MIND SCULPTOR: AN OBSESSIVE-COMPULSIVE DISORDER (OCD) EXPOSURE AND RESPONSE PREVENTION (ERP) THERAPY TOOL

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May 2025

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24-25J-046

Project Proposal Report

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DECLARATION

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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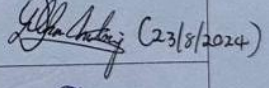
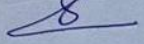
The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

	Title	First Name	Last Name	Signature
Supervisor	Dr.	Dilshan	De silva	
Co-Supervisor	Mr.	Samadhi	Rathnayaka	

ABSTRACT

This report introduces Mind Sculptor, an innovative resource for managing obsessive-compulsive disorder (OCD) through Enhanced Exposure and Response Prevention (VERP) therapy. OCD is a long-lasting disorder featuring intrusive thoughts and repetitive behaviors, which greatly impact quality of life. Although traditional ERP therapy has shown success, its effectiveness is hindered by its dependence on patients' self-assessments and the absence of integration of real-time biometric data. Mind Sculptor overcomes these constraints by employing sophisticated technologies to simulate individualized OCD-triggering situations tailored to each patient's specific subtype and severity of OCD. In therapy, the system gathers self-reported and biometric data, including facial expressions, to track anxiety levels with greater accuracy. Machine learning algorithms examine this data in live action, giving instant responses and adapting exposure situations to improve treatment efficacy. The tool also creates thorough anxiety graphs that merge subjective and objective data, providing an in-depth look at patient advancements and aiding in tailoring therapy plans. Mind Sculptor stands out from other OCD treatment apps by incorporating real-time biometric integration and advanced analytics through technologies like React Native, Python Flask, and TensorFlow for a more personalized and precise therapeutic approach. Mind Sculptor is raising the bar for digital mental health tools by combining biometric data with traditional therapeutic techniques, which enhances OCD treatment results and progresses mental health care.

Keywords: Obsessive-Compulsive Disorder (OCD), Enhanced Exposure and Response Prevention (VERP) therapy, Biometric data integration, Personalized therapy

.

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LIST OF ABBREVIATIONS

Abbreviation	Description
OCD	Obsessive Compulsive Disorder
CNN	Convolutional Neural Network
ERP	Exposure and Response Prevention Therapy
VERP	Virtual Exposure and Response Prevention Therapy

1. INTRODUCTION

Obsessive-Compulsive Disorder (OCD) is a chronic psychiatric condition characterized by persistent intrusive thoughts (obsessions) and repetitive behaviors (compulsions). Traditional Exposure and Response Prevention therapy is a commonly used treatment by psychiatrists for patients diagnosed with obsessive-compulsive-disorder (OCD). Exposure and Response Prevention (ERP) therapy has proven effective in reducing symptoms and improving outcomes for OCD patients. Enhanced Exposure and Response Prevention (VERP) is an innovative approach to treating OCD patients. VERP uses advanced technologies to simulate OCD-inducing scenarios and integrates biometric data to enhance the effectiveness of traditional exposure therapy. VERP can be used to treat patients with symmetric OCD, contamination OCD, sexual orientation OCD. Traditional ERP therapy is limited in effectiveness due to lack of integration with real-time biometric data. The proposed VERP system integrates bio-metric data to enhance the effectiveness of traditional ERP therapy.

1.1 Background and Literature survey

Obsessive-Compulsive Disorder (OCD) is a chronic psychiatric condition characterized by persistent intrusive thoughts (obsessions) and repetitive behaviors (compulsions). It affects approximately 2.3% of the population and significantly impairs daily functioning and quality of life [1]. Traditional treatments, such as Exposure and Response Prevention (ERP) therapy, have proven effective in reducing symptoms and improving outcomes for OCD patients [2, 3]. However, ERP therapy requires extensive resources, specialized care, and consistent patient engagement, which can pose substantial barriers to access and adherence for many individuals [4, 5].

Traditional ERP therapy is used by psychologists and psychiatrists to treat patients with OCD, and it has proven its effectiveness in reducing symptoms and improving outcomes

for OCD patients [2, 3]. However, traditional ERP therapy has limitations, including the lack of use of biometric data such as facial expressions to capture patients' stress levels.

