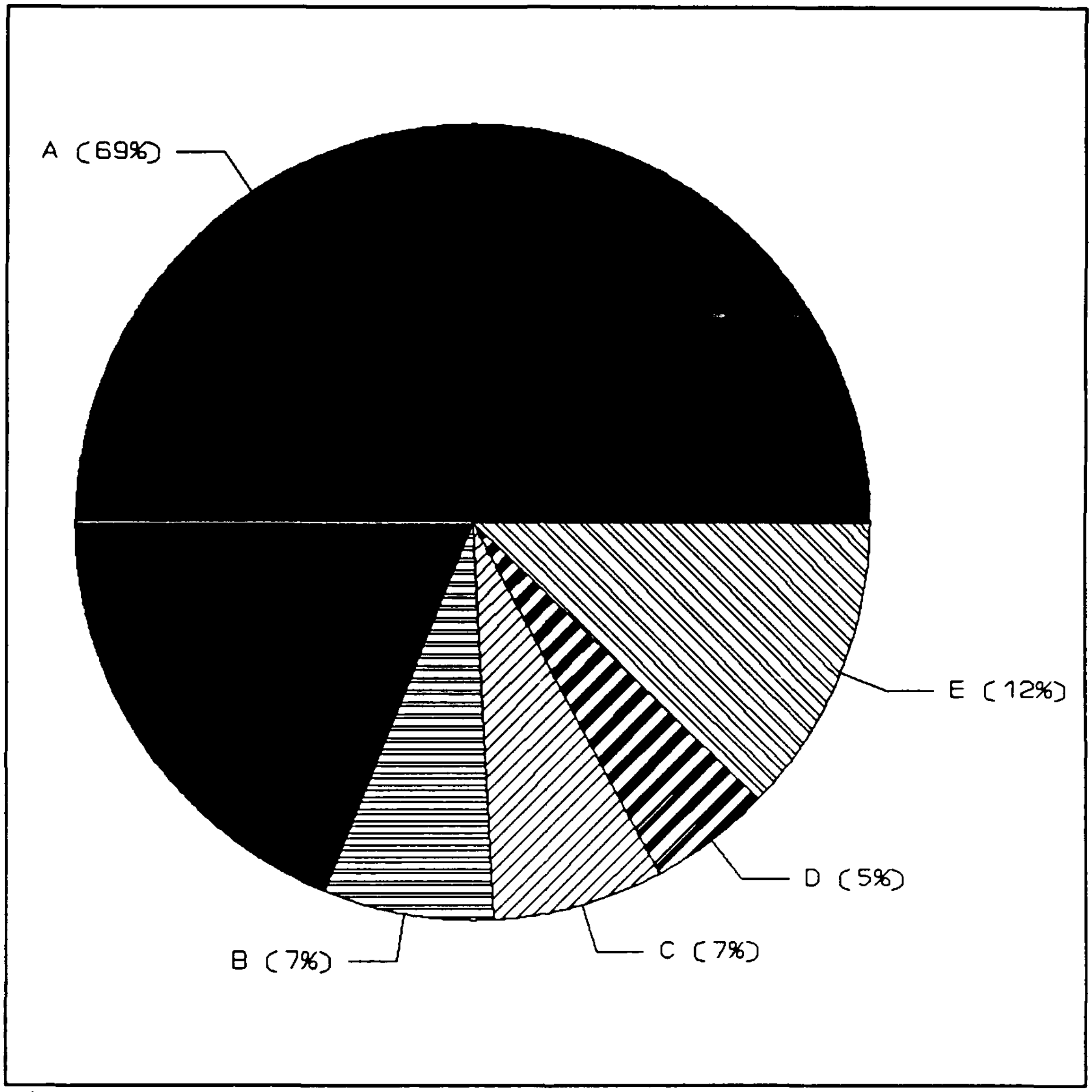

Figure D73: RESPONSE TO QUESTION 66, POPULATION CATEGORY A

66. How much experience have you had in using PAVER?

A(39/68.4%). Less than 6 mths.
B(4/7%). 6 mths. - 1 year.
C(4/7%). 1 - 2 years.
D(3/5.3%). 2 - 5 years.
E(7/12.3%). More than 5 years.

