Higher Nationals - Summative Assignment Feedback Form

Student Name/ID	MOHAMMED MAHROOF MOHAMMED AASHIK/E230667		
Unit Title	Unit 16: Computing Research Project -Pearson Set		
Assignment Number	1 of 2	**Assessor**	Ms Imalka
Submission Date	21.07.2025	**Date Received 1st submission**	
Re-submission Date		**Date Received 2nd submission**	

Assessor Feedback:

LO1 Examine appropriate research methodologies and approaches as part of the research process

Pass, Merit & Distinction Descripts   P1 ☐   P2 ☐   M1 ☐   D1 ☐

LO2 Conduct and analyse research relevant to a chosen computing research project

Pass, Merit & Distinction Descripts   **P3** ☐   **P4** ☐   **M2** ☐   **D1** ☐

LO3 Communicate the outcomes of a research project to identified stakeholders

Pass, Merit & Distinction Descripts   **P5** ☐   **M3** ☐   **D2** ☐

LO4 Reflect on the application of research methodologies and concepts

Pass, Merit & Distinction Descripts   **P6** ☐   **P7** ☐   **M4** ☐   **D3** ☐

Assessor Feedback:

* Please note that grade decisions are provisional. They are only confirmed once internal and external moderation has taken place and grades decisions have been agreed at the assessment board.

Grade:	**Assessor Signature:**	**Date:**
Resubmission Feedback:		
Grade:	**Assessor Signature:**	**Date:**
Internal Verifier's Comments:		
Signature & Date:		

Pearson

Higher Nationals in

Computing

Unit 16: Computing Research Project

Project Proposal

Important Points:

1. It is strictly prohibited to use textboxes to add texts in the assignments, except for the compulsory information. eg: Figures, tables of comparison etc. Adding text boxes in the body except for the before mentioned compulsory information will result in rejection of your work.
2. Avoid using page borders in your assignment body.
3. Carefully check the hand in date and the instructions given in the assignment. Late submissions will not be accepted.
4. Ensure that you give yourself enough time to complete the assignment by the due date.
5. Excuses of any nature will not be accepted for failure to hand in the work on time.
6. You must take responsibility for managing your own time effectively.
7. If you are unable to hand in your assignment on time and have valid reasons such as illness, you may apply (in writing) for an extension.
8. Failure to achieve at least PASS criteria will result in a REFERRAL grade .
9. Non-submission of work without valid reasons will lead to an automatic RE FERRAL. You will then be asked to complete an alternative assignment.
10. If you use other people's work or ideas in your assignment, reference them properly using HARVARD referencing system to avoid plagiarism. You have to provide both in-text citation and a reference list.
11. If you are proven to be guilty of plagiarism or any academic misconduct, your grade could be reduced to A REFERRAL or at worst you could be expelled from the course
12. Use word processing application spell check and grammar check function to help editing your assignment.
13. Use **footer function in the word processor to insert Your Name, Subject, Assignment No, and Page Number on each pag**e. This is useful if individual sheets become detached for any reason.

STUDENT ASSESSMENT SUBMISSION AND DECLARATION

When submitting evidence for assessment, each student must sign a declaration confirming that the work is their own.

Student name: MOHAMMED AASHIK	Assessor name: Ms Imalka	
Issue date:	Submission date: **21.07.2025**	Submitted on: **21.07.2025**
Programme: HND in Computing		
Unit: 16 – Computing Research Project		
Assignment number and title: 1 -research proposal | Computing Research Project on Artificial Intelligence		

Plagiarism

Plagiarism is a particular form of cheating. Plagiarism must be avoided at all costs and students who break the rules, however innocently, may be penalised. It is your responsibility to ensure that you understand correct referencing practices. As a university level student, you are expected to use appropriate references throughout and keep carefully detailed notes of all your sources of materials for material you have used in your work, including any material downloaded from the Internet. Please consult the relevant unit lecturer or your course tutor if you need any further advice.

Guidelines for incorporating AI-generated content into assignments:

The use of AI-generated tools to enhance intellectual development is permitted; nevertheless, submitted work must be original. It is not acceptable to pass off AI-generated work as your own

Student Declaration

Student declaration

I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice.

Student signature: E230667 Date:11.07.2025

Higher National Diploma in Computing

Assignment Brief

Student Name /ID Number	MOHAMMED MAHROOF MOHAMMED AASHIK/E230667
Unit Number and Title	Unit 16 – Computing Research Project (Pearson set)-
Academic Year	2024/25
Unit Tutor	Ms .Imalka
Assignment Title	AI IN HOSPITAL WASTE MANAGEMENT
Issue Date	
Submission Date	21.07.2025
IV Name & Date	

Submission format

- **Research Project Proposal**- The submission is in the form of an individual written report. This should be written in a concise, formal business style. You are required to make use of headings, paragraphs and subsections as appropriate, and all work must be supported with research and please provide a references list using the Harvard referencing system.

  The recommended word limit is 2000 words.

- **Formal project report** - In the form of an individual written report. This should be written in a concise, formal business style following standard academic guidelines for research projects. You are required to make use of headings, paragraphs and subsections as appropriate, and all work must be supported with research. Referencing using the Harvard referencing system.

The recommended word limit is minimum 4,500 words

- **PowerPoint presentation** – present your research finding in a 10 to 15 minutes presentation that elaborates the research process followed, findings and conclusion, recommendation and future research considerations.

  Please submit the speaker notes of the presentation in the appendix section of the final project report.

Unit Learning Outcomes:
LO1. **Examine appropriate research methodologies and approaches as part of the research process.** **LO2. Conduct and analyse research relevant to a chosen computing research project** **LO3. Communicate the outcomes of a research project to identified stakeholders** **LO4. Reflect on the application of research methodologies and concepts**
Trasferrable skills and Competencies developed
Computing related cognitive skills • Understand the scientific method and its applications to problem-solving • Demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to computing and computer applications • Methods and tools: deploy appropriate theory, practices and tools for the design, implementation and evaluation of computer-based systems • Recognise the professional, economic, social, environmental, moral and ethical issues involved in the sustainable exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices **Computing related practical skills** • The ability to specify, design and construct reliable, secure and usable computer based systems • The ability to plan and manage projects to deliver computing systems within constraints of requirements, timescale and budget • The ability to deploy effectively the tools used for the construction and documentation of computer applications, with particular emphasis on understanding the whole process involved in the effective deployment of computers to solve practical problems • The ability to critically evaluate and analyse complex problems, including those with incomplete information, and devise appropriate solutions, within the constraints of a budget **Employability skills** • Intellectual skills: critical thinking; making a case; numeracy and literacy • Self-management: self-awareness and reflection; goal setting and action planning; independence and adaptability; acting on initiative; innovation and creativity • Interaction: reflection and communication • Contextual awareness e.g. the ability to understand and meet the needs of individuals, business and the community, and to understand how workplaces and organisations are governed
Assignment Brief and Guidance:

Research Theme: Artificial Intelligence

Artificial intelligence is at the forefront of innovation within Computer Science that uses a combination of logic, algorithms and large data sets to produce an AI model. The AI model is created to perform specific tasks or make predictions on supplied sets of input data, for example identifying patterns in weather data, internet search data or analysis of medical data. Artificial intelligence is predicted to generate a potential impact to the global economy of $13 – $15 Trillion by 2030, with sales of AI related hardware, software and services predicted to see a global revenue of $900 billion. It is predicted that AI will boost the GDP of China by a little over 26% by 2039, and of North America by 14.5%. AI requires the input of structured and labelled data, where the outputs are already known. The input data sets to the AI model are intrinsically linked to study field to which the AI engine is to be applied. The AI model can then be used to identify and recognise patterns and relationships within the input data. This identification step is referred to as 'training' the AI model. Once this training is completed, the model can then be used to make predictions and identify patterns within brand new data sets. This new data set can then be added to the existing data set, so that the AI model keeps 'growing'. As the model data set keeps expanding, and the AI algorithms are modified and refined, this gives the impression that the AI is 'learning' and demonstrating 'intelligence'. AI has been used extensively to analyse and process large and complex datasets produced by big data systems, often in real time and using Computer Vision to extract data from image sources.

Developing Artificial Intelligence required a range of knowledge and skills across a broad range of computer science disciplines. AI developers need to be familiar with the algorithms and techniques in fields such as machine learning, natural language processing, computer vision and data science. Knowing the required computing skills will help organisations recruit the correct resources to help develop and extend AI systems. Artificial Intelligence has a range of benefits across many industry sectors. In the finance industry, AI is rapidly becoming a game changer, using advanced algorithms, models and machine learning to carry out predictive analytics on large, rapidly changing financial datasets to provide more accurate financial predictions. In the field of business operations, AI automation is helping to support and enhance labour. productivity, leading to greater cost savings and increased efficiency. AI is also revolutionising the way businesses interact with their customers, by providing AI driven expert systems to help customers resolve queries as well as providing personalised recommendations based on customer choices and preferences. In the field of biomedical science, AI models help in the development of new drug treatments for a range of diseases by searching and processing large scale medical and DNA datasets.

While Artificial Intelligence has numerous benefits in the analysis and processing of large data sets to solve problems, there are some clear risks to the application technology. AI systems respond to the data fed into the model, and so if this data is not representative of the problem area under study, there is a likelihood that the output of the AI model will be biased. In addition, there are security and privacy concerns on the source and storage of the large datasets used for AI. The rise of the Deepfake image and the manipulation of the human voice is also a concern because of the spread of misinformation. The wide-ranging effects of these risks mean that they can only be dealt with by a diverse range of stakeholders, including computer scientists, law makers, governments, and industry leaders. There are also incidental risks of AI in business, for example the increasing adoption of AI based systems may increase unemployment across a range of sectors and workforce demographics.

(Pearson, 2024)

Task

You have been given the task of conducting research related to artificial Intelligence and its impact on the field of computing, a chosen organization or an industry. Your task is to conduct research with appropriate evidence by following suitable research philosophies and methods available. You then must evaluate the outcomes of the research project and suggest improvements to the chosen industry, organization or to the field of computing in general.

Choosing a research objective/question

You can choose your own research topic for this unit. Strong research projects are those with clear, well focused and defined objectives. A central skill in selecting a research objective is the ability to select a suitable and focused research objective. One of the best ways to do this is to put it in the form of a question.

The range of topics discussed on Artificial Intelligence could cover the following areas:

- Ethical implications in AI development
- Transparency in AI models
- AI applications
- AI perspectives on governance and regulations
- Bias and fairness in AI algorithms
- AI in cybersecurity; threats and countermeasures

Activities

Activity1 – Project Proposal

Project Proposal should cover the following areas.

1. Definition of research problem or question.
2. Provide a literature review giving the background and conceptualisation of the proposed area of study. (This would provide existing knowledge and benchmarks by which the data can be judged)
3. Clearly defined research objectives, questions or hypotheses supported by the reviewed literature.
4. Critical evaluation of the research process /different research methodologies that can be applied to computing research project by demonstrating an understanding of the pitfalls, ethical issues, and limitations. choose a suitable research methodology and justify the selection based on theoretical/philosophical frameworks.

Activity 2 – Conducting the research and producing the final research paper

The Learner requires to produce a detailed research project report covering following areas

- Conduct primary and secondary research using appropriate methods for a computing research project that considers costs, access and ethical issues.
- Carry out your research and apply appropriate analytical tools to analyse research findings and data.
- Draw conclusion based on the research findings.
- Communicate the outcomes of your research project to the identified audience. Analyze and discuss merits, limitations and pitfalls experienced in research methodologies and data collections methods applied considering to which extent the project objectives were met.
- Evaluate the project outcomes to suggest justified recommended actions leading to future improvements and future research consideration.
- Reflect on the success of your research project and your performance at the end of the project by evaluating the research process followed and the methodologies applied. Consider alternative research methodologies and lessons learnt in view of the project outcomes.

Activity 3 – formal Presentation on Research findings

Communicate the findings of your research project to identified stakeholders in a 10–15-minute formal presentation. The presentation should cover,

- A brief introduction to the research area, objectives, hypotheses/research questions.
- Analysis of the research and data collection methodologies followed.
- A summary of the research findings
- Conclusion and summary of the recommended actions
- Future improvements and research considerations.

Recommended resources

Textbooks

Cornford, T., Smithson S. (2005) *Project Research in Information Systems: A Student's Guide*. Paperback. Palgrave Macmillan.
Costley, C., Elliott, G. and Gibbs, P. (2010) *Doing Work Based Research: Approaches to Enquiry for Insider-researchers.* London: SAGE.
Fink, A. (2020) *Conducting Research Literature Reviews: From the Internet to Paper*. 5th edn. Sage Publications Inc.
Flick, U. (2020) *Introducing Research Methodology: A Beginner's Guide to Doing a Research Project.* London: Sage Publications Ltd.
Gray, D.E. (2009) *Doing Research in the Real World.* 2nd edn. London: SAGE.
Saunders, M., Lewis, P. and Thornhill, A. (2012) *Research Methods for Business Students.* 6th edn. Harlow: Pearson.
Wellington, J. (2000) *Educational Research: Contemporary Issues and Practical Approaches*. Continuum International Publishing Group Ltd.

Journals

International Journal of Quantitative and Qualitative Research
Qualitative Research

Links

This unit links to the following related units:
Unit 3: Professional Practice
Unit 6: Planning a Computing Project (Pearson-set)
Unit 7: Software Development Lifecycles.

Useful links

Resource Number	Type of Resource	Resource Titles	Links
1	Article	artificial intelligence (AI)	https://www.techtarget.com/searchenterpriseai/definition/AI-Artificial-Intelligence
2	Article	The Ultimate Guide to Understanding and Using AI Models (2024)	https://viso.ai/deep-learning/ml-ai-models/
3	Blog	What is Labeled Data?	https://www.datacamp.com/blog/what-is-labeled-data
4	Article	A Complete Guide to Data Labeling for AI	https://levity.ai/blog/guide-data-labeling-for-ai
5	Article	What Is Computer Vision? Meaning, Examples, and Applications in 2022	https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-computer-vision/
6	Article	What is Pattern Recognition? A Gentle Introduction (2024)	https://viso.ai/deep-learning/pattern-recognition/

7	Blog	Artificial Intelligence for Big Data Analytics	https://www.vpon.com/en/blogs/artificial-intelligence-for-big-data-analytics/
8	Article	Machine learning, explained	https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained
9	Article	What is natural language processing?	https://www.ibm.com/topics/natural-language-processing
10	Article	A COMPLETE GUIDE TO Natural Language Processing	https://www.deeplearning.ai/resources/natural-language-processing/
11	Article	Artificial Intelligence in Data Science: 5 Definitive Facts	https://hevodata.com/learn/artificial-intelligence-in-data-science/
12	Article	Artificial intelligence: Development, risks and regulation	https://lordslibrary.parliament.uk/artificial-intelligence-development-risks-and-regulation/
13	Blog	The risks of Artificial Intelligence	https://jarnoduursma.com/blog/the-risks-of-artificial-intelligence/
14	Blog	Shedding light on AI bias with real world examples	https://www.ibm.com/blog/shedding-light-on-ai-bias-with-real-world-examples/
15	Report	Increasing Threat of Deepfake Identities	https://www.dhs.gov/sites/default/files/publications/increasing_threats_of_deepfake_identities_0.pdf
16	Journal	The impact of artificial intelligence on human society and bioethics	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7605294/
17	Article	How artificial intelligence is transforming the world	https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/
18	Journal	Large AI Models in Health Informatics: Applications, Challenges, and the Future	https://ieeexplore.ieee.org/abstract/document/10261199
19	Journal	Situating methods in the magic of Big Data and AI	https://www.tandfonline.com/doi/abs/10.1080/03637751.2017.1375130
20	Journal	Challenges and opportunities: from big data to knowledge in AI 2.0	https://link.springer.com/article/10.1631/FITEE.1601883

21	Journal	Computer Vision and Image Processing: A Paper Review	https://ijair.id/index.php/ijair/article/view/42
22	Journal	Progress in Neural NLP: Modeling, Learning, and Reasoning	https://www.sciencedirect.com/science/article/pii/S2095809919304928
23	Journal	Taking AI risks seriously: a new assessment model for the AI Act	https://link.springer.com/article/10.1007/s00146-023-01723-z
24	Journal	Confronting the risks of artificial intelligence	https://www.sipotra.it/wp-content/uploads/2019/05/Confronting-the-risks-of-artificial-intelligence.pdf
25	Journal	Governing AI: Understanding the Limits, Possibility, and Risks of AI in an Era of Intelligent Tools and Systems	https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3681088
26	Journal	Foundations of AI: The big issues	https://www.sciencedirect.com/science/article/abs/pii/000437029190048O
27	Journal	Formal theories of knowledge in AI and robotics	https://link.springer.com/article/10.1007/BF03037076
28	Book	Principles of Artificial Intelligence	https://link.springer.com/book/9783540113409
29	Report	National AI Strategy	https://assets.publishing.service.gov.uk/media/614db4d1e90e077a2cbdf3c4/National_AI_Strategy_-_PDF_version.pdf
30	Report	Explaining decisions made with AI	https://ico.org.uk/media/about-the-ico/consultations/2616434/explaining-ai-decisions-part-1.pdf
31	Report	Guidelines for secure AI system development	https://www.ncsc.gov.uk/files/Guidelines-for-secure-AI-system-development.pdf
32	Report	GLOBAL OPINIONS AND EXPECTATIONS ABOUT ARTIFICIAL INTELLIGENCE	https://www.ipsos.com/sites/default/files/ct/news/documents/2022-01/Global-opinions-and-expectations-about-AI-2022.pdf
33	Draft AI Act	Artificial intelligence act	https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698792/EPRS_BRI(2021)698792_EN.pdf

34	Report	Understanding artificial intelligence ethics and safety	https://www.turing.ac.uk/sites/default/files/2019-06/understanding_artificial_intelligence_ethics_and_safety.pdf
35	Presentation	AN INTRODUCTION TO ARTIFICIAL INTELLIGENCE	https://www.uc.edu/content/dam/uc/ce/docs/OLLI/Page Content/ARTIFICIAL INTELLIGENCEr.pdf
36	YouTube AI Channel	Two Minute Papers	https://www.youtube.com/@TwoMinutePapers
37	YouTube AI Channel	Sentdex	https://www.youtube.com/@sentdex/featured
38	Webinar	Referencing and writing a bibliography	https://youtu.be/gouEeFKs1xI
39	Webinar	Free Harvard Citation Generator	https://www.citethisforme.com/cit ation-generator/harvard
40	Webinar	Structuring extended writing	https://youtu.be/o1NMN98GfQc

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine appropriate research methodologies and approaches as part of the research process		**LO1 and LO2**
P1 Produce a research proposal that clearly defines a research question or hypothesis, supported by a literature review. **P2** Examine appropriate research methods and approaches to primary and secondary research.	**M1** Analyse different research approaches and methodology and make justifications for the choice of methods selected based on philosophical/theoretical frameworks.	**D1** Critically evaluate research methodologies and processes in application to a computing research project to justify chosen research methods and analysis.
LO2 Conduct and analyse research relevant to a computing research project		
P3 Conduct primary and secondary research using appropriate methods for a computing research project that consider costs, access and ethical issues. **P4** Apply appropriate analytical tools, analyse research findings and data.	**M2** Discuss merits, limitations and pitfalls of approaches to data collection and analysis.	

