REPUBLIC OF TÜRKİYE
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SCIENTIFIC RESEARCH PROJECTS

COP31 PROJECT APPLICATION FORM

1.	**PROJECT TITLE**	Development of a Minimal-Waste and Environmentally Friendly Clinical Practice Model in Dentistry
2.	**PROJECT COORDINATOR**	
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3.	**PROJECT FIELD**	Health
4.	**PROJECT TYPE**	Master's Thesis Research Project
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1. SUMMARY and KEYWORDS

Climate change, depletion of natural resources, environmental pollution and the increasing amount of waste are major global problems threatening the sustainability of healthcare services. In dental practice, the intensive use of single-use materials, biomedical and chemical waste, restorative material waste, and high water and energy consumption create a significant environmental burden. Therefore, there is a need for sustainable dental practices that protect environmental health as well as human health. Ecological dentistry stands out as an environmentally friendly approach that aims to reduce resource consumption and waste generation, increase reuse and recycling, and save energy and water.
The aim of this project is to develop a **"Reduce, Reuse, Recycle and Rethink"** principles-based **Minimal-Waste Dental Clinic Practice Model** that can be implemented in dental clinics. Within the scope of the project, the goals are to increase the knowledge and awareness of dentists and dental students regarding sustainability, waste management and environmentally friendly clinical practices; to promote the segregation of waste at source, the reduction of water and energy consumption, and the use of environmentally friendly materials and technologies. Current literature shows that dental professionals need training on sustainability and biomedical waste management. The model developed as a result of the project is intended to form a sustainable and scalable practice model that can be adapted to different faculties of dentistry and clinics. The pilot studies of the project are planned to be initiated in the pediatric dentistry clinic.

Keywords: Ecological dentistry, green dentistry, sustainable dentistry, zero waste, waste management, environmental sustainability, model development

2. ORIGINAL VALUE

2.1. Importance of the Subject, Original Value of the Project and Research Question or Hypothesis

Climate change, depletion of natural resources, environmental pollution and the increasing amount of waste are among the global problems that directly affect the sustainability of healthcare services today. Dental practice also has a significant environmental impact due to the single-use materials used, biomedical and chemical waste, restorative material waste, and water and energy consumption. Avinash et al. (2013) pointed out that although the waste generated by modern dental practice may seem limited at the level of individual clinics, it can cumulatively create a significant environmental burden across the profession, and emphasized that dentists should take an active role in protecting the environment.
In this context, **ecological/green dentistry** has emerged and is regarded as a sustainable approach that aims to reduce environmental impact without compromising the quality of clinical services. Sustainable dentistry is based on the efficient use of resources, waste reduction, reuse and recycling, and the reduction of energy and water consumption. In the literature, the basic principles of this approach are expressed as **"Rethink, Reduce, Reuse, Recycle"** (Veress et al., 2023).
Although dentists' attitudes towards environmentally friendly practices are positive, there are significant gaps in knowledge and practice. A study by Veress et al. (2023) showed that the vast majority of dentists had a positive attitude towards environmentally friendly dental practice and were willing to take steps towards environmental awareness. However, it was noted that practical solutions and guidance are needed to put sustainable practices into effect.
This need is also supported by the comprehensive scoping review conducted by Murariu et al. (2025). The review examined studies published between 2020 and 2025 and reported that oral health professionals' knowledge of biomedical waste management was mostly insufficient or moderate, while positive attitudes towards sustainability principles remained limited. The researchers emphasized that training on sustainability and biomedical waste management should be added to undergraduate and postgraduate dental education programs.
Current systematic evidence also shows that green dentistry is not limited to waste management alone; clinical processes, resource use, material selection, energy consumption and the concept of sustainable healthcare should be evaluated holistically. The systematic review published by Wolf et al. (2026) reveals that sustainability in oral and dental healthcare is becoming an increasingly important area of research and practice. Therefore, sustainability in dentistry should be regarded not only as an environmental responsibility but also as a professional and ethical responsibility for protecting the health of future generations.

Original Value of the Project

The original value of the "Development of a Minimal-Waste and Environmentally Friendly Clinical Practice Model in Dentistry" project lies in its aim to move the concept of sustainable dentistry beyond a merely theoretical awareness topic and transform it into an applicable and measurable model in dental clinics.

