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An Expert System for Diagnostic Construction Problems in Pavement (Flexible, Rigid, Composite , Block or Brick Pavement) in Addition to Subgrade and Subbase Condition Defects (ES-DATPs)

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Abstract: Construction of roadway pavement entail significant issues that are impacted by various factors and are nearly impossible to overcome without expert assistance. Treatment and maintenance such challenges in pavement and providing the best economical solutions requires substantial technical competence, which owing to scarce resources and far-flung locations might not be accessible at every construction site. Establishing an expert system in this scope is a highly impressive method for assisting debutant engineers in overcoming and learning about these challenges. Interviews and questionnaires are used to obtain more expert information. This information is recorded, analyzed, represented, and converted to computer application through the Visual Studio language of programming, and the system is valled as ES- DATPS. The main aim of creating this expert system (ES- DATPS) is to helps highway engineers and civil engineers to acquaint causes, prevention, degree of severity, testing, measurement, maintenance and repair of all problems for (rigid pavement, flexible pavement, composite pavement, block or brick pavement) in addition to subbase and subgrade defects with accuracy and detail. According to the degree of severity, the best practice and economic method for maintenance each type of pavement can be selected by engineers. This expert system helps highway engineers to manage challenges and recognize type of defects by figures and video

Keywords: expert system, rigid pavement, flexible pavement, composite pavement, block pavement

1. INTRODUCTION

Area of artificial intelligence (AI) is presently used to solve numerous issues within facilities by using human intelligence in numerous analysis fields and advice has been used [1] ,[2]. As a result, difficult problems requiring extensive knowledge are frequently controlled by expert systems, prompting researchers and institutions to create numerous systems in various domains [3]. All fields of knowledge can benefit from these expert systems [4]. A computer software known as an expert system controls knowledge, truth, and arguments to quickly and accurately fix issues in specific problem domains that often call for a wide range of expensive knowledge sources and human experts. According to reference [4], expert systems boost the value of expertise by fusing extensive human and computer experience, making it simple and available to everyone. Expert systems offer mathematically and logically sound evaluations of inaccurate information, particularly pertinent to ecosystems, pollution, and resource management, according to [4]. It is an area of AI study with numerous potential applications in the building industry. Additionally, it performs better than programmatic programs that use logic and mental elements. It is frequently required to analyze systems using logical representations when there are few data points accessible or when the existing understanding of the problem domain is too hazy for traditional mathematical techniques [5]. Furthermore, expert systems efficiently store and distribute knowledge at a sensible cost. This feature is especially important for traffic-related issues. B. Hard surface, soft surface, and traffic accidents. The shortage of experts and the possibility of knowledge loss brought on by passing away or retiring of experts increases the need to set up expert systems [5]. Additionally, the expert data area of scope is "fuzzy" and includes many process information. Knowledge engineers should therefore be experts in the information gathering process. Expert systems provide ways to retrieve, encode, and reuse information. In essence, an expert system consists of a demonstration of the expertise or challenge to be fixed along with a mechanism for applying the expertise to the issues as a set of rules [6] .

Expert systems were developed to assist administering different farm challenges by enhancing analysis and giving guidance [7]. Expert systems have thus been applied to resolve intricate issues requiring substantial knowledge, enabling academics and institutions to create systems in a variety of areas[8].The "RC-MSS" road manufacture substance selection system is a model that offers

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alternatives to help road planners make decisions while choosing materials[9],[10].

A rule-based expert system (ES) has been proposed to support road organizers in the design of flexible structural solutions for pavements. ES has been invented as a knowledge-based approach to determining the optimal path for new road alignments in the field of geometric highway design. [11] . ES attempted to create a knowledge-based system in the paving industry. It is a rule-based expert system created to aid in the creation of adaptable pavement systems by pavement designers. ES was created as a knowledge-based system in the area of highway geometric design to choose the best alignments for new routes [11] .An expert system for checking construction quality management was established, and in the field of pavement design, ES was made as an attempt to create a knowledge-based system for assessing stiff pavement design issues using only textual sources [12], [13]. proposed fuzzy logic expert system for ranking the priority of sewage system repair by Tagherouit et al. [14] Some researches employed ES(Expert System) to implement traffic calming methods that can improve the security of local inhabitants and users of non-motorized transportation [15],[16],[17], all of them employing ES(Expert System) to implement traffic calming methods that can improve the security of local inhabitants and users of non-motorized transportation. Tagherouit et al. have presented a similar system that uses fuzzy logic in [14]. This system can use ES to implement traffic calming techniques, which can improve its safety. used a range of traffic-calming strategies, such as horizontal, vertical, and narrowing deflection. In order to create traffic calming strategies in response to growing issues with traffic safety, such as speeding and cut-through traffic, engineers and urban planners are needed. Making a method to identify projects with higher priority is crucial before moving on to the performance of measures. It may not be required or be cost-effective to implement traffic calming measures on all residential streets. Decision-makers are also quite concerned about restrictions in the distribution of funding. Finding a strategy and framework to rank the possibilities is therefore a challenging issue [16]. An expert system's capacity for clarification is one of its distinguishing qualities. It enables the experts to examine their own justifications and justifications for their choices. When analyzing a problem, expert systems platforms apply representative reasoning. Symbols are used to represent a variety of learning, including reality, concepts, and rules. The expert system can provide guidance, make changes, add to it, enlarge it, and deal with ambiguous and inconsequent data [16].