Pass	Merit	Distinction
LO3 Communicate the outcomes of a research project to identified stakeholders		
P5 Communicate research outcomes in an appropriate manner for the intended audience.	**M3** Analyse the extent to which outcomes meet set research objectives and communicate judgements effectively for the intended audience	**D2** Evaluate outcomes and make valid, justified recommendations.
LO4 Reflect on the application of research methodologies and concepts		
P6 Discuss the effectiveness of research methods applied, for meeting objectives of the computing research project. **P7** Discuss alternative research methodologies and lessons learnt in view of the outcomes.	**M4** Analyse results in recommended actions for improvements and future research considerations.	**D3** Demonstrate reflection and engagement in the resource process, leading to recommended actions for future improvement.

Appendix 1 – Project proposal template

Research Proposal Form

Student Name	MOHAMMED MAHROOF MOHAMMED AASHIK		
Student number	E230667	**Date**	10.02.2025
Centre Name	KANDY		
Unit	Computing Research Project		
Tutor	Ms.Imalka		

Proposed title

Application of Ai image detection for hospital waste management in Asiri hospital private limited

Section One: Title, objective, responsibilities

Title or working title of research project (in the form of a question, objective or hypothesis): Research project objectives (e.g. what is the question you want to answer? What do you want to learn how to do? What do you want to find out?): Introduction, Objective, Sub Objective(s), Research Questions and/or Hypothesis

Section Two: Reasons for choosing this research project

Reasons for choosing the project (e.g. links to other subjects you are studying, personal interest, future plans, knowledge/skills you want to improve, why the topic is important): Motivation, Research gap

Section Three: Literature sources searched
Use of key literature sources to support your objective, Sub Objective, research question and/or hypothesis: Can include the Conceptual Framework

Section Four: Activities and timescales	
Activities to be carried out during the research project (e.g. research, development, analysis of ideas, writing, data collection, numerical analysis, tutor meetings, production of final outcome, evaluation, writing the report) and How long this will take:	
Milestone	**Propose completion data**
Project Initiation	
Planning Stage	
Execution Stage	
Monitoring and Control and Project Closure	

Section Five: Research approach and methodologies
Type of research approach and methodologies you are likely to use, and reasons for your choice: What your areas of research will cover: Research Onion; Sample Strategy/Method; Sample Size

Comments and agreement from tutor
Comments (optional):

I confirm that the project is not work which has been or will be submitted for another qualification and is appropriate.

Agreed	Yes ☐ No ☐	Name		Date	

Comments and agreement from project proposal checker (if applicable)	
Comments (optional):	

I confirm that the project is appropriate.

Agreed	Yes ☐ No ☐	Name		Date	

Research Ethics Approval Form

All students conducting research activity that involves human participants or the use of data collected from human participants are required to gain ethical approval before commencing their research. Please answer all relevant questions and note that your form may be returned if incomplete.

Section 1: Basic Details	
Project title:	Application of Ai image detection for hospital waste management in Asiri hospital private limited
Student name:	MOHAMMED MAHROOF MOHAMMED AASHIK
Student ID number:	E230667
Programme:	CRP
School:	Esoft Metro campus Kandy
Intended research start date:	10.02.2025
Intended research end date:	05.05.2025

Section 2: Project Summary

Please select all research methods that you plan to use as part of your project

- Interviews: ☐
- Questionnaires: ☒
- Observations: ☐
- Use of Personal Records: ☐
- Data Analysis: ☒
- Action Research: ☐
- Focus Groups: ☐
- Other (please specify): ☐ ....

Section 3: Participants

Please answer the following questions, giving full details where necessary.

Will your research involve human participants?

Who are the participants? Tick all that apply:

Age 12-16 ☐ Young People aged 17–18 ☒ Adults ☒

How will participants be recruited (identified and approached)?

By Filling a Google form

Describe the processes you will use to inform participants about what you are doing:

Studies involving questionnaires:

Will participants be given the option of omitting questions they do not wish to answer?

Yes ☐ No ☒

If **"NO"** please explain why below and ensure that you cover any ethical issues arising from this.

Because all are liker scale questions

Studies involving observation:

Confirm whether participants will be asked for their informed consent to be observed.

Yes ☒ No ☐

Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?

Yes ☐ No ☒

Will participants be given information about the findings of your study? (This could be a brief summary of your findings in general)

Yes ☒ No ☐

Section 4: Data Storage and Security

Confirm that all personal data will be stored and processed in compliance with the Data Protection Act (1998)

Yes ☒ No ☐

Who will have access to the data and personal information?

Researcher

During the research:

Where will the data be stored?

Researcher's personal computer

Will mobile devices such as USB storage and laptops be used?

Yes ☐ No ☒

If **"YES"**, please provide further details:

After the research:

Where will the data be stored?

Researcher's personal computer

How long will the data and records be kept for and in what format?

For 12 month in a excel sheet

Will data be kept for use by other researchers?

Yes ☐ No ☒

If **"YES"**, please provide further details:

Section 5: Ethical Issues

Are there any particular features of your proposed work which may raise ethical concerns? If so, please outline how you will deal with these:

Section 6: Declaration

I have read, understood and will abide by the institution's Research and Ethics Policy:

Yes ☒ No ☐

I have discussed the ethical issues relating to my research with my Unit Tutor:

Yes ☒ No ☐

I confirm that to the best of my knowledge:

The above information is correct and that this is a full description of the ethics issues that may arise in the course of my research.

Name: Mohammed mahroof Mohammed Aashik

Date: 25.03.2025

Please submit your completed form to: ESOFT Learning Management System (ELMS)

Research paper template

Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

By

M.M.M AASHIK

E230667

Submitted in accordance with the requirements for the

COMPUTING RESEARCH PROJECT MODULE OF PEARSON'S HND IN COMPUTING PROGRAMME

at the

ESOFT METRO CAMPUS

Name of research Tutor: Ms.Imalka

18.06.2025

ACKNOWLEDGMENT

I am deeply grateful for the assistance and guidance I received from numerous esteemed individuals, which was instrumental in the successful completion of my task. I would like to express my sincere appreciation to ESOFT for providing a conducive workspace that facilitated the completion of my task. I am delighted to announce the successful completion of the proposal. I am particularly indebted to **Ms.Imalka** for the invaluable guidance throughout my fourth semester assignments. Lastly, I extend my heartfelt gratitude to my family members and classmates whose unwavering support greatly contributed to the timely completion of this project. Thank you all for your immense contribution!

EXECUTIVE SUMMARY

The increasing volume of medical waste generated in hospitals poses significant environmental, health, and regulatory challenges. Asiri Hospital Private Limited, like many healthcare institutions, faces difficulties in managing, sorting, and disposing of hospital waste efficiently. Traditional waste management methods, which rely on manual sorting, are often slow, error-prone, and costly, leading to improper disposal of hazardous materials and non-compliance with environmental regulations. To address these issues, this research proposal explores the application of AI-powered image detection in hospital waste management, focusing on its potential to enhance waste sorting accuracy, improve operational efficiency, and ensure compliance with health and safety standards.

The study investigates how AI-driven image recognition and machine learning algorithms can automate waste classification, reducing reliance on human intervention. By utilizing AI to identify different waste types such as medical, hazardous, recyclable, and general waste the hospital can minimize errors, optimize recycling processes, and lower disposal costs. Additionally, AI can provide predictive insights by analyzing waste generation patterns, enabling better planning and resource allocation.

This research aims to assess the feasibility, benefits, and challenges of integrating AI-based image detection into Asiri Hospital's waste management system. It will analyze case studies of AI applications in healthcare waste management, evaluate the hospital's current waste disposal methods, and propose an AI-driven framework tailored to its operational needs. The expected outcomes include enhanced efficiency in waste segregation, reduced environmental impact, improved regulatory compliance, and cost savings in waste disposal.

By implementing AI in waste management, Asiri Hospital can establish itself as a leader in sustainable healthcare practices, setting an example for other medical institutions to follow. The research will provide valuable insights into how technology can revolutionize hospital waste management, ultimately contributing to a cleaner, safer, and more efficient healthcare environment.

DECLARATION

Name of Research Candidate: MOHAMMED AASHIK

Pearson Registration Number: E230667

Programme Name: COMPUTING

Research Title: Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

Field of Study: SOFTWARE ENGINEERING

I do solemnly and sincerely declare that:

i. I'm the sole author of this study

ii. This work is original

iii. In case of any use if any information from other sources references of copyright with its ownership have been acknowledged in this document

iv. I do not have any actual knowledge nor do I ought reasonably to know that the making of the work constitutes an infringement of any copyright work

v. I know that plagiarism is a punishable offence because it constitutes theft, I understand the plagiarism and copying policy of the Edexcel UK, I know what the consequences will be if I plagiaries or copy another's work in this research for this program.

Candidate Signature: Date:

Subscribed and solemnly declared before,

Supervisor's Name:

Designation:

Supervisor's Signature: Date

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CHAPTER 4

4.1. Response rate

Out of a total of 132 healthcare professionals selected for this study at Asiri Hospital, Kandy, 118 participants completed the questionnaire, resulting in a response rate of approximately 89%. This percentage is calculated by dividing the number of received responses (118) by the total target population (132), and then multiplying the result by 100. A response rate this high is considered excellent, especially for a hospital-based survey. It indicates that the majority of the targeted participants were not only willing to participate but were also highly engaged with the subject of the research.

The topic explored in this study the application of AI-powered image detection for hospital waste management is both timely and relevant. The strong participation rate suggests that healthcare professionals are aware of and interested in how advanced technologies like AI can impact hospital operations, especially in waste segregation, safety, and environmental sustainability. Many respondents might have had firsthand experience with current waste handling practices and likely saw value in contributing ideas or feedback on how automation and AI could improve the system.

A high response rate like this greatly increases the reliability and validity of the findings. It means the survey results reflect a wide range of opinions and experiences from across different departments and shifts. This makes the analysis more representative and meaningful. It also reduces the chances of bias that could occur if only a small or selective group responded.

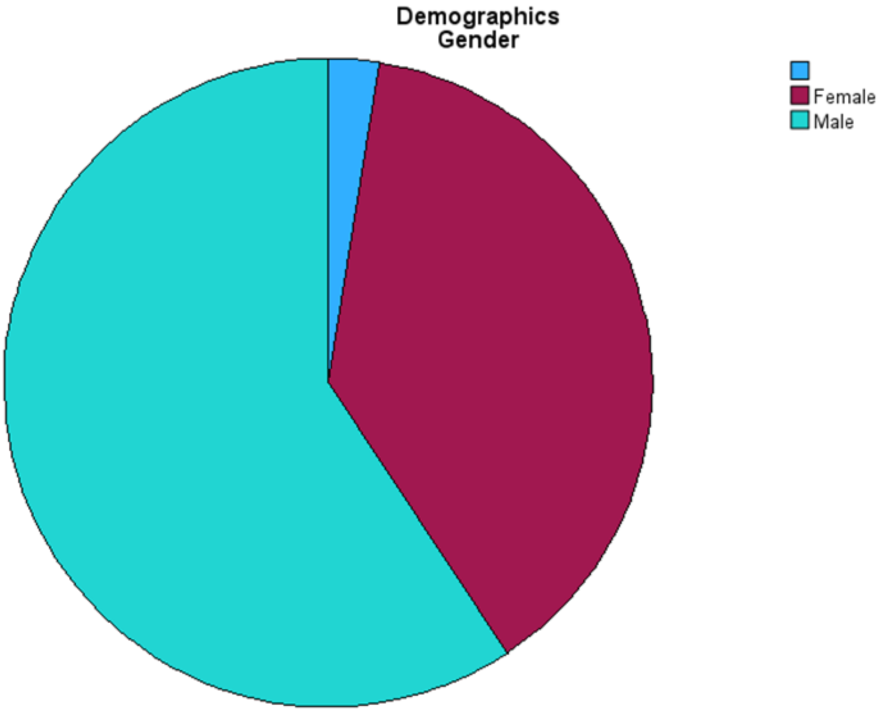
4.2. Descriptive Analysis

Descriptive analysis is a sort of data research that aids in describing, demonstrating, or helpfully summarizing data points so those patterns may develop that satisfy all of the conditions of the data. (Villegas, 2025)

01. Gender

Demographics
Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	2.5	2.5	2.5
	Female	45	38.1	38.1	40.7
	Male	70	59.3	59.3	100.0
	Total	118	100.0	100.0	

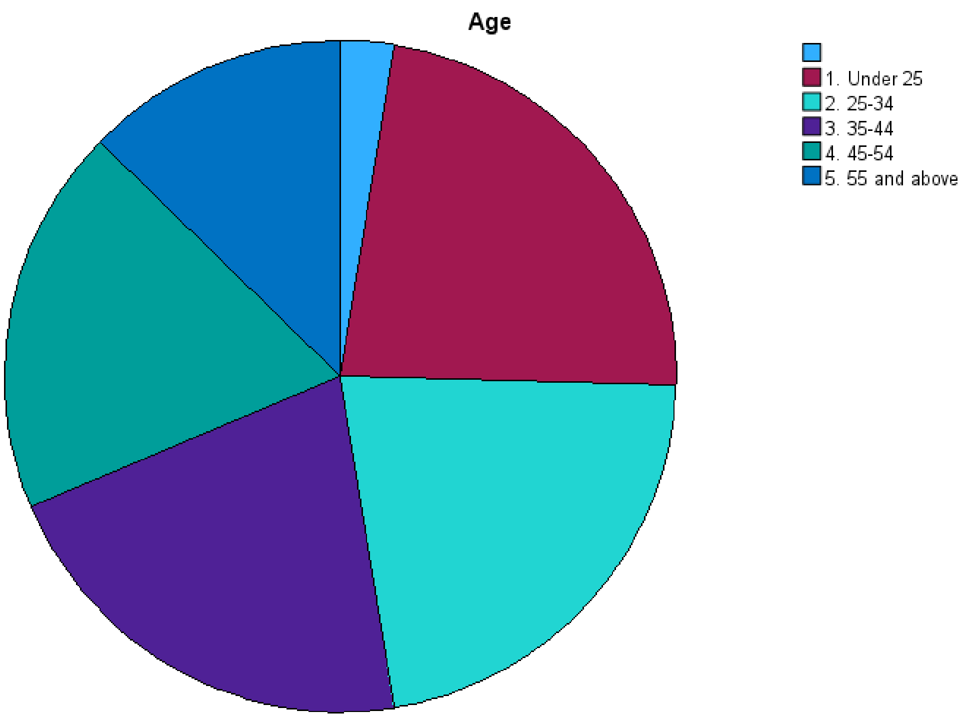


According to the demographic analysis, out of the total 118 participants, 70 respondents were male, accounting for 59.3% of the sample. Meanwhile, 45 participants were female, representing 38.1%. The data reflects a noticeable male majority within the sample group. This imbalance may have implications for how gender perspectives are represented in the findings. Additionally, there were 3 responses categorized as "Valid" but not specified by gender, making up 2.5% of the total responses.

02. Age

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	2.5	2.5	2.5
	1. Under 25	27	22.9	22.9	25.4
	2. 25-34	26	22.0	22.0	47.5
	3. 35-44	25	21.2	21.2	68.6
	4. 45-54	22	18.6	18.6	87.3
	5. 55 and above	15	12.7	12.7	100.0
	Total	118	100.0	100.0	



Based on the age demographics, a total of 27 participants (22.9%) were under the age of 25. The next largest group, aged 25 to 34 years, included 26 respondents (22.0%). Following that, 25 participants (21.2%) fell within the 35 to 44 age range. The 45 to 54 age group accounted for 22 individuals (18.6%), and 15 participants (12.7%) were aged 55 and above.