Although there are various studies in the literature on awareness, knowledge level, waste management and sustainable practices in environmentally friendly dentistry, there is still a need for a holistic **"Minimal-Waste Dental Clinic"** model that can be directly integrated into the daily operation of clinics. While Avinash et al. (2013) offered practical recommendations for environmentally friendly dentistry, Veress et al. (2023) revealed the need to increase dentists' awareness of sustainable practices and to develop practical guidelines.
Within the scope of this project, based on the **"Reduce, Reuse, Recycle and Rethink"** principles, it is planned to evaluate dental clinics from an environmental perspective and to create a model for clinical practice. Within the scope of the model;

- reducing unnecessary use of single-use materials,
- safe reuse of suitable materials,
- segregation of recyclable waste at source,
- proper management of biomedical and hazardous waste,
- reducing water and energy consumption,
- preferring environmentally friendly products and technologies,
- reducing paper consumption through digital applications,
- increasing environmental awareness among clinical staff and students — these practices will be addressed within a holistic system.

Another original aspect of the project is that it aims to make the sustainability approach **a part of professional life, starting with dental students**. In particular, the fact that the current literature identifies lack of knowledge and the need for training as one of the major barriers to sustainable dental practice supports the necessity of developing an education-based model (Murariu et al., 2025).
Accordingly, the model to be developed at the end of the project is intended not only to be implemented in a single clinic, but to form an **exemplary practice model** that can be adapted to different faculties of dentistry, oral and dental health centers, and private dental clinics. Thus, the project aims to have an innovative and scalable structure that brings together the fields of education, clinical practice and environmental sustainability.

Research Question

Can the Minimal-Waste Dental Clinic Practice Model, to be developed in dental clinics based on the "Reduce, Reuse, Recycle and Rethink" principles, contribute to the adoption of environmentally friendly clinical practices by increasing the knowledge and awareness of dentists and dental students regarding sustainability?

Hypothesis

H1: Implementation of a structured training and practice model on ecological dentistry and zero-waste practices significantly increases the sustainability knowledge and awareness levels of dentists and dental students.
H2: Implementation of the Minimal-Waste Dental Clinic Practice Model contributes to reducing waste generation in clinics and to the correct segregation of waste.
H3: Training and awareness activities on ecological dental practices lead to behavioral change towards more efficient use of water and energy resources.
H4: As the level of knowledge and awareness of sustainable dentistry increases, the level of adoption of environmentally friendly clinical practices also increases.

References:

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2.2. Aim and Objectives

The main aim of this project is to support environmental sustainability in dental clinics, to reduce waste generation and resource consumption, and to develop an applicable **"Reduce, Reuse, Recycle and Rethink"** principles-based **"Minimal-Waste Dental Clinic Practice Model"**. In this direction, it is aimed to increase the knowledge and awareness of dentists and dental students regarding sustainable dentistry, waste management, water and energy saving and environmentally friendly clinical practices, and to transfer this knowledge into daily clinical practice.

Objectives of the Project

1. **Determining the current situation:** To measure, at the start of the project, the current knowledge, attitude and practice levels of dentists and dental students regarding sustainable dentistry, environmental awareness and waste management.
2. **Developing a training program:** To prepare a structured training program covering minimal waste, biomedical waste management, recycling, water and energy saving, reduction of single-use material consumption and environmentally friendly clinical practices.
3. **Increasing environmental awareness:** To achieve **an increase of at least 20%** in participants' knowledge and awareness levels regarding sustainable dentistry after the training, compared to the baseline measurement.
4. **Improving waste management:** To ensure that waste generated in clinics is segregated at source according to type, and to establish a standard operating procedure for the proper segregation of recyclable waste.
5. **Reducing single-use material consumption:** To identify unnecessary use of single-use materials in clinical practice and to develop practices aimed at **reducing consumption by at least 10% compared to the project baseline** in appropriate areas, without compromising safety and infection control principles.
6. **Supporting water and energy saving:** To create practical recommendations and checklists for reducing water and electricity use in dental clinics, and to ensure that clinical staff integrate these practices into their daily work processes.
7. **Creating a Minimal-Waste Dental Clinic Model:** Based on the findings and implementation results obtained within the project, to develop a standardized **Minimal-Waste Dental Clinic Practice Model** covering waste management, material use, water and energy consumption, recycling and staff training.
8. **Preparing a practice guide:** To prepare an **"Ecological Dental Clinic Practice Guide"** so that the developed model can be implemented in different faculties of dentistry, oral and dental health centers, and private dental clinics.
9. **Developing sustainable behavior:** To achieve a positive change in participants' attitudes and behaviors towards environmentally friendly clinical practices at the end of the project compared to the baseline, and to support the integration of sustainable practices into daily clinical operations.
10. **Creating a scalable model:** To report the results obtained at the end of the project and develop recommendations for implementing the developed model in other dental education institutions and clinics.