Numerous professional structure programs exist in in civil engineering domain. amongst professional upkeep and recovery, with a focus on airport pavements. Structures for designing pavements and asphalt selection of materials have also progressed. By evaluating the conditions of concrete pavements with the aid of a rule-based entirely pavement professional instrument, the scrutineer and engineers have conducted local assessments. The suggested tool has assisted in the decision-making to automate the method of pavement scoring and observation system [18]. The computerization of pavement engineering and control employs numerous methodologies. According to [19] some point during the construction of flexible highway pavements, toll road engineers encountered challenging issues that are influenced by a variety of factor and factors. Milad et al. defined the improvement of a prototype internet-primarily based expert understanding device that could be used to maintain a bendy pavement within a tropical area in [20]. The prototype machine has furnished the blessing of the usage of existing internet-based totally professional device technology. Presently, the degradation of bitumen layering became one of Malaysia's most serious challenges, necessitating protection to ensure that the highways continue accessible and capable of ensuring the arrangement, timeliness, and safety of all maritime services. For pavement distress identification, Nishikawa et al. employed image analysis computer tools to determine pavement degradation [21]. Bosurgi and D'andrea created computer systems for assessing highway geometric shapes-design challenges [22].

The present paper (ES-DATPS) system includes maintenance and repair, causes, prevention, degree of severity, testing, video and measurement of problems for rigid pavement, flexible pavement, composite pavement, continued reinforced concrete pavement, block or brick pavement, and subbase and subgrade supports defects with accuracy and detail. According to the degree of severity, the best practice, and and economical method for maintenance, of each type of pavement is provided. This expert system helps highway engineers to manage challenges and recognize type of defects by figures and video. This study covers the creation of and that inexperienced engineers on highway pavement building sites may utilize to govern the troubles they encounter. On the other hand, the system can serve as an educational tool for road engineers who are interested. In Furthermore, the system may preserve and organize expert knowledge for usage by all engineers involved in this project. The system may be used by domain experts to communicate information.

In order to prevail possible challenges, the current research investigation aims to create a knowledge-based educational system for civil engineers and trainee civil engineers participating in concrete t pavement building projects. A method like this can help students learn how to deal with challenges as they arise. This article outlines the

steps of creation and assessment of a novel system, comprising knowledge gathering, knowledge demonstration, system construction, and system confirmation and validation. A survey of the literature provides the foundational information. Then, via interviews and questionnaires, expert knowledge is extracted. Using the Visual Studio programming language, this data is recorded, examined, represented, and converted into computer programs. Extensive testing was used to verify and validate the system, containing unit testing, integration testing, and questionnaire-based user acquiescence testing. The system established here supply expert knowledge about govern ways for construction problems in rigid pavement, flexible pavement, composite pavement, continued reinforced concrete pavement, block or brick pavement, and subbase and subgrade supports using a straightforward and adaptable interface to make the user's training process easier.