Traditional therapy approaches can now be improved through novel avenues because of recent developments in digital health technologies. Facial expressions and other biometric data are being used more often in mental health research to provide objective measurements of emotional and physiological responses. These measures provide a more accurate insight of the patient's stress and anxiety levels, which cannot be captured through self-reported data [6]. Research has indicated that the integration of biometric data with traditional therapeutic methods can enhance the treatment process overall and increase the accuracy of anxiety assessments.

Several mobile applications can be seen in the market that have been developed to assist with the treatment of OCD. NOCD, GGOC, Talkspace, and OCD Challenge are some examples of existing OCD treatment applications [7, 8, 9, 10]. These applications are mostly used for OCD identification, teletherapy services, to provide educational materials, and ERP exercises. However, they are unable to incorporate real-time biometric data to offer customized therapy plans based on thorough analysis. In addition, none of the above-mentioned applications can generate anxiety graphs and analyze the treatment efficacy through generated graphs.

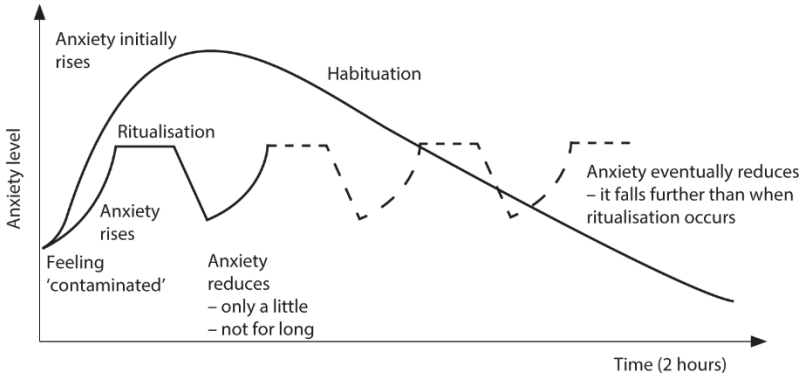

Figure 1.1 - Anxiety Graph [11]

The goal of the VERP Therapy system is to enhance these developments by combining modern technologies with the strengths of ERP therapy. The system offers a more comprehensive method of treating OCD by simulating OCD inducing scenarios and gathering both subjective and objective data. This strategy not only improves the accuracy of anxiety assessment, but also enables customized treatment plans that can change as the patient progresses.

1.2 Research Gap

Substantial gaps exist in the current solutions, despite substantial developments in digital mental health technologies, especially in the treatment of obsessive-compulsive disorder (OCD) through web and smartphone applications. These shortcomings and the necessity for a more sophisticated strategy are brought into focus by a comparative examination of the current platforms—NOCD, GGOC, Talkspace, and OCD Challenge—against the suggested Enhanced Exposure and Response Prevention Therapy (VERP Therapy) system.

The initial gap is connected to exposure therapy. Although NOCD and OCD Challenge provide organized exposure tasks, they heavily depend on self-reporting and do not have real-time feedback or adjust scenarios dynamically according to patient reactions. GGOC offers CBT techniques with exposure tasks but does not customize them based on specific OCD subtypes and severity levels. Talkspace, primarily a communication platform, does not offer structured exposure assignments or automated response prevention. On the other hand, the suggested VERP Therapy makes use of Virtual elements to imitate very precise OCD-triggering situations, adapting in response to live biometric data. This provides a therapy setting that is more tailored, engaging, and adaptable, resulting in a higher success rate for exposure exercises.

Another significant issue is the lack of incorporating biometric data into the existing platforms. NOCD, GGOC, Talkspace, and OCD Challenge do not have the ability to collect and assess biometric data such as facial expressions, and instead rely solely on feedback from the users. The suggested VERP Therapy tackles this issue by incorporating machine learning algorithms to examine facial expressions through a webcam in therapy sessions. This functionality allows for immediate tracking of the patient's stress and anxiety levels, giving an unbiased assessment of their emotional condition when faced with OCD triggers. Adding biometric data improves the understanding of the patient's condition, making treatment more effective.