Success Indicators

The success of the project will be evaluated through pre- and post-training knowledge/awareness scores, the rate of correct waste segregation, the amount of recyclable waste, single-use material consumption and, where possible, the change in water and energy consumption. Achieving the targeted indicators at the end of the project will constitute the main success criteria in terms of the applicability and sustainability of the developed model.

3. METHOD

Method and Research Techniques to be Applied in the Project

1. Research Design

This project has been planned as **a practice-based, quasi-experimental study with a pre-test/post-test design** in order to develop sustainable practices in dental clinics. The research will consist of consecutive stages: determining the current situation, training and awareness activities, monitoring clinical practices, and evaluating the change obtained after implementation.
The literature reports that dental professionals have gaps in knowledge and practice regarding environmental sustainability and biomedical waste management. In their comprehensive scoping review of studies from 2020–2025, Murariu et al. (2025) reported that oral health professionals' knowledge of sustainability and biomedical waste management was mostly insufficient or moderate, and that structured training was needed.
Current systematic reviews show that sustainable dental practices are not limited to waste reduction; water and energy saving, environmentally friendly materials, reusable products, reduction of the carbon footprint and educational approaches should be evaluated together (Wolf et al., 2026).
Therefore, rather than only measuring participants' knowledge levels, the project has been designed to also evaluate behavioral changes that may occur in clinical practice after the training and changes in environmental indicators.

2. Population and Sample of the Research

The population of the research will consist of the students, graduates, academic and clinical staff of the Faculty of Dentistry of İstanbul Kent University. Participants will be included on a voluntary basis, and inclusion and exclusion criteria will be established before the study begins.
The sample size will be determined using **G*Power** or a similar power analysis program, appropriate for pre-test/post-test comparison. In determining the sample size, 80% statistical power, a 5% error level and the expected effect size obtained from the literature or the pilot study will be taken into account.
Informed voluntary consent will be obtained from participants before the research begins.

3. Variables of the Research

Independent Variable

The main independent variable of the research is:

- **a structured training and clinical practice program on ecological dentistry and minimal-waste practices.**

The program will address sustainable dentistry, segregation of waste at source, reduction of unnecessary use of single-use materials, recycling, water and energy saving, selection of environmentally friendly materials and the “Reduce–Reuse–Recycle–Rethink” approach.

Dependent Variables

The dependent variables of the project are:

1. Level of knowledge of sustainable dentistry,
2. Level of environmental awareness,
3. Attitude towards environmentally friendly clinical practices,
4. Level of sustainable behavior,
5. Rate of correct waste segregation,
6. Amount of recyclable waste (the amount of non-contaminated paper, cardboard, plastic, glass and metal waste collected separately at source and accepted into the recycling system (kg/week and kg/patient)),
7. Single-use material consumption,
8. Water and energy consumption in clinics,
9. Level of compliance with minimal-waste practices.

4. Data Collection Tools

4.1. Sociodemographic and Professional Information Form

A structured information form will be used to determine participants' basic characteristics such as age, gender, education level, professional experience, work environment, and whether they have previously received training on sustainability.

4.2. Sustainable Dentistry Knowledge and Awareness Questionnaire

A structured questionnaire will be administered to assess participants' knowledge and awareness of sustainable dentistry, environmental impacts, waste management, recycling, water and energy saving and environmentally friendly clinical practices.
In preparing the questionnaire, assessment approaches previously used in the field of sustainable dentistry, and in particular the knowledge, attitude and practice domains reported by Veress et al. (2023) and Murariu et al. (2025), will be utilized. In evaluating dentists' environmentally friendly behaviors, Veress et al. drew attention to differences between awareness and practice levels, while Murariu et al. showed that knowledge gaps regarding biomedical waste management persist.
The content validity of the questionnaire will be evaluated by obtaining the opinions of at least three faculty members who are experts in the field. After the necessary revisions, its comprehensibility will be tested by administering it to a small pilot group.