APPENDIX D: WRITTEN SURVEY RESPONSES

Note: Responses have been organized into the topics shown. Where appropriate to maintain anonymity, references to names and locations have been deleted. For purposes of reference, comments made next to specific questionnaire questions have been annotated with the question number.

MANPOWER:

"I did attend the airfield engineering course and I found it very helpful regarding the Paver implementation. However, I have not had the opportunity to work any time on this Paver issue. I have not been appointed as the pavement engineer and the person (captain) who is the pvmt. engineer and whom actually is leaving this base has never worked on the Airfield Improvement Plan using Paver. Our main problem here I consider to be the lack of a real plan (schedule manpower) to start using the Paver software which we acquired two years ago."

"I just took paver class at AFIT last spring with Capt. Teepan--very informative. Now we just need to find time/personnel to conduct PCI and Load program!"

"The paver idea is splendid. I attended Paver class at U of ILL, however, I never have enough time to assemble data and begin the system."

#22(E.) "We lack sufficient manpower to maintain and use paver to the extent that we would wish to since we have had only 1 civil engineer on board for about a year. However, he is very familiar with Paver and is able to make it a useful tool even with the small amount he is able to devote to it."

#52: "Our base does not have an airfield, therefore we do not think it would be an efficient use of manpower to put our streets in PAVER."

#29: "Lack of continuity of available manpower."

"Paver can be an excellent tool to determine the rank of pavement projects requiring maintenance or reconstruction if used correctly by command. Lack of manpower prevents the input of repair and maintenance data which can determine the correct repairs to be made."

#22(E): "We use A-E consultants for all manpower to maintain Paver."
#29: "Down loading data from mainframe to micro."

TOP MANAGEMENT SUPPORT:

"With decreased manning and funding and increased politicizing of work priorities I don't see PAVER becoming an important element of pavement programming without strong command direction. Also, with the rapid turnover of personnel and frequent reorganizations, not much continuity can be maintained in any area."

#29: "No regulation requires to have pavement management. Therefore management do not prioritize or enforce/obligate manpower."
#37: "This base did not have chance to use Paver often, the answers 30-37 would be as indicated if we had used Paver often."

"We have all required tools and technical training, but due to work load unable to implement Paver program. Hope you or someone will educate management of importance of such program implementation. That government will save $ by preventive maintenance, or upgrading PCI on time. One recommendation would be that management should prioritize a project (non construction design) as pavement management, other wise to implement when I have time would not do any good due to increase of work load."

"Even though we lack the training, software and hardware, the ultimate reason Paver has not been implemented is the decision to dedicate the resources has not been made. Paver is more long-term goal oriented, which is opposite to be short-term goal management style at XAFB."

#52: "Required local use of the XXXXX organization hindered implementation."
#55(B): "I perceive current mgmt here as Mgmt by crisis, not by substantial preventative maintenance."

"*Successful implementation of Paver at XXX was mainly a result of total support from upper management who realized early-on the value of the system. *Since we did not have the manpower to implement or maintain Paver - we have developed two A-E consulting firms into Paver 'experts'. *The only problem we have had with Paver was the download process from the CDC mainframe to our micro. The transfer process created thousands of errors which had to be manually corrected. We had a summer student-hire perform the corrections - 2 1/2 mo. job. Help on this problem from Univ. ILL & CERL was somewhat lacking."

"This Micro Paver system needs much more support and upper level direction if it is going to be implemented and successful. There needs to be manning, computer hardware, software and training. There needs to be a special interest placed on the implementation and annual update of the system. The computer hardware and software needs to be accessible to both the pavements engineer and the pavements shop for inputs and reports. The training needs to be at high HQ level so they can see the dollar savings potential and at the shop supervisor level so that inputs can be made and at the superintendent, O & M Squadron Commander level and Chief of Engineering level so that they understand how to interpret and wisely use the data obtained. This program can be successful but it needs much more support and manning."

EQUIPMENT:

"We have the software--we lack the hardware for implementation. We have A/E design funds for Paver implementation, but no priority has been put on hardware requirements."

"Our computer hardware is being ordered and we are awaiting its delivery. We understand that the software is available from our MAJCOM and we will request that as soon as we have something to run it on."

#22(E): "No hardware--no manpower spent."