Moreover, current systems fail to produce comprehensive anxiety charts that integrate both subjective and physiological information. Although NOCD and OCD Challenge provide simple progress monitoring, they do not create detailed anxiety charts. GGOC and Talkspace do not have adequate resources for visually tracking therapy progress in a thorough way. On the other hand, the suggested VERP Therapy system merges subjective user-reported information with objective biometric data like facial expressions to produce OCD-Anxiety graphs. These charts provide a more detailed view of the patient's progression of anxiety, indicating potential areas for modification and enabling a personalized therapy plan.

Finally, the existing platforms lack sophisticated data analytics for predicting treatment effectiveness. Although NOCD and OCD Challenge offer simple progress monitoring, they do not have advanced data-driven tools to forecast treatment results. GGOC and Talkspace both depend on therapist evaluation rather than automated tools to assess the effectiveness of treatment. The suggested VERP Therapy analyzes OCD-Anxiety graphs produced during various therapy sessions, allowing the system to forecast treatment effectiveness.

Table 1.1 - Comparison of existing systems with proposed system

Feature	Proposed System	GGOC: OCD Relief [8]	NOCD [9]	TalkSpace [10]	OCD Challenge [11]
Expose the user to OCD-triggering situations.	✓	✗	✓	✗	✓
Capture stress/anxiety level using facial expressions	✓	✗	✗	✗	✗
Generate anxiety graph after VERP therapy	✓	✗	✗	✗	✗
Treatment efficacy analysis	✓	✓	✗	✓	✗

Overall, the VERP Therapy system fills important gaps in the current OCD treatment field through personalized exposure therapy, incorporating biometric data for a deeper grasp of patient anxiety, creating detailed anxiety graphs. These advancements have the possibility to greatly enhance OCD treatment results and offer a more profound insight into the condition.

1.3 Research Problem

1. How can we virtually expose patients to OCD-inducing scenarios?

The conventional approach to Exposure and Response Prevention (ERP) therapy includes exposing patients to triggers of their OCD symptoms either physically or mentally. Nevertheless, this method has constraints, including the complexity of replicating specific situations, variability in patient reactions, and the difficulties in maintaining consistent levels of exposure. The main focus of the research is on creating virtual environments capable of accurately simulating scenarios that trigger OCD. The virtual environments need to be able to be personalized for various OCD subtypes and levels of severity, ensuring a controlled and safe environment for exposure therapy that can be repeated. The objective is to enhance the efficiency of ERP therapy by utilizing visual elements to develop customized, lifelike experiences for individual patients.

2. How can response prevention therapy be implemented using modern technology?

Response prevention is a crucial element of ERP therapy, involving patients being instructed to refrain from engaging in compulsive actions when faced with OCD triggers. The focus of the research problem is on utilizing current technology to monitor and enforce response prevention in real-time. Conventional techniques depend on self-reporting and therapist observation, which may be subjective and unreliable. Current technology, like biometric tracking and instant data analysis, has the capability to accurately assess a patient's physical reactions, like facial gestures, while undergoing treatment. The difficulty is in smoothly incorporating these technologies into therapy, making sure they improve the therapeutic experience instead of taking away from it.

3. **How can the accuracy of response prevention therapy be increased using modern technology?**

The success of response prevention therapy mainly depends on how well patient responses are monitored and analyzed. Conventional approaches might overlook subtle distress signals or misinterpret patient responses because of the absence of objective information. The issue being studied is how to improve the accuracy of treatment through the utilization of contemporary tools like machine learning and biometric analysis. Algorithms can detect when a patient is having difficulties with response prevention by studying patterns in biometric data like facial expression changes, even if symptoms are not visibly obvious. This evidence-based method may result in more exact modifications in treatment, like changing the level of exposure or offering specific interventions as needed.

2. OBJECTIVES

2.1 Main Objective

The main objective of this study is to develop an application for Enhanced Exposure and Response Prevention therapy system that utilizes virtual simulations and biometric data to improve the efficiency of treatment. The patient is exposed to an OCD inducing scenario and collects both biometric data and patient's self-reported data to draw the anxiety graph.

2.2 Specific Objectives

There are four main specific objectives that must be completed in order to achieve the main objective described above.

- **Generate OCD triggering scenarios.**

  Simulate real-life scenarios using videos and images to expose the patient to OCD triggering scenario. This OCD trigger scenario is generated based on the patient's OCD subtype and severity.