3. SYSTEM REQUIREMENT AND INSTALLATION for (ES- DATPS)

The program will work on a typical computer with Windows 9x, 2000, XP, Vista new Windows system, and NT operating systems. To install the program, execute the setup file (ES- DATPS) and follow the on-screen instructions. After installation, by clicking on the program icon on the computer screen, the program is start. If the computer system is 64Bit install: AccessDatabaseEngine_X64 and If your computer system is 32Bit install: AccessDatabaseEngine_32

4. DESCRIPTION OF PROGRAM

The Expert System for Pavement Remediation and maintenance, of all types of pavements (ES- DATPS) is a computer program by using C# (visual studio) windows application form that employed to the guide of engineers for evaluation, description ,cause ,testing ,prevention, degree of severity ,measurement, repair and maintenance and video for the whole defect and problems for all types of pavement that include(rigid pavement, flexible pavement, composed pavement, continuous reinforced pavementlike or brick pavement and subgrade and sub base support condition. This program consists of splash form, main form, six forms for description of all kinds of pavement, and six tables for evaluation and treatment of entire deficiency and problems in each category of roads, in addition to an access database. With special codes for each all of them. This program can be updated according to the development of pavement maintenance techniques

5. The NECESSITY FOR SUGGESTING SYSTEM

According to the analysis of the literature and the principles outlined in the current studies, in the area under consideration, an expert system is absolutely necessary. A questionnaire survey was used to test this finding. In compared to past research in this field, this is a novel method. Other researchers relied on the literature to justify the necessity for their suggested expert system. After developing their system, they employ a questionnaire to determine whether it is required. The current approach offers two important benefits comparing with other researchers' approaches. First of all, establishing a system that is not necessary would save time, money, and effort if it were first determined that the proposed system was actually needed. Secondly the research study's scope can be selected based on the questionnaire participants' remarks.

The questionnaires were distributed among 20 highway engineers and 20 civil engineers with varying degrees of expertise. Two teams of engineers were formed. The first team comprised of twenty engineers with 5 to 9 years of experience and the second group included of 20 engineers with more than ten years of skill. The questionnaire is divided into two sections and has a total of seven questions. Since utilizing a Likert scale is an especially successful method to analyze questionnaire findings (the questions are evaluated on a Likert scale of 1 to 5, with 1 indicating " profoundly disagree" and 5 expressive "strongly agree." See Table 1. The findings are briefly shown in Table 2, that is, good, indicating and reflects the importance of the proposed system. The suggested approach can assist to teach a new generation of experts while preserving their expertise in a categorized form.

Table 1. Evaluated on a Likert Scale

Liker Scale		Value allocation
1	Strongly Disagree	1-1.49
2	Disagree	1.5-249
3	neutral	2.5-3.49
4	Agree	3.5-4.49
5	Strongly Agree	4.5-5

Table 2. Assessment of the questionnaire on the necessity of the proposed system

No.	Question s	Gr. 1		Gr. 2			
		Mean	SD	Mean	SD	*t*	*p*
Q1	The suggested system will be crucial	4.13	0.618	4.27	0.442	1.0092	0.3171
Q2	The suggested system will assist beginner engineers in resolving realm problems	4	0.632	4.4	0.49	2.7396	0.0082
Q3	Suggest system can assist an engineer in learning on scope difficulties.	4.2	0.542	4.33	0.471	0.9916	0.3255
Q4	The suggested system would serve as an archive for the domain problems.	4.4	0.49	4.5	0.5	0.7824	0.4372
Q5	The suggested system can be utilized for transferring knowledge among engineers working in the investigated area.	4.17	0.637	4.47	0.499	2.0307	0.0469
Q6	There are not sufficient experts in the field to handle the volume of projects.	4.33	0.471	4.33	0.745	0	1

6. STEPS OF PROGRAMMING

Step 1-Drawing Flowchart as an initial step for programing for all types of pavement.

Step 2-Convert flowcharts to form and writing code and programming for each of them. the main form and Six forms are the need for all types of pavements

Step 3 - Creating tables of problems and defects for all types of pavements. Six tables are needed for all types of pavement.

Step 4-Creating database in Microsoft Access program and connecting to the the C# program by special codes that can be updated at any time when we need to add or remove new information and data.

Step 5- Coding: A form of programming language called coding makes it easier to interact with computers. Computers can't comprehend the languages of humans. The ability to code permits people tonegotiate with computers.. In C# program, there are many different codes.

In this program, labels, button, text box, picture box, combo box, title box, radio button,toolbox, and different forms and tables are utilized with special codes with the addition of timer and progress bar

7. SYSTEM UPDATING

The system is created in a straightforward way to make updating it simple for the developer or any other knowledge engineer in the field who is familiar with the VISUAL STUDIO (C#) programming language. This is achieved by regularly adding new data to the system. This expert system connecting to the access database by special codes.