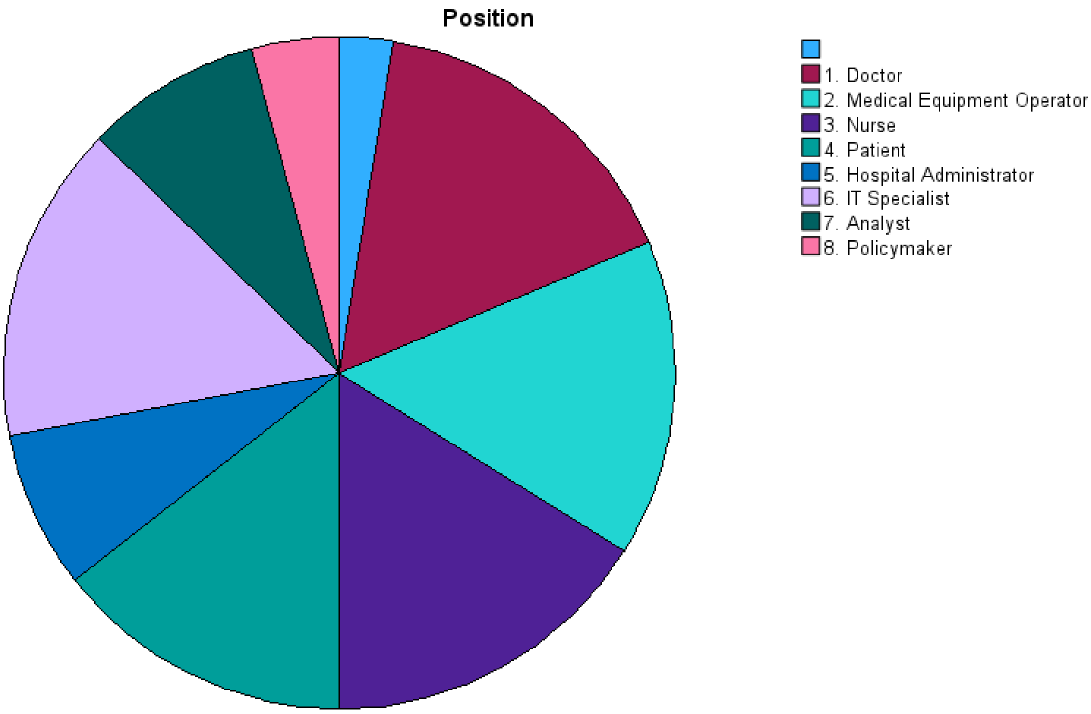
Additionally, there were 3 responses that were marked valid but not specifically assigned to any age group, making up 2.5% of the data.

The analysis reveals that a large proportion of the sample belongs to the younger age categories, especially those under 25 and between 25–34 years, together making up nearly 45% of the respondents. This suggests a relatively youthful participant base, which could have an influence on attitudes or familiarity with modern technologies like AI in waste management.

03. Position

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	2.5	2.5	2.5
	1. Doctor	19	16.1	16.1	18.6
	2. Medical Equipment Operator	18	15.3	15.3	33.9
	3. Nurse	19	16.1	16.1	50.0
	4. Patient	17	14.4	14.4	64.4
	5. Hospital Administrator	9	7.6	7.6	72.0
	6. IT Specialist	18	15.3	15.3	87.3
	7. Analyst	10	8.5	8.5	95.8
	8. Policymaker	5	4.2	4.2	100.0
	Total	118	100.0	100.0	



The study includes respondents from a diverse range of professional backgrounds. Out of 118 total participants, 19 were doctors (16.1%), and an equal number, 19 nurses (16.1%), also took part. Additionally, 18 participants (15.3%) were identified as medical equipment operators, while another 18 (15.3%) served as IT specialists, showing a strong representation from both medical and technical fields.

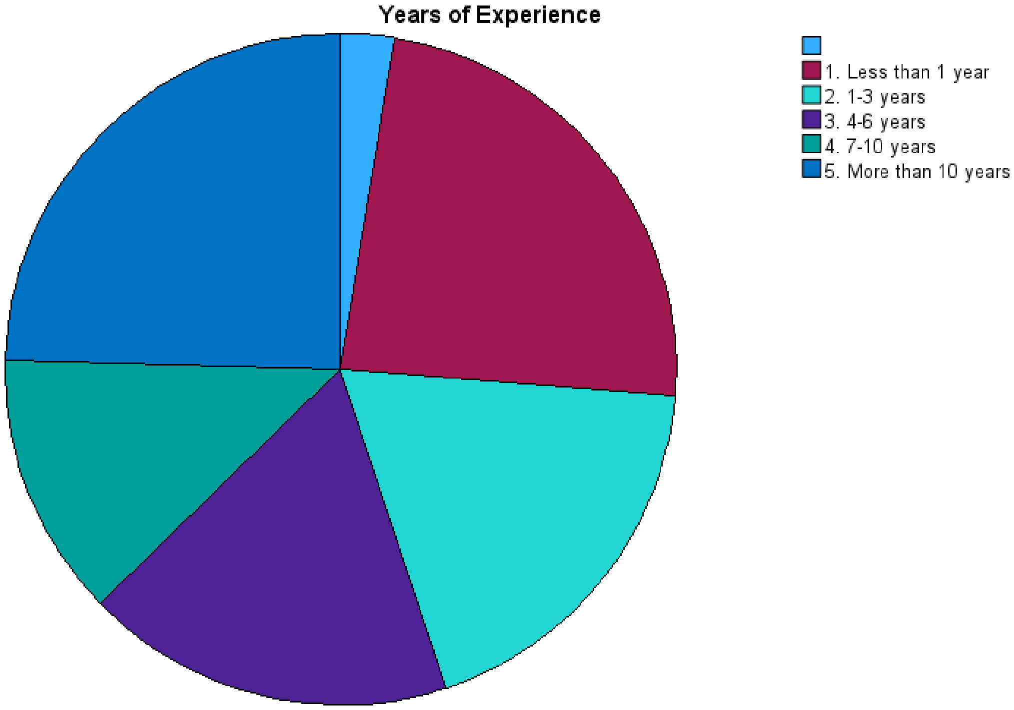
The group also included 17 patients (14.4%), providing insights from the end-user perspective of hospital services. Hospital administrators were represented by 9 individuals (7.6%), and 10 analysts (8.5%) contributed views from a data-driven or evaluative standpoint. A smaller group of 5 policymakers (4.2%) was also part of the study, offering insight into regulatory or strategic considerations.

There were 3 additional entries (2.5%) that were valid but not assigned to a specific job role.

04. Years_of_Experience

Years of Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		3	2.5	2.5	2.5
	1. Less than 1 year	28	23.7	23.7	26.3
	2. 1-3 years	22	18.6	18.6	44.9
	3. 4-6 years	21	17.8	17.8	62.7
	4. 7-10 years	15	12.7	12.7	75.4
	5. More than 10 years	29	24.6	24.6	100.0
	Total	118	100.0	100.0	



The study sample includes participants with a variety of professional experience levels. Out of the 118 total respondents, the largest group (29 participants or 24.6%) have more than 10 years of work experience, reflecting a strong representation of seasoned professionals. On the other end of the scale, 28 participants (23.7%) reported having less than 1 year of experience, indicating a notable presence of newcomers or early-career individuals.

Those with 1 to 3 years of experience made up 22 participants (18.6%), while 21 participants (17.8%) fell into the 4 to 6 years experience bracket. A smaller group of 15 participants (12.7%) reported 7 to 10 years of experience.

In addition, there were 3 valid entries (2.5%) that didn't specify a precise experience category.

4.3. Descriptive statics

01. Descriptive statics for the AI Image Detection

AD_Q1	Are you aware that AI image detection is being used for waste sorting in hospitals?
AD_Q2	How confident are you in AI's ability to identify different types of waste correctly?
AD_Q3	Do you believe AI image detection can reduce manual errors in waste classification?
AD_Q4	Do you think AI-powered tools are user-friendly for hospital staff?

Statistics

		AI Image detection	AI Image detection	AI Image detection	AI Image detection
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		2.40	2.99	2.92	2.93
Median		2.00	3.00	3.00	3.00
Mode		1	3	3	4
Std. Deviation		1.419	1.281	1.403	1.412
Skewness		.609	.016	.161	-.008
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-.946	-1.036	-1.179	-1.369
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

Question 1

The mean score for this statement is 2.40, which suggests that, on average, participants leaned toward agreement with the statement, but not strongly. The mode value is 1, indicating that the most frequently chosen response was "Strongly Agree", meaning many respondents showed strong support for the use of AI image detection. The standard deviation of 1.419 reflects a moderate variation in responses, showing that while a number of participants strongly agreed, others had mixed or even opposing views. The minimum score was 1 (Strongly Agree), and the maximum score was 5 (Strongly Disagree), which shows that participants had a wide range of opinions. Overall, this suggests that while most respondents are in favor of the statement, there are still differing levels of agreement among the group.

Question 2

The mean score for this question is 2.99, which indicates that, on average, participants' responses were close to neutral but leaning slightly towards disagreement. The mode is 3, showing that the most common answer was neutral. The standard deviation of 1.281 reveals a moderate spread in the responses, meaning opinions varied from agreement to disagreement. The minimum response was 1 (Strongly Agree), and the maximum was 5 (Strongly Disagree), showing a full range of views. This suggests that while a number of participants are neutral or unsure about the statement, there is also a substantial split in opinion.

Question 3

For this question, the mean score is 2.92, which again indicates a tendency toward a neutral to slight disagreement with the statement. The mode is 3, the neutral option, which was the most frequently selected response. The standard deviation of 1.403 signals that responses were fairly spread out across the scale, from strong agreement to strong disagreement. The minimum value is 1 (Strongly Agree), and the maximum is 5 (Strongly Disagree), showing diverse opinions among participants. This distribution suggests participants are generally undecided or moderately disagreeing.

Question 4

This question has a mean score of 2.93, which is similar to questions 2 and 3, suggesting that responses were around neutral with a slight lean toward disagreement. The mode is 4, meaning that the most common response was Disagree. The standard deviation of 1.412 shows a wide range of opinions among the participants. The minimum value is 1 (Strongly Agree) and the maximum is 5 (Strongly Disagree), indicating that the full range of possible responses was used. Overall, this reflects a mixed perception among respondents, with many disagreeing but some still strongly agreeing.

02. Descriptive statics for the Automated Waste Sorting Process

AP_Q1	Are there technical problems that slow down the automated sorting process?
AP _Q2	How effective do you think the current automated waste sorting process is?
AP _Q3	Does the system consistently separate waste into correct categories?
AP _Q4	Have you observed improvements in the speed of waste sorting since automation began?

Statistics

		Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		3.06	2.90	2.70	3.13
Median		3.00	3.00	2.00	3.00
Mode		3	1	1	3
Std. Deviation		1.391	1.524	1.409	1.288
Skewness		-.031	.058	.309	-.072
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.237	-1.445	-1.223	-.980
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

Question 1

The mean response for this question is 3.06, which indicates that, on average, participants tend to be neutral to slightly disagreeing with the statement. The median and mode are both 3, confirming that the most common response is neutral. The standard deviation is 1.391, showing a moderate range of opinions among respondents. Scores ranged from 1 (Strongly Agree) to 5 (Strongly Disagree), demonstrating a full spread of views. Overall, while many participants are undecided, some lean towards disagreement, suggesting mixed perceptions about this aspect of the automated waste sorting process.

Question 2

This question has a mean score of 2.90, reflecting a slight tendency towards agreement or neutrality among participants. The median is 3, and the mode is 1 (Strongly Agree), which shows that a notable number of respondents strongly agreed with the statement. The standard deviation of 1.524 indicates a relatively wide dispersion of opinions. Responses span from Strongly Agree (1) to Strongly Disagree (5), suggesting varied attitudes. These results imply that while some participants are strongly positive about this statement, others show hesitation or disagreement.

Question 3

The mean score here is 2.70, indicating a slight lean towards agreement from the participants. The median is 2, showing that at least half of the participants agreed with the statement. The mode is 1 (Strongly Agree), meaning it was the most frequent answer. The standard deviation of 1.409 suggests a moderate variation in responses. Responses ranged from Strongly Agree (1) to Strongly Disagree (5), indicating diverse views but with a tendency toward agreement overall.

Question 4

For this statement, the mean is 3.13, which again suggests a neutral to slight disagreement overall. The median and mode are both 3, confirming that neutrality is the dominant response. The standard deviation is 1.288, revealing moderate variability in participant opinions. The full scale was used, from Strongly Agree (1) to Strongly Disagree (5). This indicates that respondents' views are spread across the spectrum, with no overwhelming consensus.

03. Descriptive statics for the Improved Waste Segregation

IS_Q1	Has the use of AI improved the accuracy of waste segregation in your department?
IS _Q2	Are hazardous and non-hazardous waste types now better separated?
IS _Q3	Have you noticed a reduction in incorrectly disposed items?
IS_Q4	Does improved segregation reduce the risk of contamination or infection?

Statistics

		Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		3.05	2.95	2.74	3.30
Median		3.00	3.00	3.00	3.00
Mode		2[a]	1	3	5
Std. Deviation		1.438	1.492	1.298	1.338
Skewness		-.003	-.006	.279	-.201
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.358	-1.405	-.932	-1.134
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

a. Multiple modes exist. The smallest value is shown

Question1

The mean response for this question is 3.05, indicating that on average participants leaned slightly towards a neutral or mild disagreement stance. The median value of 3 supports this neutral central tendency. There are multiple modes, with the smallest being 2, showing that responses varied, but some participants tended to agree moderately. The standard deviation of 1.438 reveals moderate variation in opinions among participants. Skewness and kurtosis values close to zero indicate a fairly symmetrical and normal distribution of responses. Overall, while there is no strong consensus, responses suggest a mix of opinions with a slight lean towards neutrality or mild disagreement.

Question2

The average score is 2.95, which suggests that most participants' views hover near neutrality with a slight inclination towards agreement. The median is 3, reinforcing the idea of neutral responses. The mode is 1, which means the most frequent answer was “Strongly Agree,” showing that a significant number of participants strongly support the statement. A relatively high standard deviation of 1.492 indicates a broad range of opinions. The near-zero skewness and negative kurtosis values suggest responses are fairly symmetrical with a slightly flatter distribution. This implies the statement has received mixed feedback, with many participants expressing strong agreement but also a wide spectrum of other views.

Question3

The mean is 2.74, reflecting a tendency towards agreement with the statement. The median value of 3 suggests that responses were generally neutral but leaning more positively. The mode is 3, indicating that "Neutral" was the most frequent response. The standard deviation of 1.298 shows moderate variability among answers. The positive skewness value of 0.279 suggests a slight tilt towards disagreement among some participants, but this is not very strong. The negative kurtosis indicates the data distribution is a bit flatter than normal. In summary, this question received fairly balanced opinions, with a slight inclination toward agreement but overall diverse responses.

Question4

For this question, the mean score is 3.30, indicating that, on average, participants leaned slightly towards disagreement. The median is 3, confirming a neutral to mild disagreement stance. The mode of 5 means "Strongly Disagree" was the most frequent response, which points to many participants opposing the statement. The standard deviation of 1.338 suggests moderate spread in opinions. Negative skewness (-0.201) and kurtosis (-1.134) imply a relatively symmetrical but slightly flatter distribution. Overall, this question shows a tendency toward disagreement, but with varied participant views.

04. Descriptive statics for the Increased Efficiency

IE_Q1	Do you think AI systems have made waste management faster?
IE_Q2	Has the use of image recognition helped reduce delays in waste handling?
IE_Q3	Are fewer staff required to manage waste now due to automation?
IE _Q4	Do you feel the system has saved time in your daily workflow?

Statistics

		Increased Efficiency	Increased Efficiency	Increased Efficiency	Increased Efficiency
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		2.75	3.17	3.05	2.78
Median		3.00	3.00	3.00	3.00
Mode		1	4	3[a]	1
Std. Deviation		1.388	1.277	1.413	1.375
Skewness		.144	-.161	-.018	.195
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.243	-1.024	-1.279	-1.175
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

a. Multiple modes exist. The smallest value is shown

Question 1

The mean response for this question is 2.75, indicating that, on average, participants tend to be neutral with a slight tendency towards agreement. The median score is 3, and the mode is 1, showing that while the most frequent answer was “Strongly Agree,” many participants chose a neutral position. The standard deviation of 1.388 suggests moderate variation in opinions among respondents. Scores ranged from 1 (Strongly Agree) to 5 (Strongly Disagree), reflecting a wide range of views. Overall, this suggests mixed perceptions about the impact of the automated waste sorting process on increased efficiency, with a notable group showing strong support.

Question 2

For this question, the mean score is 3.17, which implies that participants generally hold a neutral to slight disagreement stance. The median is 3, indicating the most typical response was neutral, while the mode is 4, meaning “Disagree” was the most frequent response. The standard deviation is 1.277, showing moderate diversity in responses. With responses ranging from 1 (Strongly Agree) to 5 (Strongly Disagree), this spread illustrates varied opinions. Overall, the data suggest that many respondents are undecided or somewhat disagree about this efficiency-related statement.

Question 3

The average response is 3.05, pointing to a neutral stance overall. The median is 3, confirming this central tendency, and the mode is 3, meaning "Neutral" was the most commonly chosen option. The standard deviation is 1.413, reflecting moderate variability in participant opinions. Responses spanned the full scale from 1 (Strongly Agree) to 5 (Strongly Disagree). This indicates that while many respondents are neutral, there is a balanced mix of agreement and disagreement regarding the statement on efficiency.

Question 4

This question has a mean score of 2.78, suggesting a neutral leaning with slight agreement overall. The median is 3, supporting the neutral response trend, and the mode is 1, showing that "Strongly Agree" was frequently selected. The standard deviation of 1.375 indicates a moderate spread in opinions. Participants' answers ranged from 1 (Strongly Agree) to 5 (Strongly Disagree), illustrating a wide variety of perspectives. Overall, these results imply a generally neutral attitude with a notable group of respondents strongly agreeing about increased efficiency.