- **Capture biometric data and patient self-reported data.**

  During the therapy session, the system collects both biometric data and patient-self reported data. A patient's anxiety level is captured by using facial expressions and at the same time patient can input the level of discomfort.

- **Generate the anxiety graph.**

  After completing the therapy session, a composite anxiety score is periodically calculated using biometric data and patient self-reported data. The anxiety graph is generated based on composite anxiety score values at the end of the therapy session.

- **Analyze anxiety graphs.**

  The system analyzes the anxiety graphs of therapy sessions to predict the effectiveness of the patient's treatment.

3. METHODOLOGY

The proposed system is capable of generating customized therapy plans and monitoring patients' anxiety levels during the therapy session. This therapy plan is generated based on the patient's OCD subtype and severity.

3.1 System diagram

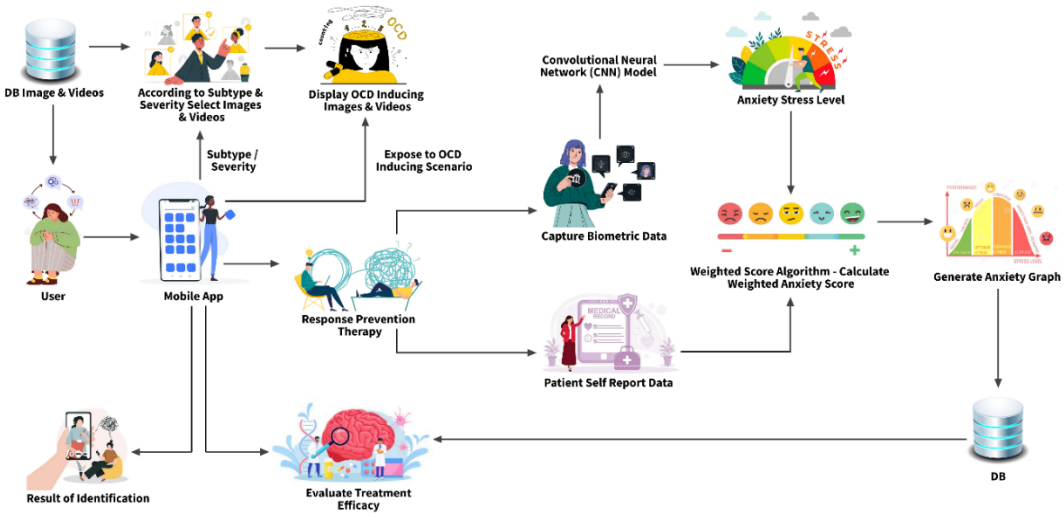

Figure 3.1- VERP System Diagram

Figure 3.1 illustrates the overall system diagram of the proposed component of Enhanced Exposure and Response Prevention therapy. Initially, the patient's OCD subtype and severity are provided by the identification component. Then the OCD inducing scenario is generated based on the OCD subtype and severity and displayed on the screen as an image or a video. The system maintains a database with various OCD inducing images and videos. A decision tree algorithm is used to select the most appropriate OCD triggering scenario based on the patient's OCD subtype and severity.

After the patient is exposed to the OCD inducing scenario, the system monitors the patient's anxiety level during the therapy session. There are two ways in which the system collects anxiety levels during the therapy session. As in traditional exposure and response

prevention therapy, the system prompts the user to enter anxiety levels during the therapy session. In addition, the system collects biometric data through facial expressions to improve anxiety level accuracy. A Convolutional Neural Network (CNN) is used within the Deepface library for real-time facial expression analysis and to capture anxiety levels during the therapy. VGG-Face, OpenFace, ResNet CNN architectures can be considered when developing the system. Both self-reported data and biometric data are simultaneously captured by the system at the same time intervals.

Then, using the captured biometric data and self-reported data, the system calculates composite anxiety score values for the relevant time intervals. A weighted scoring algorithm is used to calculate the composite anxiety score values. The system generates anxiety graph using those composite anxiety scores against time. At the end of the therapy, the patient can see the anxiety graph and can observe how the anxiety level changes during the therapy.

Finally, patients can see the anxiety graphs of previous therapy sessions and evaluate the treatment efficacy. The system compares anxiety graphs and shows the result to the patient.