"I feel Micro Paver will help if we can get the hardware to run it. We implemented Micro Paver three years ago and as of this date no computers to run it on."

"We have been 'going through the motions' of getting the necessary computer hardware/software to run Micro Paver at XXXXX. I have been notified that now that we are able to spend computer $ that the purchase can go through. We expect to be 'up' this fall. I have been to the AFIT Micro Paver seminar so it will just be a matter of devoting adequate man-hours, away from normal design obligations, and getting the data base generated. My supervisor has promised to allow time in my design schedule for this purpose."

"I have been through the airfield pvmt. course, so I am familiar with Micro Paver. We have the software for Micro Paver, but we do not have the hardware for it. No one in our C.E. knows how to use Paver."

"Many of the questions do not account for all possibilities (i.e. #3) XAFB is joint use with civilian control of R/W'S. In the case of XAFB implementation was started with an A-E doing the distresses. Project is several years old and with no hardware (which is on order) there is no way to update data base. This will be corrected though. Many questions were not answered due to no direct application for this particular situation. If you have any questions please call."

"We just received direction from XXXX to convert to 'Micro Paver'.

I have the program but do not have enough space on our Zenith 248 hard drive to run the program. I need a 40 meg drive or a new computer with 20 mg."

#29: "We lack a modem to down load Paver data now stored at CDC." "Paver can be a preventive maintenance tool but it is limited."

TRAINING:

"We are tentatively planning to attend Paver training at Ramstein In Oct. 90."

#22(E): "No one knows how to use it."

#52: "Never heard of Paver."

"My understand is our base has requested 'Paver' training and we received no response from appropriate authorities."

DATA GATHERING:

"Currently I only have access to Main frame PAVER. Its too hard to use; therefore it is never used. Also data gathering requires time and management will not allow that time away from design. If PAVER is to be used MICRO PAVER should be provided to each user with the computer to run it."

GENERAL:

"The person who filled out this form is not the pavement engineer for this base. Our recent base pavement engineer has left this month. We have one of our engineers currently taking the Pavement course at AFIT and expect to get back into the PAVER program upon that persons return. The survey contains a lot of unanswered questions in that any response would very unfairly affect survey results and no answer would prob. be preferred to one that is totally incorrect. In 6 months time the answers would better reflect actual conditions."

#7: "How can I know if its accurate? I gathered the data."
#9: "Pavements projects will be programmed: (but aren't yet)"
#9(E.): "Command priority always takes priority, of course."
#13: "ask me after 28 Sep 90 when I finish the course."

#19: "I've just started the AFIT course. The answer to this one will be A or B shortly." #22(B): "i.e., our regular jobs, like Design or Site Development. We haven't devoted anyone to Paver exclusively.
#29: "Basically, everyone's too busy doing their primary duty."
For questions 30-37: "We have PCI data in the computer, but that's it. We haven't started actively using it yet. When we do, this is what I expect:"
#33: "Hopefully, depends on the Wing/cc"
#57(B): "Not without much explanation. Wing kings generally don't know or care what PCI means or what a joint spall is."

"I'm taking pavements engineering, AFIT Engr. 550 10-28 Sep. I'll be returning to XXXXXXXX 4 Oct. Our base received Micro PAVER from XXXXXXXXX in June when he came to us to do a PCI survey. We surveyed most of the airfield. We have a few taxiways, aprons, shoulders, and the overruns left to do. The only asphalt portions are the overruns and taxiway shoulders."

#29: "Base closure."

"(1) The previous pavements engineer enrolled in the micro Paver course at AFIT. I have not. (2) Micro Paver has been loaded onto our Zenith 248 system. Data collected from XXXXXXX has been loaded into the system. (3) Emergency repair work on the runway was determined to be necessary due to the PCI survey."

"Recently our hardware was updated, giving us the capability to run micro-paver. We hope to obtain micro-paver in the near future. In Dec. 1989 a PCI was performed on the airfield and the data is available."

#52: "We have a 248 Z computer but need to know type of video for compatibility."
#53(B): "Unless someone can provide program/further information."

"No plans to implement due to pending base closure. To my knowledge, no formal training ever offered although the program exists on our Wims System."