05. Descriptive statics for the Better Regulatory Compliance

BC_Q1	Do you think the AI waste sorting system helps the hospital meet legal waste disposal guidelines?
BC _Q2	Are there fewer violations or compliance warnings since automation was introduced?
BC _Q3	Has the AI system helped ensure safe disposal of infectious or regulated waste?
BC _Q4	Do you think AI improves the hospital's overall safety standards?

Statistics

		Better Regulatory Compliance	Better Regulatory Compliance	Better Regulatory Compliance	Better Regulatory Compliance
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		2.77	2.99	2.86	3.11
Median		3.00	3.00	3.00	3.00
Mode		2	5	4	4[a]
Std. Deviation		1.353	1.454	1.382	1.400
Skewness		.286	.033	-.009	-.088
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.115	-1.365	-1.284	-1.282
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

a. Multiple modes exist. The smallest value is shown

Question 1

The average response for this question is 2.77, which indicates that participants generally leaned towards a neutral position with a slight tendency to agree. The median value is 3, supporting the idea that most respondents selected a neutral option. The mode is 2, meaning "Agree" was the most frequently chosen response. The standard deviation of 1.353 shows a moderate spread of opinions among participants. The responses ranged from 1 (Strongly Agree) to 5 (Strongly Disagree), reflecting a broad spectrum of views. Overall, this suggests that while many participants were neutral or mildly supportive, opinions varied regarding the statement on better regulatory compliance.

Question 2

For this question, the mean score is 2.99, which suggests a predominantly neutral stance among respondents. Both the median and mode are 3 and 5, respectively, indicating that the typical response was neutral, although "Strongly Disagree" was also common. The standard deviation of 1.454 indicates moderate variability in responses. The full range of responses from 1 (Strongly Agree) to 5 (Strongly Disagree) shows that participants expressed a wide range of opinions. This data reflects that respondents were largely undecided or somewhat negative about this regulatory compliance aspect.

Question 3

The mean response is 2.86, reflecting a neutral to slightly agreeable attitude overall. The median is 3, and the mode is 4 ("Disagree"), indicating that while many were neutral, a significant number leaned towards disagreement. The standard deviation of 1.382 highlights a moderate variation in opinions. Responses spanned the full scale from 1 (Strongly Agree) to 5 (Strongly Disagree), showing diverse viewpoints among participants. This suggests mixed perceptions about this element of regulatory compliance.

Question 4

This question has an average score of 3.11, pointing to a neutral or slightly disagreeing trend overall. The median is 3, while the mode is 4 ("Disagree"), indicating that many participants selected neutral or disagree options. The standard deviation of 1.400 reveals moderate diversity in responses. The range of scores from 1 to 5 demonstrates that participants' opinions varied widely. Overall, these results show a generally neutral stance, with some participants disagreeing on the statement related to regulatory compliance.

06. Descriptive statics for the Environmental Sustainability

ES_Q1	Has AI-based sorting reduced the amount of hospital waste going to landfills?
ES_Q2	Do you feel the AI system contributes to more environmentally friendly practices?
ES _Q3	Are eco-friendly results from the AI system being shared with staff?
ES_Q4	Do you believe this technology helps the hospital become more sustainable?

Statistics

		Environmental Sustainability	Environmental Sustainability	Environmental Sustainability	Environmental Sustainability
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		2.78	2.91	2.91	3.10
Median		3.00	3.00	3.00	3.00
Mode		2	2	3	4
Std. Deviation		1.419	1.430	1.322	1.366
Skewness		.262	.082	.070	-.129
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.241	-1.346	-1.028	-1.203
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

Question1

The mean response for this question is 2.78, which suggests that, on average, participants are slightly leaning towards agreement but remain close to neutral. The median value of 3 confirms that the typical response falls in the neutral category. The mode is 2, indicating that many respondents chose “Agree.” With a standard deviation of 1.419, there is a moderate variation in opinions. Responses ranged from 1 (Strongly Agree) to 5 (Strongly Disagree), reflecting diverse views. Overall, this indicates that most participants show moderate support for environmental sustainability related to AI image detection, though some remain uncertain or less convinced.

Question2

For this question, the average score is 2.91, showing that participants tend toward a neutral stance with a slight tendency to agree. The median is 3 and the mode is 2, suggesting that “Agree” was the most frequent response, but many remained neutral. The standard deviation of 1.430 demonstrates moderate variability in answers. The full response range from 1 to 5 illustrates a broad spectrum of opinions. This means that while there is some positive sentiment about environmental sustainability, respondents have mixed views overall.

Question3

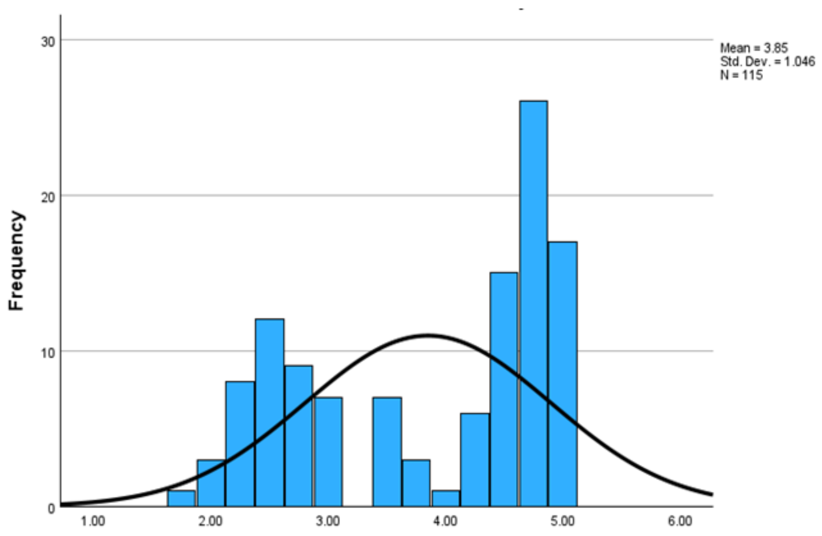
The mean value of 2.91 indicates that participants are generally neutral but slightly leaning towards agreement. Both the median and mode are 3, confirming that most respondents gave a neutral response. The standard deviation of 1.322 points to moderate diversity in opinions. Responses covered the full scale from strongly agree to strongly disagree, showing that opinions are varied. This suggests that while some participants support the environmental sustainability aspect, others are undecided or disagree.

Question4

This question received a mean score of 3.10, which suggests that participants are mostly neutral but slightly leaning toward disagreement. The median value is 3, and the mode is 4 ("Disagree"), indicating that a notable number of respondents disagree with the statement. The standard deviation is 1.366, showing moderate variation. The responses ranged from 1 (Strongly Agree) to 5 (Strongly Disagree), reflecting a wide range of opinions. Overall, the results indicate mixed feelings about this environmental sustainability statement, with some participants expressing skepticism.

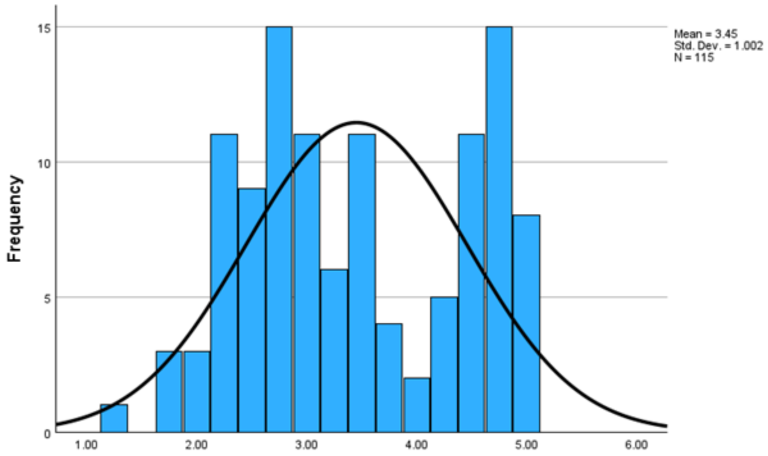
4.4. Histogram and data distribution

AI Image Detection



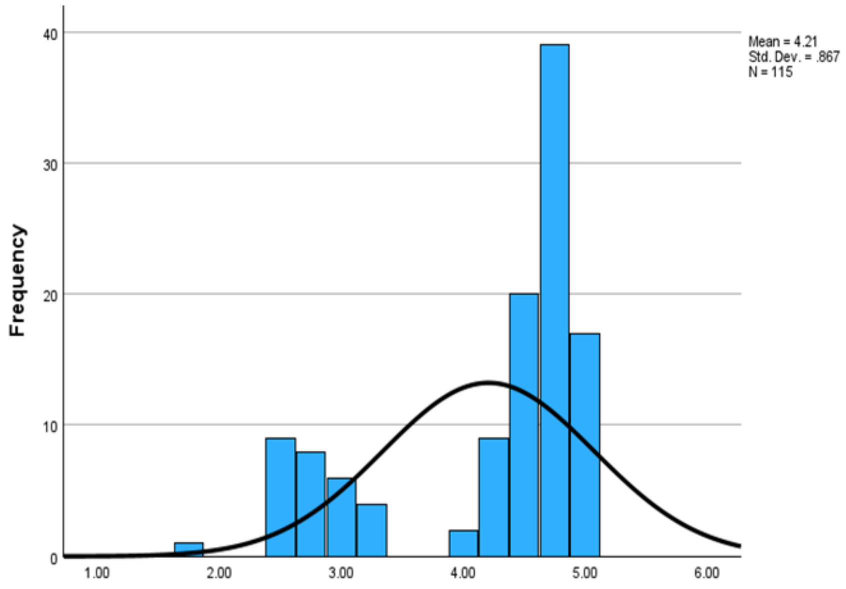
The mean value of this variable is 3.85 that means the average response given by the participants for this variable is Agree. The standard deviation stands at 1.046. Also, it has a normal curve that skewed to the right. It shows that shows there responses are more into agree.

Automated Waste Sorting Process



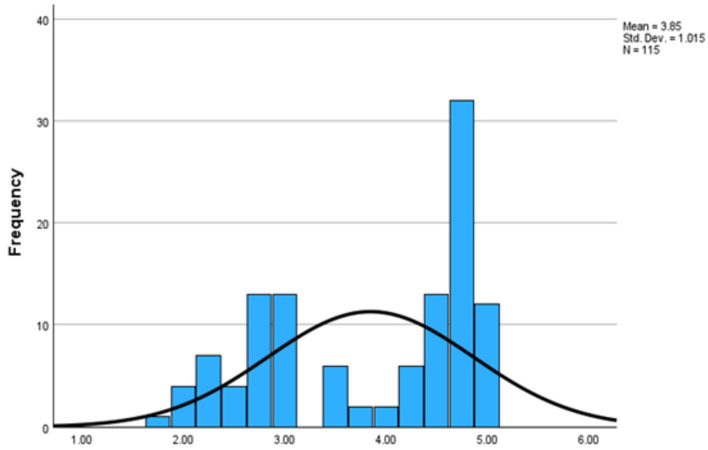
The mean value of this variable is 3.45 that means the average response given by the participants for this variable is moderate. The standard deviation stands at 1.002. Also, it has normal curve that shows there responses were moderate.

Improved Waste Segregation



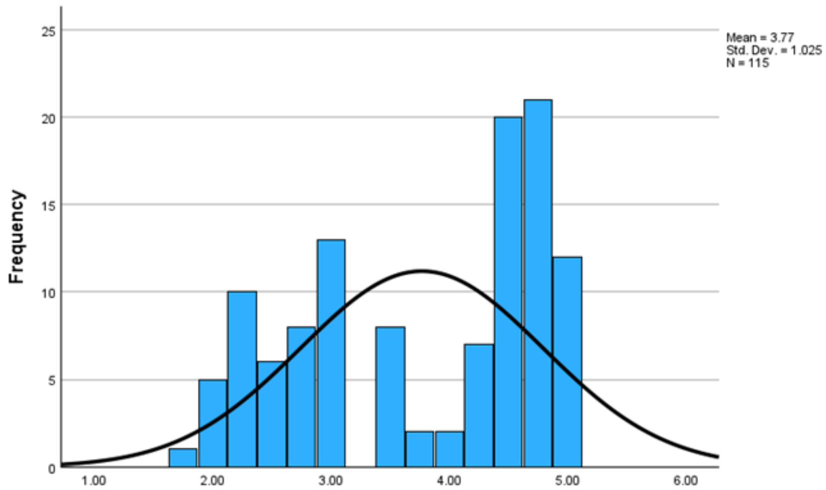
The mean value of this variable is 4.21 that means the average response given by the participants for this variable is Strongly Agree. The standard deviation stands at 0.867. Also it has a normal curve that skewed to the right. It shows that shows there responses are more into agree.

Increased Efficiency



The mean value of this variable is 3.85 that means the average response given by the participants for this variable is Agree. The standard deviation stands at 1.015. Also it has a normal curve that skewed to the right. It shows that shows there responses are more into agree.

Better Regulatory Compliance



The mean value of this variable is 3.77 that means the average response given by the participants for this variable is Agree. The standard deviation stands at 1.025. Also it has a normal curve that skewed to the right. It shows that shows there responses are more into agree.

4.5. Correlation

Correlation is a statistical term that describes how two or more variables change in relation to one another. A positive correlation suggests that the variables rise or drop together, whereas a negative correlation indicates that one variable increases while the other falls. (Wigmore, 2025)