8. SYSTEM PERFORMANCE AND OPERATION

After the installation the program of the expert (ES-DATPS) into the computer, the ion program display on the screen, like any other program in the Microsoft Windows environment, may be launched by double-clicking the pragmatic file's icon or shortcut. The system starts instantly and presents a splash form and after some seconds the main form will be shown on the screen. The main form contains six buttons which each button represents one type of pavement as shown in Figure 1. Users can navigate to the next screen by pushing or clicking one of the buttons of the main form . see figure 2 and Figure 3, a. The performance and operation of the system are summarized in figure 4.

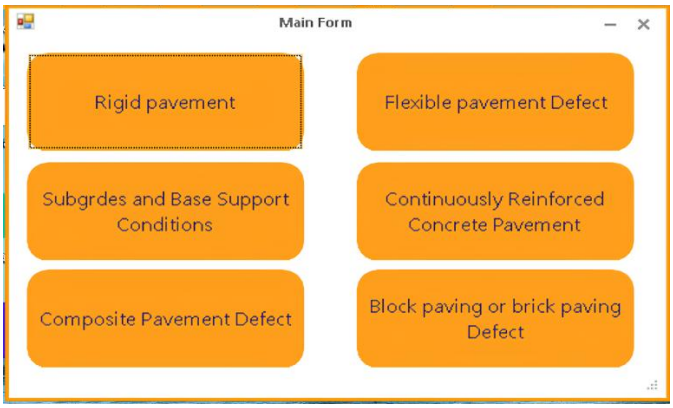

Fig 1. Example of screenshot of the main form

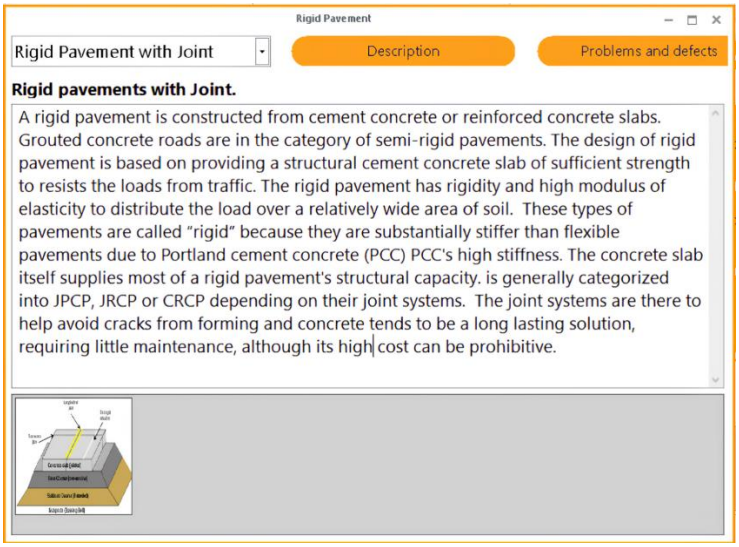

Fig. 2: Example of screenshot of flexible pavement form

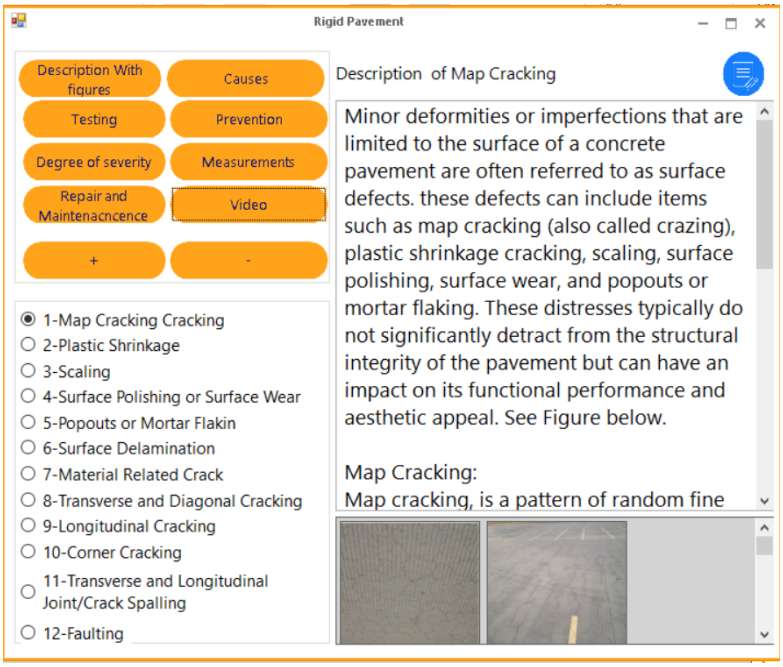

Fig. 3: Example of screenshot of rigid pavement form