- Data requirement

An accurate dataset is required to train the CNN model to capture patients' anxiety levels using facial expression. Datasets such as AffectNet and FER-2013 can be used to train the CNN model.

3.2 Technologies, Techniques, Algorithms and architectures

Table 3.1 - Technologies, techniques, algorithms and architectures.

Technologies	• React Native • Expo • Python Flask • TensorFlow • Vscode • Deepface
Techniques	• Facial recognition. • Emotion detection. • Deep learning. • Data augmentation. • Graph visualization
Algorithms	• Convolutional Neural Network (CNN) model • Decision tree algorithm. • Weighted scoring algorithm.
Architectures	• VGG-Face • OpenFace • ResNet
Database	• MongoDB

4. PROJECT REQUIREMENTS

4.1 Functional requirements

- The system should be able to generate OCD inducing scenarios using videos and images based on the OCD subtype and severity.
- The system should be able to capture accurate anxiety/stress level using emotion detection during the therapy.
- The system should be able to capture the patient's self-reported data.
- The system should be able to calculate the weighted anxiety score accurately using biometric data and user input data.
- The system should be able to generate the anxiety graph using the weighted anxiety score.
- The system should be able to analyze anxiety graphs of the patient.

4.2 User requirements

- Patient requirements:
    1. An intuitive user interface should be provided by the system so that users may interact with simulations and enter self-reported data.
    2. Patient data security and confidentiality should be guaranteed by the system.

- Administrative Requirements:
    1. Administrators should be able to control system settings, user roles, and access levels.
    2. To avoid data loss, the system should provide data backup and recovery.

4.3 System requirements

- Hardware requirements
    1. The system should support cameras for facial expression analysis.
    2. The system should run on standard mobile devices, tablet, desktop or laptop computers with high-resolution displays.
- Software requirements
    1. The system should be compatible with Android, IOS, Windows, macOS, and Linux operating systems.
    2. Requires React Native and Expo to create a cross platform mobile application.
    3. React to develop the frontend of web application.
    4. Python Flask, NodeJS for the back-end development.
    5. Visual studio code IDEA to implement the code.

4.4 Non-functional requirements

- The application should be reliable and efficient.
- Interfaces should be user-friendly.
- The application should be compatible with different devices.
- Patient data must be secure.
- The results of VERP therapy must be accurate.