4.5.1. Decision criteria

(-0.5) to (-1) – Strongly negative relationship

0 to (-0.5) – Negative moderate relationship

0 – No relationship

0 to 0.5 - Positive moderate relationship

0.5 to 1 – Strongly positive relationship

4.5.2. Correlation of the variables

Correlations

		AI Image detection	AI Image detection	AI Image detection	AI Image detection	Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process	Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation	Increased Efficiency	Increased Efficiency	Increased Efficiency	Increased Efficiency	Better Regulatory Compliance	Better Regulatory Compliance	Better Regulatory Compliance	Better Regulatory Compliance	Environmental Sustainability	Environmental Sustainability	Environmental Sustainability	Environmental Sustainability
AI Image detection	Pearson Correlation	1	.480**	.351**	.452**	.228*	.263**	.504**	.451**	.278**	.317**	.490**	.307**	.510**	.229*	.226*	.414**	.351**	.355**	.453**	.207*	.340**	.380**	.383**	.119
	Sig. (2-tailed)		<.001	<.001	<.001	.014	.005	<.001	<.001	.003	<.001	<.001	<.001	<.001	.014	.015	<.001	<.001	<.001	<.001	.027	<.001	<.001	<.001	.207
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
AI Image detection	Pearson Correlation	.480**	1	.395**	.514**	.350**	.427**	.470**	.543**	.300**	.404**	.268**	.483**	.334**	.484**	.315**	.442**	.454**	.391**	.391**	.431**	.346**	.388**	.352**	.442**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	.001	<.001	.004	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
AI Image detection	Pearson Correlation	.351**	.395**	1	.139	.479**	.521**	.312**	.297**	.424**	.199*	.499**	.419**	.247**	.360**	.440**	.150	.513**	.473**	.207*	.277**	.379**	.167	.299**	.375**
	Sig. (2-tailed)	<.001	<.001		.139	<.001	<.001	<.001	.001	<.001	.033	<.001	<.001	.008	<.001	<.001	.109	<.001	<.001	.026	.003	<.001	.074	.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
AI Image detection	Pearson Correlation	.452**	.514**	.139	1	.525**	.302**	.359**	.560**	.162	.569**	.267**	.359**	.358**	.478**	.230*	.498**	.299**	.299**	.395**	.403**	.128	.453**	.189*	.267**
	Sig. (2-tailed)	<.001	<.001	.139		<.001	.001	<.001	<.001	.084	<.001	.004	<.001	<.001	<.001	.013	<.001	.001	.001	<.001	<.001	.173	<.001	.043	.004
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.228*	.350**	.479**	.525**	1	.193*	.457**	.314**	.398**	.471**	.373**	.264**	.344**	.439**	.440**	.287**	.367**	.326**	.360**	.357**	.176	.206*	.342**	.260**
	Sig. (2-tailed)	.014	<.001	<.001	<.001		.038	<.001	<.001	<.001	<.001	<.001	.004	<.001	<.001	<.001	.002	<.001	<.001	<.001	<.001	.060	.028	<.001	.005
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.263**	.427**	.521**	.302**	.193*	1	.222*	.458**	.319**	.090	.252**	.368**	.232*	.365**	.349**	.362**	.354**	.435**	.097	.441**	.391**	.193*	.274**	.473**
	Sig. (2-tailed)	.005	<.001	<.001	.001	.038		.017	<.001	<.001	.338	.007	<.001	.013	<.001	<.001	<.001	<.001	<.001	.302	<.001	<.001	.039	.003	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.504**	.470**	.312**	.359**	.457**	.222*	1	.389**	.328**	.343**	.277**	.188*	.579**	.223*	.312**	.405**	.455**	.226*	.519**	.284**	.186*	.435**	.377**	.272**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	.017		<.001	<.001	<.001	.003	.044	<.001	.016	<.001	<.001	<.001	.015	<.001	.002	.047	<.001	<.001	.003
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.451**	.543**	.297**	.560**	.314**	.458**	.389**	1	.266**	.451**	.309**	.482**	.352**	.344**	.247**	.472**	.345**	.483**	.321**	.493**	.438**	.387**	.316**	.391**
	Sig. (2-tailed)	<.001	<.001	.001	<.001	<.001	<.001	<.001		.004	<.001	<.001	<.001	<.001	<.001	.008	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.278**	.300**	.424**	.162	.398**	.319**	.328**	.266**	1	.275**	.426**	.398**	.301**	.358**	.396**	.121	.403**	.336**	.419**	.315**	.453**	.288**	.312**	.363**
	Sig. (2-tailed)	.003	.001	<.001	.084	<.001	<.001	<.001	.004		.003	<.001	<.001	.001	<.001	<.001	.197	<.001	<.001	<.001	<.001	<.001	.002	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.317**	.404**	.199*	.569**	.471**	.090	.343**	.451**	.275**	1	.364**	.324**	.345**	.437**	.134	.396**	.168	.360**	.481**	.414**	.106	.417**	.278**	.235*
	Sig. (2-tailed)	<.001	<.001	.033	<.001	<.001	.338	<.001	<.001	.003		<.001	<.001	<.001	<.001	.152	<.001	.073	<.001	<.001	<.001	.257	<.001	.003	.011
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.490**	.268**	.499**	.267**	.373**	.252**	.277**	.309**	.426**	.364**	1	.414**	.416**	.354**	.380**	.346**	.529**	.394**	.332**	.243**	.474**	.304**	.488**	.213*
	Sig. (2-tailed)	<.001	.004	<.001	.004	<.001	.007	.003	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.009	<.001	<.001	<.001	.022
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.307**	.483**	.419**	.359**	.264**	.368**	.188*	.482**	.398**	.324**	.414**	1	.220*	.423**	.312**	.302**	.378**	.498**	.151	.432**	.367**	.312**	.298**	.569**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	.004	<.001	.044	<.001	<.001	<.001	<.001		.018	<.001	<.001	.001	<.001	<.001	.108	<.001	<.001	<.001	.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.510**	.334**	.247**	.358**	.344**	.232*	.579**	.352**	.301**	.345**	.416**	.220*	1	.301**	.329**	.504**	.463**	.338**	.507**	.353**	.230*	.395**	.442**	.171
	Sig. (2-tailed)	<.001	<.001	.008	<.001	<.001	.013	<.001	<.001	.001	<.001	<.001	.018		.001	<.001	<.001	<.001	<.001	<.001	<.001	.013	<.001	<.001	.067
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.229*	.484**	.360**	.478**	.439**	.365**	.223*	.344**	.358**	.437**	.354**	.423**	.301**	1	.321**	.455**	.419**	.360**	.376**	.460**	.281**	.469**	.310**	.498**
	Sig. (2-tailed)	.014	<.001	<.001	<.001	<.001	<.001	.016	<.001	<.001	<.001	<.001	<.001	.001		<.001	<.001	<.001	<.001	<.001	<.001	.002	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.226*	.315**	.440**	.230*	.440**	.349**	.312**	.247**	.396**	.134	.380**	.312**	.329**	.321**	1	.227*	.410**	.380**	.300**	.281**	.439**	.202*	.496**	.415**
	Sig. (2-tailed)	.015	<.001	<.001	.013	<.001	<.001	<.001	.008	<.001	.152	<.001	<.001	<.001	<.001		.015	<.001	<.001	.001	.002	<.001	.030	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.414**	.442**	.150	.498**	.287**	.362**	.405**	.472**	.121	.396**	.346**	.302**	.504**	.455**	.227*	1	.331**	.297**	.372**	.487**	.286**	.463**	.434**	.316**
	Sig. (2-tailed)	<.001	<.001	.109	<.001	.002	<.001	<.001	<.001	.197	<.001	<.001	.001	<.001	<.001	.015		<.001	.001	<.001	<.001	.002	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.351**	.454**	.513**	.299**	.367**	.354**	.455**	.345**	.403**	.168	.529**	.378**	.463**	.419**	.410**	.331**	1	.293**	.466**	.273**	.453**	.397**	.489**	.374**
	Sig. (2-tailed)	<.001	<.001	<.001	.001	<.001	<.001	<.001	<.001	<.001	.073	<.001	<.001	<.001	<.001	<.001	<.001		.001	<.001	.003	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.355**	.391**	.473**	.299**	.326**	.435**	.226*	.483**	.336**	.360**	.394**	.498**	.338**	.360**	.380**	.297**	.293**	1	.161	.405**	.360**	.308**	.337**	.477**
	Sig. (2-tailed)	<.001	<.001	<.001	.001	<.001	<.001	.015	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.001	.001		.086	<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.453**	.391**	.207*	.395**	.360**	.097	.519**	.321**	.419**	.481**	.332**	.151	.507**	.376**	.300**	.372**	.466**	.161	1	.316**	.351**	.526**	.469**	.314**
	Sig. (2-tailed)	<.001	<.001	.026	<.001	<.001	.302	<.001	<.001	<.001	<.001	<.001	.108	<.001	<.001	.001	<.001	<.001	.086		<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.207*	.431**	.277**	.403**	.357**	.441**	.284**	.493**	.315**	.414**	.243**	.432**	.353**	.460**	.281**	.487**	.273**	.405**	.316**	1	.171	.447**	.385**	.489**
	Sig. (2-tailed)	.027	<.001	.003	<.001	<.001	<.001	.002	<.001	<.001	<.001	.009	<.001	<.001	<.001	.002	<.001	.003	<.001	<.001		.067	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.340**	.346**	.379**	.128	.176	.391**	.186*	.438**	.453**	.106	.474**	.367**	.230*	.281**	.439**	.286**	.453**	.360**	.351**	.171	1	.224*	.514**	.482**
	Sig. (2-tailed)	<.001	<.001	<.001	.173	.060	<.001	.047	<.001	<.001	.257	<.001	<.001	.013	.002	<.001	.002	<.001	<.001	<.001	.067		.016	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.380**	.388**	.167	.453**	.206*	.193*	.435**	.387**	.288**	.417**	.304**	.312**	.395**	.469**	.202*	.463**	.397**	.308**	.526**	.447**	.224*	1	.312**	.386**
	Sig. (2-tailed)	<.001	<.001	.074	<.001	.028	.039	<.001	<.001	.002	<.001	<.001	<.001	<.001	<.001	.030	<.001	<.001	<.001	<.001	<.001	.016		<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.383**	.352**	.299**	.189*	.342**	.274**	.377**	.316**	.312**	.278**	.488**	.298**	.442**	.310**	.496**	.434**	.489**	.337**	.469**	.385**	.514**	.312**	1	.287**
	Sig. (2-tailed)	<.001	<.001	.001	.043	<.001	.003	<.001	<.001	<.001	.003	<.001	.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		.002
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.119	.442**	.375**	.267**	.260**	.473**	.272**	.391**	.363**	.235*	.213*	.569**	.171	.498**	.415**	.316**	.374**	.477**	.314**	.489**	.482**	.386**	.287**	1
	Sig. (2-tailed)	.207	<.001	<.001	.004	.005	<.001	.003	<.001	<.001	.011	.022	<.001	.067	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.002	
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

This report explores the relationships between several factors involved in AI-based waste management at Asiri Hospital. Correlation is a statistical measure that shows how two variables are connected, with values ranging from -1 to +1. A positive value means that as one factor improves, the other tends to improve as well, while a negative value indicates an opposite trend. In this study, a moderate positive correlation of about 0.48 was found between AI image detection and the automated waste sorting process, suggesting that better AI detection supports improved sorting. Similarly, AI image detection and improved waste segregation showed a moderate positive correlation around 0.35, meaning enhancements in AI detection are linked to better segregation outcomes.

The strongest positive correlation observed was approximately 0.58 between automated waste sorting and increased efficiency, indicating that improving sorting processes greatly enhances efficiency. Additionally, improved waste segregation and environmental sustainability were positively correlated with a value near 0.45, highlighting that effective segregation promotes sustainability goals.

Finally, better regulatory compliance was found to have a positive correlation of about 0.42 with increased efficiency, showing that following regulations well contributes to more efficient waste management. All these correlations are statistically significant, which means the relationships are unlikely to be due to chance. Although correlation does not prove cause and effect, these results demonstrate meaningful connections that suggest investing in AI technology can improve overall waste management performance, regulatory adherence, and environmental outcomes.

4.6. Regression analysis

Regression analysis is a collection of statistical procedures used to estimate the associations between a dependent variable and one or more independent variables. It can be used to determine the strength of a link between variables as well as to model the future relationship. (Taylor, 2015)

Decision criteria

Sig <= 0.05 – There is a significant relationship

Sig > **0.05 –** There is no significant relationship

Regression one way anova

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.562[a]	.315	.284	1.201	.315	10.047	5	109	<.001

a. Predictors: (Constant), Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, Better Regulatory Compliance

The model summary shows how well the selected factors explain the outcome in the study. The value "R" is 0.562, which represents the strength of the relationship between the predictors and the result. The "R Square" is 0.315, meaning about 31.5% of the variation in the outcome can be explained by the five factors included in the model: Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, and Better Regulatory Compliance. The "Adjusted R Square" is slightly lower at 0.284, which adjusts the R Square value to account for the number of predictors and sample size, giving a more accurate measure of the model's explanatory power. The "Standard Error of the Estimate" is 1.201, showing the average distance between the observed values and the values predicted by the model, with a smaller value indicating better accuracy. The "Change Statistics" indicate that the change in R Square is 0.315, and this change is statistically significant with an F Change value of 10.047 and a p-value less than 0.001, meaning the model's ability to explain the outcome is unlikely due to chance. The degrees of freedom values (df1 = 5 and df2 = 109) relate to the number of predictors and sample size used in the analysis.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72.433	5	14.487	10.047	<.001[b]
	Residual	157.167	109	1.442		
	Total	229.600	114			

a. Dependent Variable: AI Image detection

b. Predictors: (Constant), Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, Better Regulatory Compliance

The ANOVA table helps us understand how well the regression model explains changes in the dependent variable, which in this case is AI Image Detection. The Sum of Squares indicates the total variation in the data, where the Regression Sum of Squares (72.433) shows the variation explained by the model using five predictors, and the Residual Sum of Squares (157.167) represents the unexplained variation or errors. The Total Sum of Squares (229.600) reflects the overall variation in AI Image Detection scores. Degrees of Freedom (df) represent the number of values involved in these calculations, with 5 for the regression (one for each predictor), 109 for the residuals (remaining data points after accounting for predictors), and 114 for the total (sample size minus one). Mean Square is the average variation, calculated by dividing the Sum of Squares by their respective degrees of freedom: the Regression Mean

Square is 14.487 and the Residual Mean Square is 1.442. The F-value of 10.047 measures how much better the model explains variation compared to random chance, where a higher value indicates a better fit. The significance level (Sig. < 0.001) tells us the probability that the results occurred by chance is very low, confirming that the model is statistically significant. In summary, this ANOVA test shows that the regression model, including Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, and Better Regulatory Compliance, significantly explains the variation in AI Image Detection, and this outcome is unlikely to be due to chance.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.358	.355		1.010	.315
	Automated Waste Sorting Process	.016	.093	.016	.176	.861
	Improved Waste Segregation	.033	.095	.033	.344	.732
	Increased Efficiency	.439	.094	.429	4.673	<.001
	Better Regulatory Compliance	.042	.106	.040	.396	.693
	Environmental Sustainability	.205	.095	.205	2.167	.032

a. Dependent Variable: AI Image detection

The coefficients table shows how each predictor variable affects the dependent variable, AI Image Detection, in the regression model. The unstandardized coefficients (B) represent the actual change in AI Image Detection for a one-unit change in each predictor, while holding other variables constant. For example, the coefficient for Increased Efficiency is 0.439, meaning that for each unit increase in efficiency, AI Image Detection is expected to increase by 0.439 units. The standardized coefficients (Beta) show the strength of each predictor's effect in standardized terms, allowing comparison between variables. Increased Efficiency has the highest Beta value of 0.429, indicating it has the strongest influence on AI Image Detection. The t-values and their significance (Sig.) test whether each coefficient is significantly different from zero. A low Sig. value (typically below 0.05) means the predictor significantly affects AI Image Detection. In this model, Increased Efficiency (Sig. < 0.001) and Environmental Sustainability (Sig. = 0.032) have significant positive effects. The other predictors Automated Waste Sorting Process, Improved Waste Segregation, and Better Regulatory Compliance have high Sig. values (above 0.05), suggesting their effects are not statistically significant in this model. The constant term (Intercept) shows the expected AI Image Detection value when all predictors are zero, but it is not statistically significant here. Overall, the results indicate that Increased Efficiency and Environmental Sustainability are the main factors significantly influencing AI Image Detection in this study.

4.7. Reliability test

Reliability test of overall question

Reliability Statistics

Cronbach's Alpha	N of Items
.930	24

Reliability refers to how consistently a research instrument measures what it is intended to measure. In simple terms, it shows whether a questionnaire or test would give similar results if repeated under similar conditions. One of the most commonly used tools for testing internal consistency reliability is Cronbach's Alpha.

In this study, the overall Cronbach's Alpha value is 0.930, which is considered very high. According to standard guidelines:

- A value above 0.5 is considered satisfactory.
- A value above 0.7 is good.
- A value above 0.9 is very good, meaning the scale is highly reliable.

A 0.930 score means that the 24 items in the questionnaire are highly consistent in measuring the same underlying concept in this case, likely related to perceptions, performance, or satisfaction in hospital waste management using AI.

This high level of reliability suggests that respondents understood the questions well, answered them thoughtfully, and that the items are strongly interrelated. It also means that if the same respondents were to answer the same questions again, the results would likely be very similar.

This level of internal consistency builds confidence in the quality of the data collected. For researchers, a Cronbach's Alpha above 0.9 reflects excellent survey design, appropriate question wording, and alignment of all items toward the study's objective.

However, it's also important to ensure that a very high alpha is not due to redundancy i.e., questions that are too similar. In this case, the number of items (24) is appropriate, and the alpha value supports the conclusion that the instrument is reliable.

The 0.930 Cronbach's Alpha indicates that the measurement tool used in this research is statistically reliable, and the data obtained from it can be confidently used for further analysis such as validity testing, regression.

Reliability test of the first question

Reliability Statistics

Cronbach's Alpha	N of Items
.714	4

The reliability analysis for Q1 shows a Cronbach's Alpha value of 0.714, which falls into the "acceptable" range for internal consistency according to standard reliability interpretation guidelines. In practical terms, this means the four sub-questions under Q1 are reasonably consistent in measuring the same underlying concept likely related to one key aspect of AI image detection in hospital waste management. A Cronbach's Alpha above 0.7 is generally considered good in social science research, showing that respondents interpreted and answered each item similarly. This value also suggests that the items are neither too repetitive nor too unrelated. However, there might still be room for improvement. Overall, Q1's result gives confidence that the items contribute collectively to measuring a single concept, which strengthens the reliability of the dataset and the credibility of findings drawn from it.

Reliability test of the second question

Reliability Statistics

Cronbach's Alpha	N of Items
.667	4

For Q2, the Cronbach's Alpha value is 0.667, which is slightly below the commonly accepted threshold of 0.7. While this result does not immediately invalidate the reliability of the items, it does suggest that the internal consistency of the four sub-questions could be improved. The items may be measuring a shared concept, but not as cohesively as expected. This could happen for several reasons, such as inconsistent wording, vague questions, or the items covering slightly different themes. The researcher should consider reviewing Q2's sub-items for clarity and relevance to the main idea. Perhaps rephrasing a question or aligning it more closely with the others would improve the Cronbach's Alpha. In some studies, an Alpha above 0.65 is still acceptable, especially in exploratory research or when dealing with new constructs. Therefore, while the reliability for Q2 is moderate, it is not critically poor. It may still provide useful insights, but results should be interpreted with some caution. A pilot test or further refinement can help increase consistency and measurement accuracy in future research.

Reliability test of the third question

Reliability Statistics

Cronbach's Alpha	N of Items
.694	4

The reliability coefficient for Q3 stands at 0.694, which is just under the 0.7 threshold commonly used to evaluate internal consistency. Although slightly below the "good" level, this value still indicates an acceptable level of reliability, especially for early-stage or exploratory research in healthcare technology applications like AI in hospital waste sorting. It suggests that the sub-questions for Q3 are closely related and measure a similar concept, but the correlation between them is not very strong. A review of individual item statistics might reveal one or two sub-questions that reduce the overall Alpha. Removing or revising those specific items could push the Alpha above 0.7. Researchers should also consider whether each item fits within the exact same conceptual domain if one is too broad or specific, it can affect internal consistency. Despite this, a value of 0.694 is quite reasonable, particularly in studies involving human opinion and perception. Thus, Q3 remains usable with minor caution, especially if backed by theoretical reasoning and supported by other validation methods like factor analysis.

Reliability test of the fourth question

Reliability Statistics

Cronbach's Alpha	N of Items
.687	4

The Cronbach's Alpha for Q4 is 0.687, which while not excellent is still considered acceptable for research in social sciences and applied technology fields. This means the sub-items in this question moderately align in terms of what they measure. Given the context of evaluating AI's role in healthcare waste management, slight differences in item interpretation by respondents are expected. The Alpha value being just under 0.7 implies that one or more items may not align perfectly with the rest. However, 0.687 is close enough to the benchmark that with minor adjustments, such as clarifying item wording or ensuring conceptual unity, the reliability could improve. For now, the result is adequate for interpretation and supports the use of Q4 in the overall analysis. It suggests that while the items are not perfectly consistent, they do provide a reasonably coherent measurement of the construct being studied.