4.3. Ecological Clinical Practice Observation Form

A standardized observation form will be created to evaluate environmentally friendly behaviors in clinical practice.
Indicators in the form such as;

- Sorting waste into the correct categories,
- Segregation of recyclable materials,
- Unnecessary use of single-use materials,
- Reduction of paper use,
- Whether water use is continued unnecessarily,
- Prevention of unnecessary use of electrical devices,
- Preference for environmentally friendly products,
- Proper use of waste bins

will be evaluated.

4.4. Measurement of Waste Quantity and Types

Waste generated in clinics will be recorded by category during the specified monitoring periods. In particular, recyclable waste, general waste and biomedical/hazardous waste that must be managed separately in accordance with the relevant legislation will be evaluated separately.
Where possible, waste quantities will be standardized as **grams or kilograms/day and kilograms/patient**. In this way, not only the total amount of waste but also the amount of waste per clinic or per patient can be evaluated independently of changes in patient numbers.
This approach is consistent with current literature emphasizing that the environmental impacts of sustainable dentistry should be evaluated through measurable indicators (Wolf et al., 2026).

4.5. Monitoring of Water and Energy Consumption

If the existing meter and recording systems in the clinics are suitable, electricity and water consumption will be recorded in the pre-project and post-project periods.
Consumption values will be standardized as;

- kWh/day or kWh/patient,
- L/day or L/patient

and compared.

5. Project Implementation Program

During the implementation phase of the project, participants will be given a structured **"Ecological Dentistry and Minimal-Waste Training"**.
The training content will include;

1. Ecological and sustainable dentistry,
2. Environmental impacts of dental clinics,
3. The "Reduce–Reuse–Recycle–Rethink" approach,
4. Biomedical waste management,
5. Recycling and segregation of waste at source (the amount of non-contaminated paper, cardboard, plastic, glass and metal waste collected separately at source and accepted into the recycling system (kg/week and kg/patient),
6. Reduction of single-use material consumption,
7. Water and energy saving,
8. Selection of environmentally friendly materials and products,
9. Digital applications and reduction of paper consumption,
10. Sustainable clinical behaviors.

Avinash et al. (2013) emphasized the importance of practical and applicable approaches to reducing energy consumption and waste generation in environmentally friendly dentistry.
After the training, an **"Ecological Dental Clinic Checklist"** and visual waste segregation materials will be used for implementation in the clinics.

6. Linking the Method with the Work Packages

Work Package 1 – Literature Review and Current Situation Analysis
Current literature on sustainable dentistry, green dentistry, minimal waste and biomedical waste management will be reviewed. At this stage, the relevant literature, primarily Avinash et al. (2013), Veress et al. (2023), Murariu et al. (2025) and Wolf et al. (2026), will be utilized.
Output: Preparation of the data collection tools and the implementation program.

Work Package 2 – Pre-Test and Clinical Environmental Assessment
Knowledge, awareness and attitude questionnaires will be administered to participants at baseline. During the same period, the amount of waste, waste segregation status, single-use material use and, where possible, water/energy consumption in the clinics will be evaluated.
Output: Establishment of baseline measurement data.

Work Package 3 – Training and Implementation
Participants will receive structured ecological dentistry training, and the prepared minimal-waste practices will be put into effect in the clinics.
Output: Initiation of ecological clinical practices.

Work Package 4 – Monitoring and Data Collection
During the specified monitoring period, clinical practices will be followed with observation forms; waste quantities and, where available, water/energy consumption will be recorded.
Output: Obtaining post-implementation environmental and behavioral data.

Work Package 5 – Post-Test and Effectiveness Evaluation
After implementation, participants will complete knowledge and awareness questionnaires tailored to their own fields and roles (e.g., dentists, students, academic and clinical staff). Post-test results will be compared with pre-test results to assess the changes.
Output: Determination of the effectiveness of the training and implementation.
Work Package 6 – Creation of the Minimal-Waste Dental Clinic Model

By evaluating the quantitative and observational data obtained, a standard **Minimal-Waste Dental Clinic Practice Model** applicable in clinics will be created.
Output: Practice model, checklist and ecological clinic guide.