5. GANTT CHART

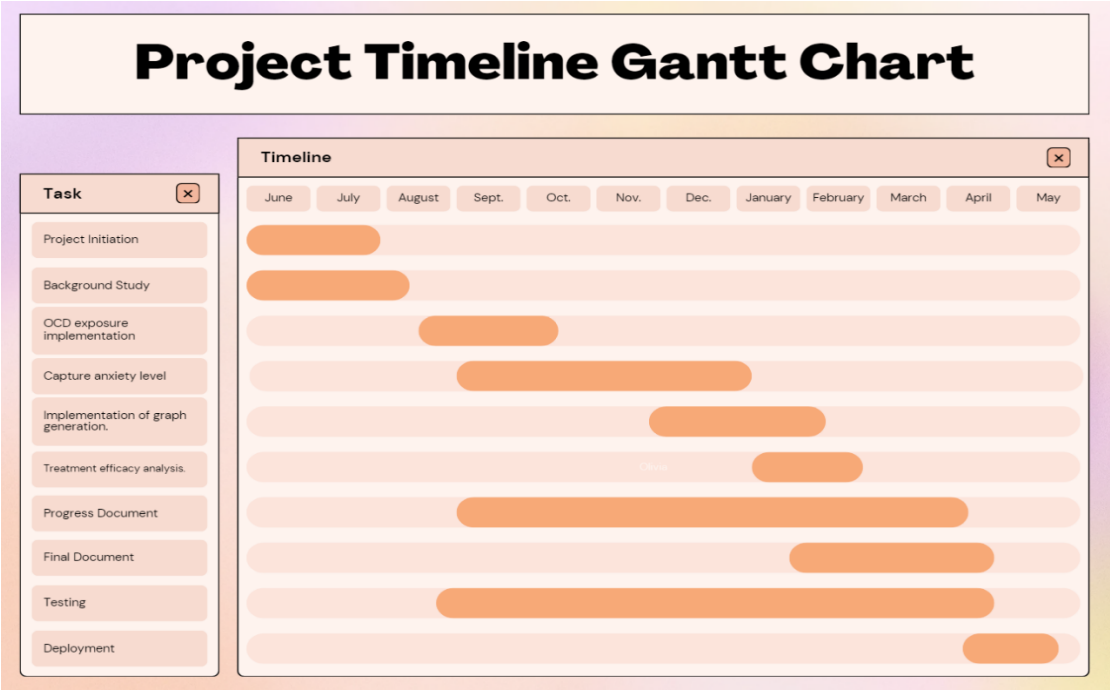

Figure 5.1 - Gann chart

5.1 Work Breakdown Structure (WBS)

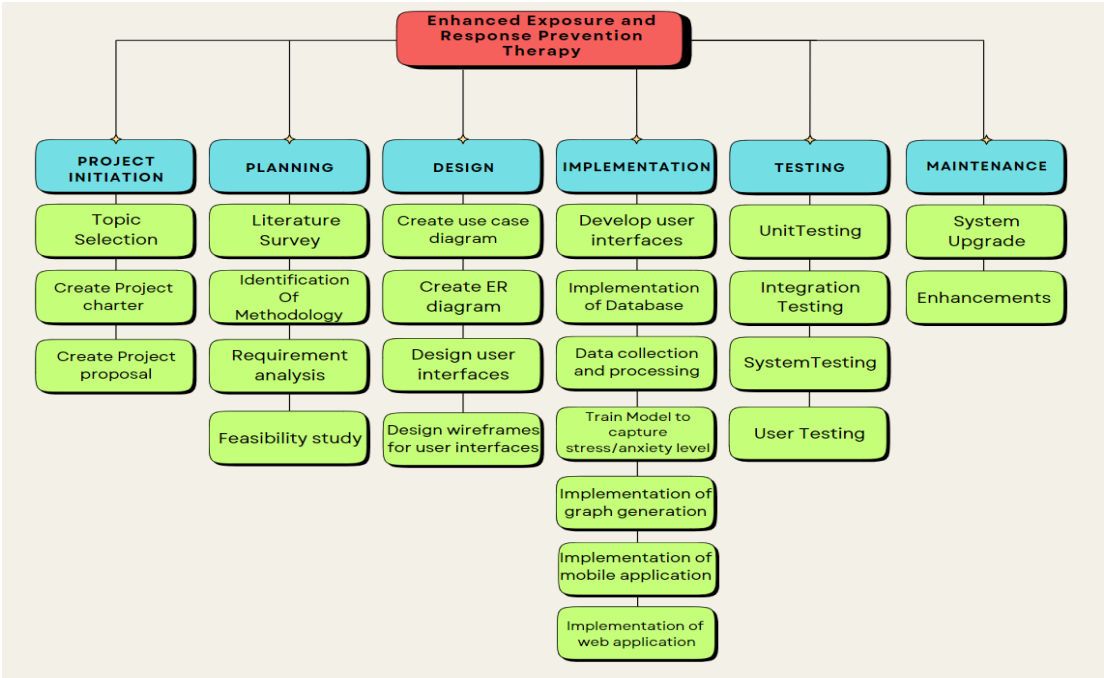

Figure 5.2 - Work Breakdown Structure

6. BUDGET AND BUDGET JUSTIFICATION

The table below shows the overall budget for the proposed system.

Table 6.1 - Overall budget for the proposed system

Requirement	Cost (Rs.)
Development costs for Licenses/subscriptions	10,000.00
Cost for the dataset	4,900.00
Cost of deployment	8,705.00/month
Cost of hosting in Play Store	6,250.00
Cost of hosting in App store	22,825.00/month
Total cost	**52,680.00**

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8. APPENDIX

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ORIGINALITY REPORT

13%	9%	5%	9%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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2	Submitted to National Institute of Business Management Sri Lanka Student Paper	3%
3	fastercapital.com Internet Source	2%
4	www.coursehero.com Internet Source	1%
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7	Submitted to universititeknologimara Student Paper	<1%
8	Francesca Borgnis, Elisa Pedroli. "Technological Interventions for Obsessive–	<1%

Figure 8.1 - Plagiarism Report