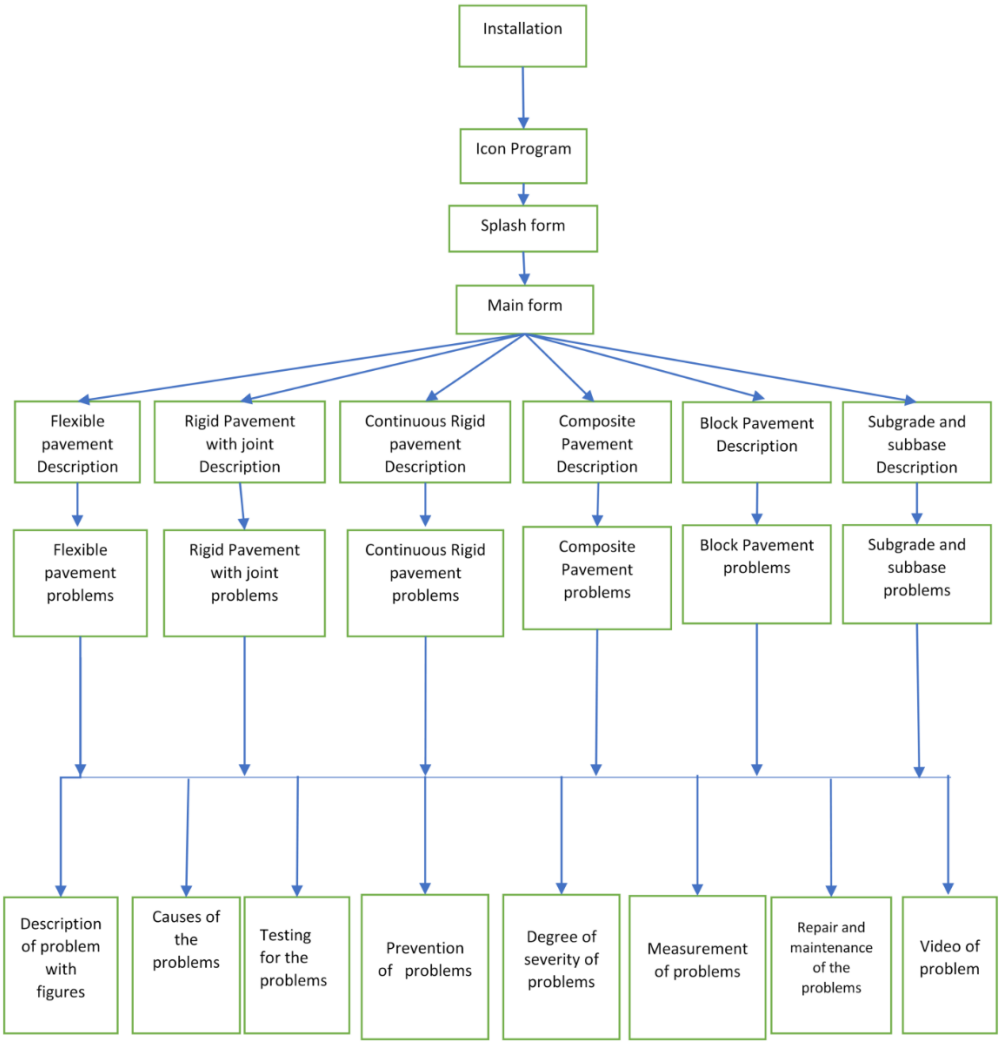

Figure 4*:* flow chart of the system operating

9. KNOWLEDGE ELICITATION AND CLASSIFICATIONS

The process of acquiring knowledge is the most crucial step in developing an expert system. It is both time-consuming and challenging. Specialized analytical methodologies are required for knowledge-based systems. Obtaining and classifying expertise from others is an element of acquiring knowledge. Several sources. Knowledge of a review is usually the first step in the engineering approach. Written sources include books, instructions, manuals, and articles that are connected to the issue domain.

An exhaustive evaluation of specialized sources is performed in the present study to create the basic background knowledge and grasp the ideas of rigid pavement, flexible pavement, composite pavement, continued reinforced concrete pavement, block or brick pavement, and subbase and subgrade supports defects and challenges that may be predicted to emerge throughout various phases of construction.