"The 3AF bases use the British Property Service Agency (PSA) to perform airfield pavement inspections. Although PSA's system is not 'Paver' it is a relatively in depth look at the pavements every 18 months and provides short and long term maintenance recommendations."

"Please note the information provided above is for XXXXXXXXX which is being drawn down to standby status. Real property interests will be controlled from XXXXXXXX from 1 Oct 1990."

#52: "No airfield. Base is only 6 years young, and closing."

"I have filled out your questionnaire as best I can. Unfortunately, I have no idea what PAVER is. Also, I'm not certain it has application in the UK as all our work is done by the Property Services Agency (PSA). PSA would be responsible for operating PAVER, but innovation is slow in the UK. Additionally, PSA is the throes of becoming a private rather than a government organization. It is unlikely they would purchase and use PAVER. As for our squadron, we simply do not have the manning or the funds to operate such a system. Sorry I couldn't be more help. If you have more questions feel free to call at XXXXXXX."

#52: "Our pavement responsibility is minimal, consequently a 'short drive' gives accurate data on condition on our few roads and parking lots."

"We are a site attached to XXXXXX. As such, we have no responsibility for aircraft paving areas. We have no responsibility for anything on XXXXXX. We're off-base, and as such, deal mostly with parking areas (housing) and a minimal amount of streets--most are the responsibility of the appropriate cities or XXXXXX authorities. Many of the survey questions I could not answer--we don't have Paver, don't really see a need in our situation, and don't even perform the DEE function. So, we don't 'design' pavement projects. Would suggest the XXXXXX be considered for this survey--they do design support for both the XXXX CES and the XXX CES."

#52: "We do not have a runway or a bluesuit workforce."

"I was introduced to PAVER through AFIT's Pavement Engineering Course in June 1986. Here at XXXXXXXX, we are planning for major pavement repair work in FY 91. Our current working estimate for the three projects involved is $2 million. The last time any repair was done to our roads was in FY 85, and the base has no pavement repair plan, in regards to intermediate repairs. Our engineering section has the computer hardware necessary to run Micro PAVER, and I have acquired a copy of the PAVER Jointed Concrete Roads and Parking Lots and Asphalt Surfaced Roads and Parking Lots PCI Field Manuals. I hope to have PAVER implemented at XXXXXXX before I PCS in FY 92."

#10: "The contract which implemented PAVER also provided some training. #13-14: "The next pavements engineer doesn't have this training."
#30-37: "We have not been using PAVER very actively."
#55: "except it doesn't account for/make use of the politics in prioritizing work."
#57: "requires a great deal of implementation."

#52: "Do not have any airfield pavement, repair base pavement as required."

"Would like to be able to enter PCI's directly into micro paver instead of putting in the distress. When we first started with micro paver we had to enter in our data that had already been calculated manually. We could have saved a lot of work by entering in the PCI's."

#26: "For converting to Micro."
#29: "Other projects are prioritized higher."

#6: "Depends on funding & local command."
#20: "Have basic implementation no PCI update, in transition."
#39: "Initial condition survey and paver implementation performed by Waterways Experiment Station, Corps of Engineers, contracted by XXXXXX Air Force Base. Base implementation with current staff and workload would be impossible. P.C.I. update and expansion to include asphalt shoulders."
#40: "Don't know."

"Paver has not been in use here long enough to plot trends or use in predicting. Implementation was done in the fall of 89, the 1990 update was not funded so we are trying for 90, 91 update in 91."

#30-37: "Has not been actively used."

"Data has been in computer less than one week. Not all questions were pertinent."

#1(A): "The initial survey is partially completed."
#2(D): "Yes; (E): Probably, we do not have the computer."
#3: "The initial survey of the concrete has been completed. The establishment of the random sampler has not."
#9: "There is a problem with implementation here. There is no dedicated pavements engineer. The civil engineer is heavily involved in environmental work. Of the other 2 people that attended the AFIT class one is gone to PME school and than PCS. The other is in a one deep position and retiring soon."
#10-22: "There seems to be a problem getting a computer to use. Then there will be a software problem, followed by no trained people 2 years from now."
#19: "Limited, the system discourages enlisted people regardless of qualifications opportunity to attend most AFIT courses. The entire system could be accomplished by 55170 TSgTs with a little bit of training."
#57: "But I perceive upper management priorities to be different."

VITA

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