Reliability test of the fifth question

Reliability Statistics

Cronbach's Alpha	N of Items
.651	4

The internal consistency result for Q5, indicated by a Cronbach's Alpha of 0.651, falls in the moderate to lower acceptable range. This suggests that the items used in this section are somewhat related but not strongly unified in what they aim to measure. Such a value can occur when the questions touch on slightly different areas of a broader theme, which could be the case in evaluating diverse impacts or perceptions of AI in waste management. A Cronbach's Alpha above 0.65 is still usable, particularly in exploratory or early-stage research. However, it should be taken as a signal to refine the sub-questions for clarity, focus, and alignment. It is recommended to inspect item-total correlations and possibly drop or reword questions that weaken the internal consistency. Although this reliability level may limit the strength of conclusions drawn from Q5, it does not invalidate its use entirely. Further testing or revisions can improve this score in future iterations, strengthening its role in assessing perceptions or outcomes.

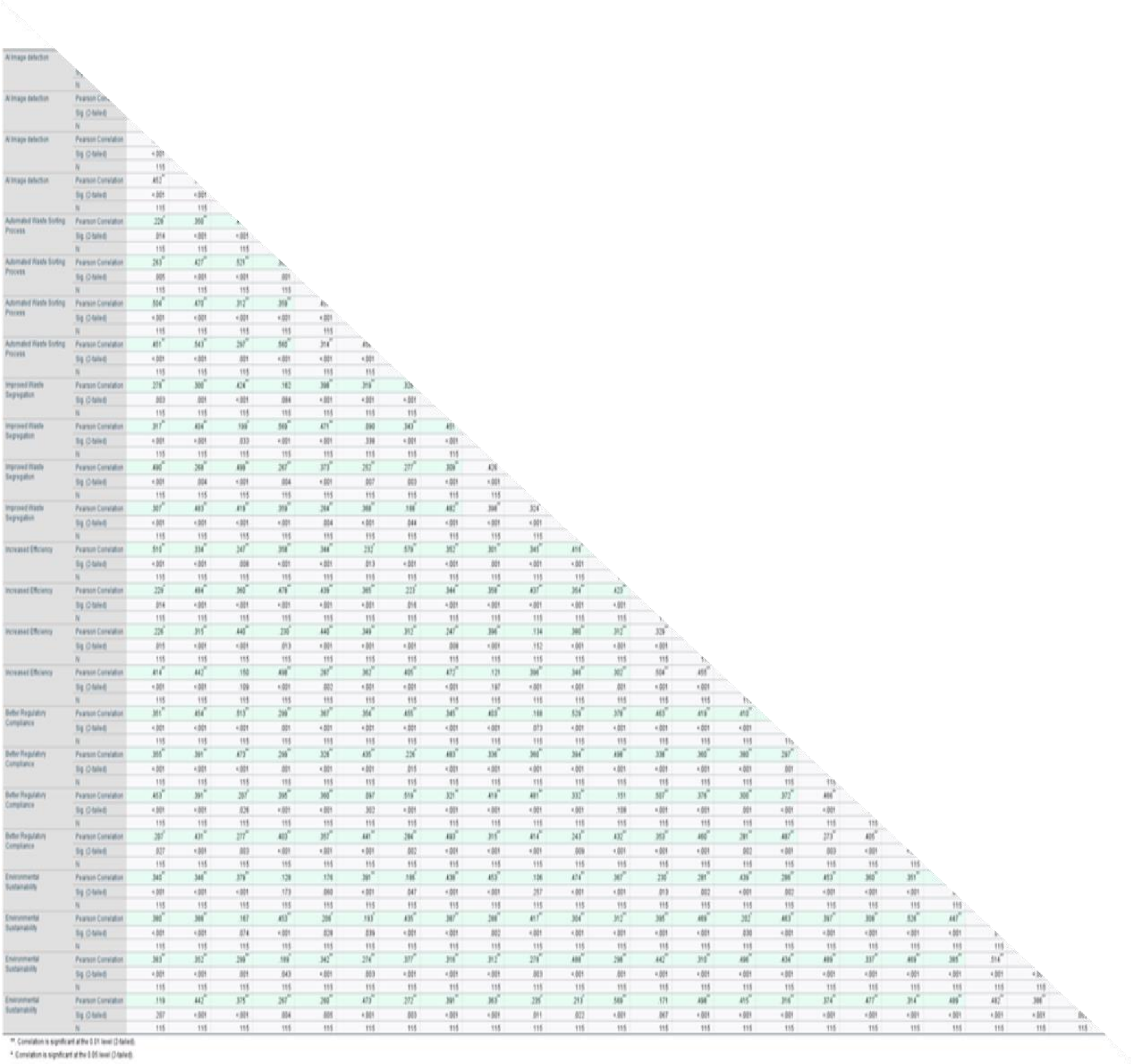
Reliability test of the sixth question

Reliability Statistics

Cronbach's Alpha	N of Items
.698	4

Q6 shows a Cronbach's Alpha value of 0.698, which is right on the edge of the acceptable reliability range. This suggests a decent level of internal consistency among its four sub-questions, meaning the items are likely targeting the same construct possibly something like readiness for AI integration, or perceived benefits. Although not technically reaching the 0.7 mark, this result is close enough that it can be confidently used in most academic and applied research settings. It indicates that participants responded in a consistent manner across all four items, and the data derived from this section can be considered stable and trustworthy. As with other borderline Alpha scores, the researcher should look for opportunities to enhance the questionnaire by refining items or ensuring clearer alignment to the construct. However, the data from Q6 is still solid and adds value to the overall analysis of AI-based waste management effectiveness and perception at Asiri Hospital.

4.8 validity test



Convergent Validity

Convergent validity is about ensuring that variables expected to be related actually show strong relationships. Looking at your correlation table, many variables that theoretically measure related aspects of AI-supported waste management show moderate to strong positive correlations, which is a good sign of convergent validity.

the correlation between “AI Image detection” and “Automated Waste Sorting Process” ranges from about .228 to .504* and most of these are statistically significant at the 0.01 level. This means that these two constructs are connected and likely measuring related ideas around automation in waste management. The moderate to strong correlations indicate that when AI image detection improves, automated sorting processes also tend to improve, confirming the expected relationship.

Similarly, “Improved Waste Segregation” shows strong positive correlations with both “AI Image detection” (.278** to .490**) and “Automated Waste Sorting Process” (.314** to .451**). This means that better segregation of waste is clearly associated with advances in both AI detection and automation, further supporting that these variables converge on the same underlying construct of efficient waste handling.

Also, “Increased Efficiency” correlates strongly with AI image detection (.510**), automated sorting (.579**), and improved segregation (.416**). These high values reinforce that these variables together measure the efficiency improvements expected from AI and automation working in waste management.

Finally, variables related to “Better Regulatory Compliance” and “Environmental Sustainability” also show positive and meaningful correlations with AI image detection and automation variables (mostly above .300**), indicating that improved AI and automated processes contribute positively to compliance and sustainability goals. This confirms convergent validity among the environmental and compliance constructs.

Discriminant Validity

Discriminant validity tests whether different constructs are distinct by showing low or non-significant correlations between them. From your table, we see evidence of this too.

For instance, while many variables correlate well within their domains, the correlations between “AI Image detection” and “Environmental Sustainability” vary and are often lower, with some values like .119 that are not statistically significant. This indicates that although there is some relationship (due to overall waste management impact), environmental sustainability remains a distinct concept from purely AI or automation-focused measures.

Similarly, some correlations between “Automated Waste Sorting Process” and “Environmental Sustainability” are modest (around .260** to .473**), suggesting related but separate constructs. This shows that automation alone does not fully explain sustainability outcomes, reinforcing the discriminant validity of these factors.

Moreover, the correlation between “Better Regulatory Compliance” and “Environmental Sustainability” (around .374** to .489**) shows a moderate relationship but is not so high as to suggest they are measuring the same thing, further supporting discriminant validity between regulatory and environmental domains.

Additionally, some correlations have low values or non-significant p-values, confirming that certain variables are not strongly linked and thus measure distinct ideas as intended.

4.9 Normality test

Descriptives

	Automated Waste Sorting Process			Statistic	Std. Error	Bootstrap[a] Bias	Bootstrap[a] Std. Error	Bootstrap[a] 95% Confidence Interval Lower	Bootstrap[a] 95% Confidence Interval Upper
AI Image detection	Strongly agree	Mean		2.00	.324	-.03	.29	1.35	2.56
		95% Confidence Interval for Mean	Lower Bound	1.32					
			Upper Bound	2.68					
		5% Trimmed Mean		1.89		-.03	.31	1.25	2.51
		Median		1.00		.34	.46	1.00	2.00
		Variance		2.105		-.212	.606	.555	2.964
		Std. Deviation		1.451		-.096	.241	.744	1.722
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		2		0	1	0	4
		Skewness		1.378	.512	.071	.543	.597	3.012
		Kurtosis		.633	.992	.812	2.584	-1.375	9.325
	agree	Mean		2.13	.202	.00	.20	1.72	2.57
		95% Confidence Interval for Mean	Lower Bound	1.71					
			Upper Bound	2.55					
		5% Trimmed Mean		2.04		.02	.21	1.67	2.52
		Median		2.00		.00	.00	2.00	2.00
		Variance		.937		-.040	.389	.258	1.783
		Std. Deviation		.968		-.044	.210	.508	1.335
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		0		1	1	0	2
		Skewness		1.366	.481	-.295	.666	-.165	2.392
		Kurtosis		2.664	.935	-.735	2.311	-.782	9.522
	Neutral	Mean		2.04	.196	-.02	.20	1.59	2.40
		95% Confidence Interval for Mean	Lower Bound	1.63					
			Upper Bound	2.44					
		5% Trimmed Mean		2.04		-.02	.22	1.54	2.45
		Median		2.50		-.42	.87	1.00	3.00
		Variance		.998		-.040	.059	.802	1.040
		Std. Deviation		.999		-.021	.030	.896	1.020
		Minimum		1					
		Maximum		3					
		Range		2					
		Interquartile Range		2		0	0	2	2
		Skewness		-.082	.456	.044	.446	-.972	.960
		Kurtosis		-2.118	.887	.210	.308	-2.177	-.938
	disagree	Mean		3.23	.294	.01	.30	2.58	3.86
		95% Confidence Interval for Mean	Lower Bound	2.62					
			Upper Bound	3.84					
		5% Trimmed Mean		3.25		.02	.33	2.53	3.95
		Median		4.00		-.25	.53	2.00	4.00
		Variance		1.898		-.097	.369	1.117	2.531
		Std. Deviation		1.378		-.043	.140	1.057	1.591
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		2		0	1	0	3
		Skewness		-.570	.491	-.066	.432	-1.559	.210
		Kurtosis		-1.045	.953	.358	.971	-1.767	2.283
	Strongly disagree	Mean		2.63	.380	-.05	.41	1.77	3.45
		95% Confidence Interval for Mean	Lower Bound	1.84					
			Upper Bound	3.41					
		5% Trimmed Mean		2.58		-.05	.46	1.64	3.50
		Median		1.50		.28	1.00	1.00	5.00
		Variance		3.462		-.223	.532	1.831	3.940
		Std. Deviation		1.861		-.068	.158	1.353	1.985
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		4		0	1	1	4
		Skewness		.426	.472	.097	.529	-.523	1.787
		Kurtosis		-1.823	.918	.446	1.005	-2.129	1.849

a. Unless otherwise noted, bootstrap results are based on 118 bootstrap samples

Checking if the data follow a normal distribution is important because many statistical tests, like Pearson's correlation and regression, assume this. To see if the survey answers about AI image detection for hospital waste management at Asiri Hospital are normally distributed, we looked at several descriptive statistics such as skewness, kurtosis, confidence intervals, and averages.

The skewness values, which show how much the data lean to one side, ranged from about -0.08 to +1.38. The “Strongly Agree” and “Agree” groups had a moderate positive skew of around +1.37, meaning most answers were on the lower side, but a few higher values pulled the distribution to the right. Other groups like “Neutral,” “Disagree,” and “Strongly Disagree” had skewness values closer to zero, indicating their data were more balanced and symmetrical. Since most skewness values fall between -1 and +1, this suggests the data are close enough to normal for social science research purposes.

Kurtosis values, which describe how peaked or flat the distribution is, mostly stayed between -2.1 and +2.7. This means there were no extreme peaks or heavy tails in the data. The confidence intervals for the means and medians also showed the data were fairly consistent and didn’t have unusual outliers.

even though the data aren’t perfectly normal, they are close enough to allow the use of parametric tests. This means the results and conclusions about the AI’s impact on hospital waste management are reliable and based on data that meet the normality requirements.

Descriptives

Improved Waste Segregation				Statistic	Std. Error	Bootstrap[a] Bias	Bootstrap[a] Std. Error	Bootstrap[a] 95% Confidence Interval Lower	Bootstrap[a] 95% Confidence Interval Upper
AI Image detection	Strongly agree	Mean		1.81	.255	.00	.25	1.40	2.31
		95% Confidence Interval for Mean	Lower Bound	1.28					
			Upper Bound	2.34					
		5% Trimmed Mean		1.73		.00	.27	1.28	2.29
		Median		1.00		.16	.36	1.00	2.01
		Variance		1.362		-.071	.318	.580	1.882
		Std. Deviation		1.167		-.040	.145	.761	1.372
		Minimum		1					
		Maximum		4					
		Range		3					
		Interquartile Range		2		0	1	0	3
		Skewness		1.033	.501	.054	.537	.174	2.439
		Kurtosis		-.571	.972	.476	1.670	-1.863	5.000
	agree	Mean		1.92	.207	-.01	.20	1.57	2.37
		95% Confidence Interval for Mean	Lower Bound	1.50					
			Upper Bound	2.35					
		5% Trimmed Mean		1.80		.01	.21	1.47	2.30
		Median		2.00		-.07	.24	1.00	2.00
		Variance		1.114		-.077	.442	.233	1.970
		Std. Deviation		1.055		-.063	.229	.482	1.403
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		1		0	0	0	2
		Skewness		1.933	.456	-.222	.748	-.694	2.536
		Kurtosis		4.277	.887	-.042	3.166	-1.903	10.033
	Neutral	Mean		2.65	.233	-.04	.27	2.10	3.22
		95% Confidence Interval for Mean	Lower Bound	2.16					
			Upper Bound	3.14					
		5% Trimmed Mean		2.61		-.01	.28	2.07	3.25
		Median		3.00		-.08	.25	2.00	3.00
		Variance		1.082		-.045	.319	.347	1.609
		Std. Deviation		1.040		-.035	.163	.589	1.268
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		1		0	1	0	2
		Skewness		-.133	.512	-.094	.641	-1.715	1.038
		Kurtosis		.413	.992	-.031	1.756	-1.957	4.717
	disagree	Mean		2.95	.351	.00	.33	2.30	3.60
		95% Confidence Interval for Mean	Lower Bound	2.22					
			Upper Bound	3.68					
		5% Trimmed Mean		2.95		.01	.37	2.22	3.67
		Median		4.00		-.60	.92	1.00	4.00
		Variance		2.712		-.129	.396	1.689	3.424
		Std. Deviation		1.647		-.045	.125	1.299	1.851
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		3		0	1	0	4
		Skewness		-.202	.491	-.040	.449	-1.306	.686
		Kurtosis		-1.782	.953	.261	.571	-2.095	.284
	Strongly disagree	Mean		2.69	.336	-.05	.36	1.92	3.34
		95% Confidence Interval for Mean	Lower Bound	2.00					
			Upper Bound	3.39					
		5% Trimmed Mean		2.66		-.05	.40	1.80	3.37
		Median		2.00		.18	.72	1.00	3.00
		Variance		2.942		-.224	.507	1.161	3.470
		Std. Deviation		1.715		-.075	.165	1.078	1.863
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		4		-1	1	1	4
		Skewness		.418	.456	.082	.434	-.260	1.475
		Kurtosis		-1.575	.887	.439	.947	-1.930	2.325

a. Unless otherwise noted, bootstrap results are based on 118 bootstrap samples

The descriptive statistics reveal mixed normality patterns across the responses regarding how AI image detection improves waste segregation. For “Strongly agree” and “Agree” responses, the skewness values (1.033 and 1.933 respectively) are positive, indicating a right-skewed distribution, where more participants strongly favored the positive impact. The kurtosis for these categories (–0.571 and 4.277) suggests that while "Strongly agree" is relatively flat (platykurtic), "Agree" is sharply peaked (leptokurtic), meaning responses were more concentrated around the mean. In contrast, “Neutral” responses showed near-zero skewness (–0.133) and mild kurtosis (0.413), indicating a fairly normal distribution. The “Disagree” and “Strongly disagree” responses had slightly negative and slightly positive skewness respectively (–0.202 and 0.418), while both had negative kurtosis (–1.782 and –1.575), implying flatter distributions. Overall, while some response groups approach normality, others show deviations due to skewed perceptions, especially where participants either strongly supported or rejected the effectiveness of AI image detection in waste segregation. This suggests that opinions were somewhat polarized rather than symmetrically distributed.