During this evaluation, the first knowledge base is built as a basis for the main knowledge base, which serves as the expert system's nucleus. This preliminary understanding is regularly assessed to improve it and emphasize the research. Review topics include problem explanation, reasons, and avoidance; quick fixes for issues that crop up; and possible repercussions of issues that are not prevented or governed.

Following the creation of the first knowledge base via literature research realm, experts were consulted regarding their understanding. Through study and experience, the specialists eventually gained domain expertise.

The domain problems were grouped based on their form, location, consequences, types of pavement, and other mutual qualities, manuals, books, and guidelines after evaluating and reanalyzing the knowledge. As a result, trainee engineers would be able to readily grasp and identify problems and defects. Furthermore, the explanations, Preventive measures, remedies, and

potential consequences of many difficulties were defined in order to offer engineers with appropriate information on the realm of issues. The pavement specialists recruited for this investigation were also polled during the multiple categorisation rounds. During the focus interviews, three experts assessed and consent the final categorisation. Furthermore, the last classification form was authorized by 6 road engineering professionals (four assisting professors) who were chosen to participate in the classification and assessment phases. Table 3 organizes the problems and defects into categories.

The choice of dominion experts is critical in any extraction expertise. Domain expert selection criteria ensure the elicitation of proper expert knowledge. Domain experts must meet two crucial requirements. The first factor is the expert's length of experience in the topic, which influences their assessment and analytical activity. The second can be reflected by the conditions in which the knowledge is developed, which might be theoretical, practical, or a combination of the two. Knowledge elicitation is the process of gathering information from experts in order to better understand how they make judgments. Methods like interviews can help attain this aim. Experts can also be seen working to detect implicit knowledge. The knowledge engineer can choose which approach to utilize based on the research field, the quantity of knowledge necessary, and the time demanded to evaluate the obtained data. Unstructured interviews, structured interviews, and questionnaires were used in this work to gather expertise from the selected experts. Unstructured interviews were conducted with the experts in order to obtain a basic grasp of their practical proficiency with realm challenges and to establish a good connection with them in order to facilitate the procedure of eliciting expertise. Topics in the research territory were examined in usual, and a few particular topics were explored. Every expert shared some of his realistic experiences with problems he encountered when building rigid pavements and how he resolved them on the job.

throughout the unstructured interviews, the experts were only asked a limited number of questions, but they answered all of them in detail. Following each unstructured interview, the information was reanalyzed, categorized, and updated in preparation for the next phase of expertise elicitation, structured interviews. To provide strong findings, structured interviews focus on a certain area of the domain in each session. The main data acquired via expertise elicitation is significantly greater than the secondary knowledge gleaned from the literature because experts do not write about their experiences. To complete the knowledge acquisition stage, the acquired knowledge was combined into a questionnaire and given to the specialists. The process can be streamlined with the use of a questionnaire.

Since this allows the expert to consider his reaction before responding. Questionnaires are a successful pathway of eliciting information since they reduced time, money, and attempt, exceptionally when the knowledge engineer understands exactly what knowledge qualities are. Furthermore, the categorised form of the questionnaire simplifies the expert's duty by allowing him to evaluate each problem independently. Following each question, blank slots were provided for the expert to add his thoughts. Three experts completed surveys with just one form not returned. Several valuable comments on the questionnaire were provided by the experts which helped to expand the knowledge base. Following a study and analysis of their questionnaire responses and comments, the experts were questioned again to clarify certain points in their remarks and to focus on specific aspects in their solutions to the difficulties. The knowledge base is reanalyzed and restructured in the final phase of the knowledge achievement procedure in preparation for the final categorization. The problems and deficits are defined based on their features, which can be detected visually or by measurements and testing. Each problem's name encapsulates its description. Experts can readily identify such issues and make judgments to fix them, but rookie engineers cannot. By taking preventive measures, you may save time, money, and effort. To control these issues, immediate choices must be made to identify and implement Preventive actions. Site inspectors have the ability to reject any cargo containing faulty concrete.