7. Statistical Analysis

Statistical analysis of the data will be performed using an appropriate statistical software package. First, descriptive statistics will be calculated. Mean ± standard deviation or median and interquartile range will be given for continuous variables; counts and percentages will be given for categorical variables.
Conformity of the data to normal distribution will be evaluated using the **Shapiro–Wilk test** and graphical methods.
For comparison of pre-test and post-test measurements;

- for normally distributed dependent continuous variables, the **paired t-test**,
- for non-normally distributed variables, the **Wilcoxon signed-rank test**,
- for categorical variables, the **McNemar test** or appropriate chi-square tests will be used.

If measurements are taken at more than one time point, **repeated measures ANOVA** or, if parametric assumptions are not met, appropriate non-parametric methods will be used.
To evaluate the relationships between knowledge, awareness and behavior scores, **Pearson or Spearman correlation analysis** will be used. Where appropriate, multivariate regression analyses will be used to evaluate the effect of participants' demographic and professional characteristics on the results.
The level of statistical significance will be accepted as **$p<0.05$** for all analyses. In addition to statistical significance, where possible, **effect sizes and 95% confidence intervals** will also be reported.

8. Suitability of the Method to the Aims and Objectives

The proposed method has been structured to directly serve the aims and objectives of the project. While the pre-test phase determines the current level of knowledge, awareness and clinical practice, the training and clinical implementation phase aims to bring about the targeted behavioral change. The comparison of post-test results and environmental indicators will allow the effectiveness of the practices to be evaluated objectively.
This approach is consistent with the literature showing that merely raising awareness is not sufficient in sustainable dentistry and that knowledge and attitudes must be translated into clinical practice. While Veress et al. (2023) demonstrated the importance of awareness in developing environmentally friendly behaviors, Murariu et al. (2025) emphasized the need for training, particularly in terms of biomedical waste management.
The systematic review published by Wolf et al. (2026) revealed the necessity of multidimensional approaches for sustainable dentistry, such as education, reduction of resource consumption, use of environmentally friendly materials and technologies, and reduction of the carbon footprint.
Therefore, the **pre-assessment–training–clinical implementation –monitoring–post-assessment–model development** approach proposed within the project is considered appropriate and realistic both for achieving the measurable objectives of the project and for developing a sustainable practice model that can be adapted to different dental clinics.

4. WIDESPREAD IMPACT

4.1. Information on the Expected Outputs of the Project

Output Type	Output	Expected Time Frame for Obtaining the Output (*)
Scientific/Academic Outputs (Conference Paper, Article, Book Chapter, Book, etc.):	Preparation of at least 1 scientific article containing the project results and its submission to a national/international peer-reviewed journal. Presentation of the project results as an oral/poster presentation at at least 1 national or international scientific meeting.	**6-12**
Economic/Commercial/Social Outputs (Product, Prototype, Patent, Utility Model, Production Permit, Registration, Visual/Audio Archive, Inventory/Database/Documentation, Copyrighted Work, Spin-off/Start-up Company, etc.):	Development of a “Minimal-Waste Dental Clinic Practice Model” applicable in dental clinics. Creation of an Ecological Dental Clinic Practice Guide, a waste segregation system and an Ecological Dental Clinic Checklist within the scope of the model. Presentation of the model as an applicable and scalable social practice model for faculties of dentistry, Oral and Dental Health Centers and private dental clinics.	**12–15**
Outputs for Researcher Training (Undergraduate/Master's/PhD/Medical Specialty Theses):	The data obtained within the project will, where appropriate, provide a basis for 3 undergraduate thesis studies, contributing to the training of researchers in sustainable dentistry, minimal waste and environmentally friendly clinical practices.	**12–15**

4.2. Sharing and Dissemination of Project Outputs

TABLE OF SHARING AND DISSEMINATION OF PROJECT OUTPUTS (*)

Activity Type (Meeting, Workshop, Training, Website, Media, Fair, Project Market, etc.)	Stakeholders / Potential Users	Timing and Duration of the Activity
Training and awareness seminar	Dentists, students, academic and clinical staff	Months 4–6 of the project; at least 1 training event
Website and digital material sharing	Dentists, faculties, Oral and Dental Health Centers, private clinics	Months 10–12 / at least 1 year
Presentation at a national/international congress	Academics, researchers, dentists	Months 12–18 / at least 1 meeting
Project dissemination event	Faculties of dentistry, healthcare institutions, clinic managers	Months 12–18 / at least 1 event

(*) The rows in the table can be expanded and duplicated as needed.