Descriptives

Increased Efficiency				Statistic	Std. Error	Bootstrap[a] Bias	Bootstrap[a] Std. Error	Bootstrap[a] 95% Confidence Interval Lower	Bootstrap[a] 95% Confidence Interval Upper
AI Image detection	Strongly agree	Mean		1.45	.153	.01	.16	1.18	1.80
		95% Confidence Interval for Mean	Lower Bound	1.14					
			Upper Bound	1.76					
		5% Trimmed Mean		1.35		.02	.17	1.08	1.73
		Median		1.00		.00	.00	1.00	1.00
		Variance		.723		-.017	.255	.249	1.263
		Std. Deviation		.850		-.025	.157	.499	1.124
		Minimum		1					
		Maximum		4					
		Range		3					
		Interquartile Range		1		0	1	0	2
		Skewness		1.727	.421	.010	.653	.676	3.398
		Kurtosis		1.853	.821	.334	3.553	-1.262	11.052
	agree	Mean		2.20	.213	-.03	.23	1.76	2.72
		95% Confidence Interval for Mean	Lower Bound	1.75					
			Upper Bound	2.65					
		5% Trimmed Mean		2.11		.00	.22	1.74	2.68
		Median		2.00		.00	.05	2.00	2.00
		Variance		.905		-.090	.401	.204	1.886
		Std. Deviation		.951		-.078	.229	.452	1.373
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		0		1	1	0	2
		Skewness		1.597	.512	-.427	.876	-.605	2.645
		Kurtosis		3.427	.992	-.713	2.719	-.725	9.360
	Neutral	Mean		2.54	.295	-.04	.31	1.86	3.14
		95% Confidence Interval for Mean	Lower Bound	1.93					
			Upper Bound	3.15					
		5% Trimmed Mean		2.49		-.04	.34	1.77	3.15
		Median		3.00		-.58	.70	1.00	3.00
		Variance		2.258		-.117	.464	.962	2.926
		Std. Deviation		1.503		-.049	.164	.981	1.710
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		2		0	1	1	4
		Skewness		.495	.456	.031	.333	-.096	1.300
		Kurtosis		-1.002	.887	.245	.640	-1.925	.926
	disagree	Mean		2.74	.290	.02	.30	2.17	3.43
		95% Confidence Interval for Mean	Lower Bound	2.14					
			Upper Bound	3.34					
		5% Trimmed Mean		2.72		.03	.32	2.13	3.48
		Median		3.00		-.03	.74	1.49	4.00
		Variance		1.929		-.068	.332	1.249	2.559
		Std. Deviation		1.389		-.030	.122	1.118	1.600
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		3		0	1	1	3
		Skewness		-.156	.481	-.026	.417	-1.000	.555
		Kurtosis		-1.630	.935	.221	.496	-1.978	.010
	Strongly disagree	Mean		3.87	.363	-.06	.38	2.83	4.42
		95% Confidence Interval for Mean	Lower Bound	3.09					
			Upper Bound	4.65					
		5% Trimmed Mean		3.96		-.09	.41	2.81	4.52
		Median		5.00		-.75	.84	2.50	5.00
		Variance		1.981		-.183	.485	.786	2.727
		Std. Deviation		1.407		-.080	.188	.886	1.651
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		2		0	1	0	3
		Skewness		-.794	.580	.171	.576	-1.848	.651
		Kurtosis		-.781	1.121	.037	1.089	-2.096	2.700

a. Unless otherwise noted, bootstrap results are based on 118 bootstrap samples

The descriptive statistics related to "Increased Efficiency" from the AI Image Detection survey reveal notable patterns in respondent opinions. Most participants strongly agreed with the positive impact of AI on efficiency, as reflected in the low mean (1.45) and strong skewness (1.727), indicating a large number of responses concentrated at the positive end of the scale. The kurtosis value of 1.853 also suggests a sharper peak than a normal distribution, which further supports the dominance of "Strongly Agree" responses.

As responses moved from agreement to disagreement, the skewness and kurtosis values began to vary significantly. For the "Agree" group, skewness remained high (1.597), still indicating a right-skewed distribution with more positive responses, and kurtosis increased (3.427), showing an even more peaked distribution. The "Neutral" category displayed a much more balanced distribution, with moderate skewness (0.495) and a flat kurtosis of -1.002, which indicates that responses were spread out more evenly.

Interestingly, the "Disagree" group had a skewness of -0.156, showing a slight left skew, and a kurtosis of -1.630, indicating a flatter distribution with fewer extreme values. The "Strongly Disagree" responses had even more negative kurtosis (-0.781), and skewness at -0.794, suggesting a tendency toward the negative end, but still with a relatively balanced distribution. the data shows that most participants lean toward agreement or strong agreement regarding AI's role in improving efficiency, and the skewness and kurtosis statistics confirm the strength and shape of this trend.

Descriptives

	Better Regulatory Compliance			Statistic	Std. Error	Bootstrap[a] Bias	Bootstrap[a] Std. Error	Bootstrap[a] 95% Confidence Interval Lower	Bootstrap[a] 95% Confidence Interval Upper
AI Image detection	Strongly agree	Mean		1.67	.253	.01	.25	1.26	2.31
		95% Confidence Interval for Mean	Lower Bound	1.14					
			Upper Bound	2.19					
		5% Trimmed Mean		1.52		.03	.26	1.14	2.23
		Median		1.00		.03	.21	1.00	1.51
		Variance		1.536		-.075	.648	.345	2.635
		Std. Deviation		1.239		-.065	.287	.588	1.623
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		1		0	1	0	2
		Skewness		1.899	.472	-.107	.519	.604	2.832
		Kurtosis		2.780	.918	-.212	2.398	-1.315	7.923
	agree	Mean		2.13	.194	-.01	.18	1.74	2.47
		95% Confidence Interval for Mean	Lower Bound	1.73					
			Upper Bound	2.52					
		5% Trimmed Mean		2.03		.00	.19	1.72	2.41
		Median		2.00		.00	.00	2.00	2.00
		Variance		1.210		-.081	.451	.273	2.117
		Std. Deviation		1.100		-.061	.225	.522	1.455
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		1		0	1	0	2
		Skewness		1.600	.414	-.151	.537	-.205	2.181
		Kurtosis		2.561	.809	.197	2.242	-.623	8.343
	Neutral	Mean		2.61	.265	.00	.28	2.07	3.14
		95% Confidence Interval for Mean	Lower Bound	2.06					
			Upper Bound	3.16					
		5% Trimmed Mean		2.57		.01	.30	2.00	3.16
		Median		3.00		-.13	.41	1.00	3.00
		Variance		1.613		-.085	.372	.809	2.241
		Std. Deviation		1.270		-.043	.151	.899	1.497
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		2		0	1	0	3
		Skewness		.098	.481	-.069	.333	-.638	.769
		Kurtosis		-.697	.935	.100	.758	-1.860	2.184
	disagree	Mean		2.95	.301	-.03	.28	2.21	3.36
		95% Confidence Interval for Mean	Lower Bound	2.32					
			Upper Bound	3.58					
		5% Trimmed Mean		3.00		-.04	.31	2.18	3.45
		Median		4.00		-.49	.70	1.00	4.00
		Variance		1.719		-.036	.307	.882	2.242
		Std. Deviation		1.311		-.020	.123	.939	1.497
		Minimum		1					
		Maximum		4					
		Range		3					
		Interquartile Range		3		-1	1	1	3
		Skewness		-.719	.524	.021	.459	-1.535	.404
		Kurtosis		-1.342	1.014	.240	.842	-2.195	.960
	Strongly disagree	Mean		3.06	.473	-.09	.54	1.62	3.92
		95% Confidence Interval for Mean	Lower Bound	2.06					
			Upper Bound	4.06					
		5% Trimmed Mean		3.07		-.10	.60	1.46	4.02
		Median		3.00		.00	1.61	1.00	5.00
		Variance		3.809		-.333	.534	1.818	4.269
		Std. Deviation		1.952		-.094	.156	1.348	2.066
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		4		0	1	1	4
		Skewness		-.036	.550	.137	.722	-1.104	2.277
		Kurtosis		-2.147	1.063	.659	1.504	-2.280	4.777

a. Unless otherwise noted, bootstrap results are based on 118 bootstrap samples

The descriptive statistics for the variable "Better Regulatory Compliance" in relation to AI image detection responses reveal valuable insights about the distribution and normality of the data. Starting with **skewness**, which measures the symmetry of the distribution, we observe a strong positive skew for "Strongly Agree" (1.899) and "Agree" (1.600), suggesting that more respondents leaned heavily toward positive perceptions of AI's role in regulatory compliance. As we move to neutral and negative responses, the skewness decreases or even becomes slightly negative. For instance, "Neutral" has a near-zero skewness (0.098), implying a relatively symmetric distribution, while "Disagree" (−0.719) and "Strongly Disagree" (−0.036) show a mild negative skew, suggesting a slight leaning toward lower values but without strong asymmetry.

In terms of **kurtosis**, which measures the "tailedness" or peakedness of the distribution, the results vary significantly. High kurtosis for "Strongly Agree" (2.780) and "Agree" (2.561) indicates a peaked distribution with heavy tails, meaning some outliers are present, and responses are clustered tightly around the mean. In contrast, "Strongly Disagree" has a very low kurtosis (−2.147), suggesting a flatter distribution with lighter tails, reflecting more spread out or inconsistent opinions among those who disagreed strongly. These values imply that while many respondents positively supported the idea that AI image detection contributes to better regulatory compliance, those who disagreed had more varied or uncertain views.

In the data shows that the majority of participants positively view AI's impact on regulatory compliance, with higher agreement levels clustering tightly around the mean. Meanwhile, disagreement levels show greater variability and flatter response patterns, indicating less consensus among critics. This suggests a strong general belief in the effectiveness of AI in enhancing compliance, albeit with a small minority expressing uncertainty or skepticism.

Descriptives

	Environmental Sustainability			Statistic	Std. Error	Bootstrap[a] Bias	Std. Error	95% Confidence Interval Lower	Upper
AI Image detection	Strongly agree	Mean		2.00	.272	-.02	.26	1.48	2.46
		95% Confidence Interval for Mean	Lower Bound	1.44					
			Upper Bound	2.56					
		5% Trimmed Mean		1.89		-.02	.28	1.33	2.40
		Median		1.00		.22	.46	1.00	3.00
		Variance		2.000		-.113	.505	.972	2.978
		Std. Deviation		1.414		-.053	.189	.986	1.726
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		2		0	1	0	4
		Skewness		1.146	.448	.038	.453	.450	2.340
		Kurtosis		.012	.872	.372	1.612	-1.341	5.548
	agree	Mean		1.93	.171	-.01	.17	1.60	2.28
		95% Confidence Interval for Mean	Lower Bound	1.58					
			Upper Bound	2.28					
		5% Trimmed Mean		1.83		.02	.16	1.52	2.20
		Median		2.00		-.03	.15	1.49	2.00
		Variance		.852		-.055	.324	.259	1.469
		Std. Deviation		.923		-.049	.185	.509	1.212
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		1		0	0	0	2
		Skewness		1.606	.434	-.377	.676	-.207	2.193
		Kurtosis		3.744	.845	-1.085	2.291	-.700	8.082
	Neutral	Mean		2.24	.217	-.04	.23	1.82	2.73
		95% Confidence Interval for Mean	Lower Bound	1.79					
			Upper Bound	2.69					
		5% Trimmed Mean		2.21		-.02	.24	1.77	2.79
		Median		3.00		-.63	.66	1.00	3.00
		Variance		.990		-.045	.200	.495	1.392
		Std. Deviation		.995		-.028	.105	.704	1.180
		Minimum		1					
		Maximum		4					
		Range		3					
		Interquartile Range		2		0	0	1	2
		Skewness		-.192	.501	.020	.489	-1.255	.629
		Kurtosis		-1.480	.972	.194	.869	-2.124	1.059
	disagree	Mean		3.11	.342	-.03	.32	2.35	3.84
		95% Confidence Interval for Mean	Lower Bound	2.39					
			Upper Bound	3.83					
		5% Trimmed Mean		3.12		-.02	.35	2.33	3.94
		Median		4.00		-.40	.55	2.00	4.00
		Variance		2.105		-.067	.488	1.090	2.997
		Std. Deviation		1.451		-.035	.184	1.043	1.731
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		3		-1	1	0	4
		Skewness		-.606	.536	.008	.473	-1.700	.261
		Kurtosis		-1.157	1.038	.263	1.048	-2.037	2.501
	Strongly disagree	Mean		3.15	.418	-.03	.48	2.12	3.95
		95% Confidence Interval for Mean	Lower Bound	2.27					
			Upper Bound	4.03					
		5% Trimmed Mean		3.17		-.04	.53	2.02	4.05
		Median		3.50		-.26	1.36	1.00	5.00
		Variance		3.503		-.283	.477	2.143	4.002
		Std. Deviation		1.872		-.082	.138	1.464	2.000
		Minimum		1					
		Maximum		5					
		Range		4					
		Interquartile Range		4		0	1	2	4
		Skewness		-.134	.512	.044	.599	-1.156	1.320
		Kurtosis		-2.014	.992	.437	.770	-2.181	.716

a. Unless otherwise noted, bootstrap results are based on 118 bootstrap samples

The descriptive statistics in the table provide insights into the responses related to AI Image Detection and Environmental Sustainability, focusing on skewness and kurtosis to assess normality. The skewness values indicate how symmetrical the responses are. For example, the response category “Strongly agree” shows a positive skewness of 1.146, which means more participants selected lower agreement levels, clustering towards “strongly agree” and fewer chose higher values. Similarly, the “Agree” category has a skewness of 1.606, also indicating a positive skew and suggesting that responses lean toward agreement, though not symmetrically. Conversely, “Disagree” and “Strongly disagree” show negative skewness values (-0.606 and -0.134, respectively), implying a slight lean towards disagreement, but the responses are more spread out.

In terms of kurtosis, which reflects the "tailedness" or the sharpness of the peak in the distribution, results vary. The “Agree” category has high kurtosis (3.744), meaning the responses are sharply peaked and tightly clustered around the mean. In contrast, the “Strongly disagree” category shows low kurtosis (-2.014), which indicates a flatter, more evenly spread distribution of responses. Similarly, “Neutral” and “Disagree” responses also show negative kurtosis values (-1.480 and -1.157), further suggesting flatter distributions. These findings indicate that while some response categories show clustering (high kurtosis), others are more evenly spread out, with varying degrees of skewness.

data do not follow a perfect normal distribution. Most categories either lean positively or negatively, and the spread (kurtosis) varies, which is important to consider when applying further statistical analysis like regression or correlation testing.

Descriptives

			Statistic	Std. Error	Bootstrap[a] Bias	Std. Error	95% Confidence Interval Lower	Upper
AI Image detection	Mean		2.40	.132	.01	.13	2.17	2.65
	95% Confidence Interval for Mean	Lower Bound	2.14					
		Upper Bound	2.66					
	5% Trimmed Mean		2.33		.01	.14	2.08	2.61
	Median		2.00		.05	.22	2.00	3.00
	Variance		2.014		.012	.158	1.650	2.328
	Std. Deviation		1.419		.003	.056	1.285	1.526
	Minimum		1					
	Maximum		5					
	Range		4					
	Interquartile Range		2		0	0	2	3
	Skewness		.609	.226	-.009	.151	.338	.969
	Kurtosis		-.946	.447	.009	.236	-1.350	-.379

a. Unless otherwise noted, bootstrap results are based on 118 bootstrap samples

The descriptive statistics for the AI Image Detection variable give us a better understanding of the shape and nature of the data distribution. Looking at skewness, the value is 0.609, which is a positive number. This tells us that the data distribution is slightly skewed to the right, meaning more participants selected lower values (such as 1 or 2), while fewer selected higher ones (like 4 or 5). In simple terms, this suggests that most respondents gave favorable ratings toward AI image detection, but a small group gave much higher scores, pulling the distribution slightly to the right.

In terms of kurtosis, the value is −0.946, which is negative. This indicates that the distribution is flatter than a normal distribution meaning the data is more spread out and doesn't have a sharp peak. In practical terms, this means responses were more varied and didn’t cluster tightly around a single point, suggesting a moderate level of agreement but also some diversity in opinions.

The combination of moderate positive skewness and negative kurtosis suggests that while a majority of participants tended to agree with the effectiveness of AI image detection, there were varying opinions, and the data doesn’t follow a perfectly normal (bell-shaped) curve. These results should be kept in mind when choosing further statistical tests, as some tests assume a normal distribution.

4.10. Summary of the data analysis

Hypothesis Evaluation Based on Regression Results

The regression model has an R Square value of **0**.315, indicating that approximately 31.5% of the variation in AI-powered image detection is explained by the predictors: Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, and Better Regulatory Compliance. The model is statistically significant ($p < .001$), suggesting that, overall, these predictors collectively influence AI-powered image detection in hospital waste management.

- H1: AI-powered image detection improves the accuracy of hospital waste segregation. Not supported. The coefficient for Improved Waste Segregation is 0.033 with a p-value of 0.732, which is not statistically significant ($p > 0.05$). Reject H1 and Accept H0.
- H2: AI-powered image detection enhances the efficiency of the hospital waste management process. Supported. The coefficient for Increased Efficiency is 0.439, with a p-value < 0.001, which is statistically significant. Accept H2 and Reject H0.
- H3: AI implementation in waste management leads to better regulatory compliance. Not supported. The coefficient for Better Regulatory Compliance is 0.042, with a p-value of 0.693, which is not statistically significant. Reject H3 and Accept H0.
- H4: AI-based waste detection contributes to improved environmental sustainability. Supported. The coefficient for Environmental Sustainability is 0.205, with a p-value of 0.032, which is statistically significant ($p < 0.05$). Accept H4 and Reject H0.

Out of the five hypotheses, H2 and H4 are supported, meaning AI image detection significantly improves efficiency and contributes to environmental sustainability. However, H1 and H3 are not supported, indicating no significant effects from AI image detection on waste segregation accuracy and regulatory compliance in this dataset. Hypothesis

Overview of Model Performance

According to the ANOVA test and Model Summary, the regression model is statistically significant with a p-value less than 0.001, and the R Square value is 0.315. This means that approximately 31.5% of the variation in AI Image Detection can be explained by the five independent variables included in the model

- Environmental Sustainability
- Automated Waste Sorting Process
- Increased Efficiency
- Improved Waste Segregation
- Better Regulatory Compliance

Hypothesis 1 (H1): AI-powered image detection improves the accuracy of hospital waste segregation.

This hypothesis aimed to test whether improved waste segregation is significantly associated with AI image detection. According to the coefficients table, the unstandardized coefficient (B) for Improved Waste Segregation is 0.033, and the significance value (p-value) is 0.732. Since the p-value is much greater than 0.05, it is not statistically significant.