Table 3. Domain problem classification

Types of pavement + subgrade and subl	Classification of domain problems
1-Rigid Pavement	1-Surface Distortions: Map Cracking 2-Surface Distortions: Plastic Shrinkage 3-Surface Distortions: Scaling 4-Surface Distortions: Surface Polishing or Surface Wear 5-Surface Distortions: Popouts or Mortar Flakin 6-Surface delamination 7-Material related crack 8-Transverse and diagonal cracking 9-Longitudinal cracking 10-Corner cracking 11-Transverse and longitudinal joint/crack spalling 12-Faulting 13-Joint Curling and warping 14-Blowup
2-Flexible pavement	1-Alligator (fatigue) cracking 2- Edge cracks 3- Paving joint and widening cracking (Longitudinal crack) 4-Linear wheel path cracks 5-Reflective cracks 6-Slippage cracking 7-Shrinkage cracking or block cracking 8-Transverse Cracks in Asphalt 9-Helical or diagonal cracks 10-Surface Distortions: Rutting 11-Surface distortions: Corrugated and Shoving 12-Surface distortions: Local depressions 12-Surface distortions: Local depressions 13-Surface distortions: Upheaval (Swell) 14-Surface distortions: Utility cut depressions 15- Disintegration: Ravelling 16- Disintegration: Potholes 17- Disintegration: Loss of Surface Skid Resistance 18- Disintegration: Polished aggregates 19- Disintegration: Bleeding or flushing
3-Subgrdes and Base Support Conditions	1-settlements and heaves 2-Cracking due to trench backfill settlement 3-Corner break and settlement due to subgrade soil movement under 4-Pavement settlement adjacent to a rigid structure that has not settled 5-cracking due to frost heave of the subgrade soil 6- Settlement due to subgrade soil movement under traffic 7- cracking due to settlement and loss of support 8- Settlement due to consolidation of the soil without significant traffic loading
4-Continuously Reinforced Concrete Pavement	1-Longitudinal Cracking 2-Irregular Transverse Cracking 3-Punchouts 4-Transverse cracking in CRCP
5-Bonded Concrete Overlay on Asphalt (BCOA) (Composite pavements)	1-Corner Cracking 2-Transverse Cracking ((Nonreflective) 3-Longitudinal Cracking

	4-Reflective Cracking (Any Type) 5-Wide Transverse Joints/Panel 6-Transverse Joint Faulting 7-Longitudinal Lane-Shoulder Joint Spalling (Due to Heaving) 8-Compression Failure at Transverse Joint
6- Block paving or brick paving Defect	1-Sand The absence in Joints 2- Discrepant Joint Widths 3-Corner or Edge Chipping -4-Spalled/ cracked/ broken blocks 5-Depressions/distortions 6-Pumping and Water Bleeding 7-Rutting 8-Horizontal Creeping 9-Swell 10-Settlement Or Faulting 11-Potholes / patching / reinstatements

10. BUILDING THE SYSTEM

An expert system is constructed in this study to characterize faults and assist the user during the recognize and repair procedure. Rules can be used to represent knowledge about these issues. As a result, a rule-based system is the most appropriate alternative. When problems develop, professionals must gather data before making decisions. As a result, a data-driven forward chaining inference engine is appropriate for knowledge display in a rule-based expert system. This approach progresses from the knowledge-based facts to the aim or conclusion. The argument begins with the supplied information and then proceeds with that information. The fundamental knowledge of the proposed system, the classified knowledge, is given as computer-programmable rules. Because Microsoft Visual Studio is a strong and adaptable programming language for creating Windows applications, it was utilized to create ES-DATPS. The produced system's source code version has numerous forms that are linked simultaneously in a single structure. Each form contains a set of commands that are liable for carrying out certain system operations. The names of the forms and commands are descriptive and correspond to the subordinates of each command. Furthermore, several notes are given in the code options to make the upgrading process easier. This version is intended for usage by the knowledge engineer in charge of building and maintaining the system. A secured practicable version (with the extension) is generated for application by the finale user, the highway engineer, and this version cannot be modified.

In this program, labels, button, text box, picture box, combo box, title box, radio button, toolbox, and different forms and tables are utilized with special codes with the addition of timer and progress

11. SYSTEM VALIDATION AND VITRIFICATION

The most critical and challenging jobs in intelligent system development are verification and validation, verification may be accomplished by testing operations, which ensure that the proper system is being developed. Each test in successful testing should try to discover a flaw. Each level and all system components should be evaluated. Testing is carried out on a regular basis To ensure that every system activity is performing the intended function during the system creation process. A variety of test methodologies are used to evaluate (ES-DATPS), as discussed in the following sections.

11.1. TESTING AT THE UNIT AND INTEGRATION LEVELS

Validation and verification of such systems are critical but challenging procedures . Testing operations must be carried out to ensure that the correct system is built. Throughout the course of the research, the suggested system was subjected to continuous integration and unit testing. This method allows the knowledge engineer to validate that the system's components are functional and work together. Unit testing entails evaluating individual units using different testing activities. This testing was carried out continuously throughout the development of the (ES-DATPS) to ensure that every component within the system fulfills the desired purpose. The knowledge engineer validates the system's internal structure by enveloping all potential combinations of constants, variables, interactions between them, and source code pathways. During the testing procedure, just a few errors were discovered. These errors were addressed while the system was still being built and before it was converted

into practicable versions. The knowledge engineer will undertake integration testing to ensure that all modules are working together properly. To execute the system, the user must give the system with the necessary input data, such as the kind of region, problem explanation, position, and layer where the problem is discovered. The system includes several instructions that ease the user's job regardless of his knowledge of roadway paving, construction, or computer use. The user can enter his input data by selecting one of the system's alternatives. The knowledge engineer put it to the test.

Evaluation of user satisfaction. The system was evaluated using questionnaires. These surveys were created for end-users to assess their degree of satisfaction with the system. To assess user satisfaction (ES-DATPS), a questionnaire survey was created. Two classes of users were chosen to take part in these investigates. The 1st class consists of 10 computer engineers. The second category consists of 10 civil engineer and construction professionals who were not comprised in the knowledge elicitation step. Participants utilized the system to evaluate the system based on the questionnaire supplied in Table 4. The assessment result demonstrates the assessment result indicates the users' agreement, as evidenced by their high mean score (greater than 3).Their high mean rating (greater than 3). Users assessed the system after using it under the supervision of a knowledge engineer. All users who provided evaluation values higher than three on a five-point Likert scale (from 1: strongly not satisfy to 5: strongly satisfy) indicated that they were satisfied with the system's usefulness and effectiveness for resolving area issues, speed of operation, and user-friendliness. The evaluation results are displayed in Table 4. The questionnaire was statistically examined using the -test. The -test reveals. Validation is carried out to verify that the system appropriately represents the experts' knowledge.

Table 4. Results of ES-DATPS evaluation statistically

No.	Questions	G. 1		G. 2	
		Mean	SD	Mean	SD
Q1	ES-DATPS is easy to utilization	4.20	0.980	4.40	0.917
Q2	ES-DATPS operates swiftly	4.70	0.458	4.50	0.500
Q3	The user interface is easy to use	4.20	0.400	4.50	0.500
Q4	acquire an interpretationation from the ES-DATPS is simple.	4.00	0.775	4.10	0.700
Q5	The explanations are beneficial	4.00	0.775	4.20	0.400
Q6	Help facilities are effective	4.1	0.700	4	0.775
Q7	The phrases are obvious	4	1.095	4.6	0.490
Q8	The results are presented completely and clearly	3.90	1.300	4.80	0.400
Q9	ES-DATPS useful in providing repair and treatment	3.90	0.700	4.40	0.663
Q10	ES-DATPS is useful in determining the root causes of issues	4.10	0.700	4.30	0.640
Q11	ES-DATPS is useful for taking Preventive measures.	4.20	0.980	4.30	0.781
Q12	ES-DATPS is useful for determining the consequences of issues	4.11	0.875	4.60	0.490
Q13	In general, I am acquiescent with the ES-DATPS	3.50	0.922	4.70	0.458

12. CONCLUSION

All civil engineers can use **(**ES-DATPS**)** to solve problems in the construction of all types of pavement. This can save money, time, and effort. This type of expert system (ES-DATPS) helps students and engineers to acquisition the repair and treatment, causing, testing, degree of severity, prevention, measurement, and videos for all types of pavements. The system is tested for rigid pavements, flexible pavement, continuous rigid pavement, composed pavement, block or brick pavement and and sub-grade and subbase, and it can be continuously upgraded by being fed fresh information. A knowledge engineer or any competent user of Visual Studio can update the system under supervision by a civil engineer. This article can serve as a reference for inexperienced highway engineers at pavement building sites to solve, mitigate, and prevent such issues. Additionally, this expert system can be codified as a knowledge-based expert system and evaluated by human

specialists in the field of all kinds of road pavements. According to the degree of severity, the best practice and economic method for maintenance each type of pavement is provided. This expert system helps highway engineers to manage challenges and recognize type of problems and defects by figures and videos. In the redesign process, the system employs the AASHTO procedure and excludes all other procedures. The system has been confirmed and validated, and end users may utilize it with confidence. Furthermore, it may be utilized as a database to store defect and faulting found in the scope, as well as to exchange highway engineers' experiences and pass skills to future generations of engineers.

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