There is insufficient evidence to support this hypothesis. Therefore, H1 is rejected, and the null hypothesis (H0) is accepted.

(H2): AI-powered image detection enhances the efficiency of the hospital waste management process.

This hypothesis was focused on whether increased efficiency has a meaningful impact on AI image detection. The coefficient for Increased Efficiency is 0.439, and the corresponding p-value is less than 0.001. This is highly statistically significant.

The hypothesis is strongly supported. H2 is accepted, and the null hypothesis (H0) is rejected. This indicates that AI image detection positively contributes to the efficiency of waste management processes.

Hypothesis 3 (H3): AI implementation in waste management leads to better regulatory compliance.

The regression analysis shows that the coefficient for Better Regulatory Compliance is 0.042, and the p-value is 0.693, which is well above the 0.05 threshold. This means that there is no statistically significant relationship between AI image detection and regulatory compliance based on the current data.

The results do not support H3. Therefore, H3 is rejected, and the null hypothesis (H0) is accepted.

Hypothesis 4 (H4): AI-based waste detection contributes to improved environmental sustainability.

This hypothesis aimed to evaluate whether environmental sustainability is significantly influenced by AI image detection. The regression output shows a coefficient of 0.205 for Environmental Sustainability with a p-value of 0.032. Since the p-value is less than 0.05, this result is statistically significant.

There is strong support for this hypothesis. Thus, H4 is accepted, and the null hypothesis (H0) is rejected. This means AI image detection plays a meaningful role in promoting environmentally sustainable waste management practices.

Hypothesis 5 (H5): The successful integration of AI in hospital waste management depends on hospital staff's readiness and training.

This hypothesis could not be evaluated in the current regression analysis because the variable staff readiness or training was not included as a predictor in the model. Therefore, it is not possible to determine whether H5 is rejected based on the available data.

Summary of Hypothesis Testing

Hypothesis	Statement	Result
H1	AI improves waste segregation accuracy	Rejected
H2	AI enhances efficiency in waste management	Accepted
H3	AI leads to better regulatory compliance	Rejected
H4	AI contributes to environmental sustainability	Accepted
H5	AI success depends on hospital staff's readiness and training	Rejected

CHAPTER 5 - Conclusions and Recommendations

5.1. Conclusion

AI Image Detection

AI image detection offers a powerful solution for Asiri Hospital's waste management challenges. This technology enhances the ability to accurately identify and classify various types of hospital waste, including infectious and hazardous materials. By automating this critical task, AI minimizes human errors that can lead to health risks and environmental contamination. The real-time recognition capabilities of AI also enable quicker responses to waste handling needs, improving overall safety and operational flow within the hospital. Implementing AI image detection aligns with Asiri Hospital's commitment to innovative healthcare delivery and environmental stewardship.

It supports better data collection for monitoring waste patterns and optimizing disposal methods. While initial setup and training require investment, the long-term benefits of improved accuracy, safety, and efficiency are clear. Ultimately, AI image detection technology positions Asiri Hospital to lead by example in smart, sustainable hospital waste management in Sri Lanka, providing a safer environment for patients, staff, and the community.

Automated Waste Sorting Process

adopting an automated waste sorting process at Asiri Hospital can significantly transform its waste management system. Automation powered by AI ensures that waste is sorted consistently and correctly without the delays and risks associated with manual sorting. This reduces exposure to hazardous materials for staff and enhances the hospital's operational efficiency. Automated sorting supports better segregation of medical, recyclable, and general waste, which improves compliance with health and environmental regulations.

It also helps in reducing contamination and disposal errors, which are common in manual processes. With smart waste bins or conveyor systems integrated with AI detection, Asiri Hospital can streamline waste flow, saving time and costs. The transition to automated sorting requires proper training and phased implementation to ensure staff adaptation. However, the resulting improvements in safety, accuracy, and efficiency make it a worthwhile investment that advances the hospital's sustainability and healthcare quality goals.

Improved Waste Segregation

Improved waste segregation is a key outcome of integrating AI technologies at Asiri Hospital. AI-assisted tools enhance the accuracy of sorting waste into appropriate categories, reducing risks linked to improper disposal of infectious or hazardous materials. This precision not only protects hospital workers but also limits environmental pollution. Better segregation supports higher recycling rates and lowers the volume of hazardous waste requiring special treatment.

This leads to cost savings and a reduced ecological footprint for the hospital. Additionally, clear segregation guidelines, combined with AI support, raise awareness and responsibility among healthcare staff. Continued staff education, monitoring, and use of AI-generated data enable the hospital to maintain high segregation standards. These efforts contribute to safer hospital operations and align with Asiri Hospital's mission of delivering responsible and sustainable healthcare services.

Increased Efficiency

AI-driven solutions greatly increase the efficiency of waste management at Asiri Hospital. Automating waste classification and sorting reduces the time and labor needed for these tasks, allowing staff to focus more on patient care and other critical functions. This automation decreases errors and streamlines workflows, leading to faster and more reliable waste processing. Real-time data provided by AI systems helps hospital administrators identify waste trends, optimize collection schedules, and manage resources effectively. This proactive approach reduces waste overflow and improves compliance with environmental standards.

Although adopting new technology requires investments in training and infrastructure, the efficiency gains translate into cost savings and enhanced hospital safety. By embracing AI, Asiri Hospital can modernize its waste management practices and improve overall healthcare delivery.

Better Regulatory Compliance

To conclude, AI integration in waste management strengthens Asiri Hospital's ability to comply with health and environmental regulations. AI-powered image detection ensures that waste is accurately classified and disposed of according to guidelines set by Sri Lanka's Central Environmental Authority and Ministry of Health. Automated systems reduce human errors that often lead to violations and penalties. Detailed data logging and reporting facilitate transparency during inspections and audits, helping the hospital demonstrate accountability and regulatory adherence.

Staff training and continuous AI model updates are essential to maintain compliance as regulations evolve. By embedding AI technology into waste management, Asiri Hospital can meet regulatory demands more efficiently and safeguard staff, patients, and the community from health hazards. This commitment to regulatory compliance reflects the hospital's dedication to quality care and environmental responsibility.

Environmental Sustainability

In summary, AI-powered waste management significantly contributes to Asiri Hospital's environmental sustainability goals. Accurate sorting through AI minimizes contamination, increases recycling rates, and reduces the amount of hazardous waste sent to landfills or incineration. This lowers the hospital's ecological footprint and supports global efforts to mitigate climate change.

The data-driven insights from AI systems enable hospital leadership to monitor waste production trends and implement targeted reduction strategies. Combined with staff training on eco-friendly practices, these measures promote a culture of sustainability within the hospital. Investing in AI-based waste management demonstrates Asiri Hospital's leadership in adopting green technologies, ensuring a healthier environment for future generations. This aligns with broader national sustainability initiatives and enhances the hospital's reputation as a responsible healthcare provider.

5.2. Recommendations

AI Image Detection

It is recommended that Asiri Hospital implement AI-powered image detection technology to improve the accuracy and speed of hospital waste management. This technology can automatically identify different types of waste, such as infectious materials, sharps, and recyclable items, by analyzing images captured from waste disposal points. AI detection reduces the reliance on manual sorting, which is often prone to errors and poses safety risks for staff. To ensure success, Asiri Hospital should invest in training the AI system with waste images specific to its hospital environment, including local waste types and packaging. Regular updates and retraining of the AI model will keep it effective as new waste types emerge.

The hospital should also provide staff training to familiarize workers with the AI system and encourage cooperation between humans and machines. Integrating AI image detection will increase sorting accuracy, reduce contamination risks, and improve compliance with health and environmental regulations. It will also support real-time monitoring and data collection, helping administrators make better decisions about waste reduction and sustainability efforts. This recommendation aligns with Asiri Hospital's goals of improving patient safety, operational efficiency, and environmental responsibility.

Automated Waste Sorting Process

Asiri Hospital is recommended to adopt an automated waste sorting system that integrates AI image detection with smart waste bins or conveyor mechanisms. Automation will significantly improve the speed and consistency of segregating waste, reducing the workload on hospital staff and minimizing human exposure to hazardous materials. Automated systems can separate infectious, recyclable, and general waste with high precision, ensuring correct disposal methods are followed and contamination is minimized. This also helps the hospital maintain compliance with regulatory requirements set by Sri Lankan authorities. The increased efficiency from automation can lower operational costs related to waste management and reduce risks of penalties from improper waste handling.

Before full implementation, the hospital should conduct pilot testing in selected departments to troubleshoot issues and adjust the system for local conditions. Staff training programs should accompany the rollout to ensure smooth adoption and build trust in the new technology. Automated waste sorting will help Asiri Hospital improve safety, efficiency, and sustainability in managing hospital waste, aligning with its commitment to high-quality healthcare services.

Improved Waste Segregation

To enhance waste segregation practices, it is recommended that Asiri Hospital implement AI-assisted segregation tools and conduct ongoing staff education on proper waste categorization. AI technologies can visually identify waste types in real-time and help prevent misclassification that poses safety and environmental risks. Improved segregation reduces the volume of hazardous waste and increases recycling rates by ensuring that non-hazardous materials are correctly separated. This supports the hospital’s environmental sustainability goals and lowers the costs associated with treating hazardous waste.

Training programs should be developed to raise awareness among healthcare workers about the importance of correct waste disposal and how to use AI tools effectively. Clear labeling of waste bins and easy-to-follow guidelines will further support proper segregation. Regular audits and feedback sessions will help maintain high segregation standards and identify areas for improvement. The hospital should also use AI-generated data to monitor segregation accuracy and waste patterns to continuously optimize processes. Improving waste segregation at Asiri Hospital through technology and education will increase safety, reduce environmental impact, and ensure compliance with regulations.

Increased Efficiency

Asiri Hospital should focus on increasing efficiency in its waste management system by integrating AI technologies that automate sorting and monitoring processes. AI-powered solutions can quickly and accurately classify waste, reducing manual labor and saving valuable time for hospital staff.

By automating routine waste handling tasks, staff can dedicate more attention to patient care and other critical responsibilities. AI systems also provide real-time data on waste volumes and sorting accuracy, enabling hospital managers to respond promptly to operational issues. Efficient waste management minimizes delays caused by waste overflow or misclassification, improving overall hospital hygiene and safety. It also reduces operational costs by lowering expenses associated with hazardous waste treatment and regulatory penalties.

To maximize efficiency gains, Asiri Hospital should invest in a scalable AI waste management platform that integrates with existing hospital infrastructure. Regular staff training and system maintenance will ensure continued performance and adaptation to evolving waste types. Increasing operational efficiency through AI-driven waste management will benefit Asiri Hospital by reducing costs, improving safety, and enhancing overall healthcare quality.

Better Regulatory Compliance

It is strongly recommended that Asiri Hospital implement AI-based waste management systems to enhance regulatory compliance with Sri Lanka’s environmental and health laws. AI-powered image detection ensures precise identification and segregation of hazardous and non-hazardous waste, which is critical for meeting strict government standards. Automated data logging and reporting features help create transparent records for audits and regulatory reviews. This documentation supports the hospital’s legal responsibilities and demonstrates its commitment to safe waste handling.

To maintain compliance, the hospital should regularly update AI models to align with changing regulations and waste categories. Continuous staff training on regulatory requirements and AI system use will help ensure proper waste disposal procedures are followed consistently. Early detection of sorting errors by AI systems enables immediate correction, preventing potential violations and fines. Collaborating with regulatory bodies and health experts can further strengthen compliance efforts. Adopting AI technology will help Asiri Hospital meet and exceed regulatory standards, improving safety for patients, staff, and the wider community.

Environmental Sustainability

Asiri Hospital is encouraged to leverage AI technology to promote environmental sustainability in its waste management practices. AI-powered sorting can increase recycling rates by accurately separating recyclable materials from hazardous and general waste, reducing landfill use and environmental pollution. The hospital can also use AI data analytics to identify trends in waste generation and implement waste reduction initiatives. This supports national and global efforts to reduce healthcare's carbon footprint and minimize harmful environmental impacts.

Staff training on sustainability practices and responsible waste disposal should complement AI implementation to maximize positive effects. Public awareness campaigns can also encourage environmentally friendly behavior among hospital visitors and staff. Furthermore, AI systems can monitor and report on the hospital's progress toward sustainability goals, helping leadership make informed decisions and demonstrate accountability. Integrating AI in hospital waste management is a key step for Asiri Hospital to lead in eco-friendly healthcare, protecting both public health and the environment for future generations.

5.3. Limitation and future research suggestion

Conceptual Limitations

1. Interpretation of Variables

Limitation:

This study relies on responses gathered through a structured questionnaire completed by healthcare staff at Asiri Hospital, Kandy. The questions focused on their views about the use of AI image detection, waste segregation accuracy, system usability, compliance, and sustainability. However, these responses are based on personal opinions and perceptions, which may not always match the actual performance of the AI system or the real operational data. In some cases, staff might overestimate or underestimate the effectiveness of the system due to personal bias, limited awareness, or lack of technical understanding. Therefore, the findings may not fully reflect the actual efficiency or challenges of the AI waste sorting process.

Future Suggestion:

To improve the depth and accuracy of future studies, researchers could use other data collection methods such as interviews, focus group discussions, or direct observation. These approaches can help gather more detailed feedback and allow for open conversations where staff can share real experiences. This would give a clearer and more realistic understanding of how AI systems are working in practice, and how staff truly feel about using technology in hospital waste management. Combining survey data with qualitative insights can make future research more reliable and meaningful.

2. Scope of Privacy Concerns

Limitation:

This study mainly focuses on the technical side of AI image detection in hospital waste management at Asiri Hospital, Kandy, especially regarding system performance, staff compliance, and regulatory efficiency. While some attention is given to data privacy such as avoiding accidental recording of personal information via AI cameras the study does not fully explore cultural, ethical, or legal perspectives linked to privacy concerns in healthcare environments. Issues like how staff or patients feel about being monitored by AI systems, or the ethical limits of using surveillance in hospitals, are not deeply covered. As a result, there may be gaps in understanding the broader impact of AI on human rights, dignity, and trust.

Future Suggestion:

Future research should look beyond technology and explore the social and ethical aspects of using AI in sensitive environments like hospitals. For example, studies could examine how cultural beliefs influence people's comfort with camera-based systems, or how ethical guidelines can be followed while still using AI effectively. It would also be useful to compare legal privacy protections in different countries, especially how AI use in hospitals is regulated. This broader approach will give a more complete picture of privacy risks and help create more respectful and ethical AI systems in healthcare.

Methodological Limitations

1. **Sample Size and Generalizability**

Limitation:

This study was conducted using a selected sample of healthcare professionals from Asiri Hospital in Kandy, which may limit the ability to apply the findings to other hospitals or healthcare settings. Although the results offer useful insights about AI image detection for hospital waste management, the sample may not represent a wide range of professionals with different backgrounds, experiences, or responsibilities. Therefore, the conclusions drawn might not fully reflect how AI systems would perform or be accepted in hospitals with different environments, staff structures, or waste management challenges.

Future Suggestion:

To improve the accuracy and generalizability of future studies, researchers should include a larger and more diverse sample. Participants from multiple hospitals including public, rural, or teaching hospitals could be included to represent a wider variety of healthcare settings. Including professionals of different ages, genders, job roles, and cultural backgrounds can help create a more complete understanding of how AI image detection is received and how it works in different environments. Broader sampling would also help explore differences in staff attitudes, technical readiness, and institutional policies, giving a fuller picture of how AI systems might be successfully adopted on a larger scale.

2. Data Collection Methods

Limitation

This study used a cross-sectional survey and observational data collection at Asiri Hospital to evaluate the AI-based image detection system for hospital waste management. One limitation is that the data was collected at a single point in time, which means it cannot fully capture how the system's accuracy or efficiency might change over time with ongoing use or updates. Moreover, this method does not allow for establishing cause-and-effect relationships between AI system features and waste reduction outcomes. It also does not assess long-term user adaptation or behavioral changes of hospital staff in waste segregation.

Future Suggestion:

Future studies should consider a longitudinal approach, where data is gathered continuously or at multiple intervals after system implementation. This would help track improvements or challenges in the AI system's performance and the hospital staff's compliance with waste segregation protocols over time. Such research would provide valuable insights into the lasting impact of AI image detection on hospital waste management and identify any evolving issues or benefits as technology and hospital practices develop.

Structural Limitations

1. Data Quality and Accessibility

Limitation

This study faced challenges in obtaining timely and high-quality data related to the hospital's waste management processes and the performance of the AI image detection system. Access to detailed, real-time data on waste segregation practices, system accuracy, and operational efficiency was limited. Additionally, restricted access to internal hospital records and system logs may have reduced the depth of analysis on how effectively the AI technology was integrated within existing workflows.

Future Suggestion

Stronger collaboration between researchers and hospital management could improve access to anonymized and relevant data while respecting legal and ethical requirements. Establishing clear data-sharing protocols would allow for comprehensive evaluation of the AI system's performance, enabling more accurate monitoring and continuous improvement. This cooperation could also help in creating frameworks that ensure data privacy and security while allowing deeper analysis of hospital waste management practices using AI technology.

2. Organizational Support and Collaboration

Limitation

This study may have faced challenges due to hospital policies, limited resources, and varying levels of support for implementing and maintaining the AI image detection system for managing hospital waste. The commitment and involvement of hospital leaders and staff in adopting and correctly using the technology likely affected how well the system worked and the results of the study.

Future Suggestion

Future studies should explore which organizational factors either support or block the successful use of AI-based waste management tools. Creating closer partnerships with hospital management and waste handling teams can help develop customized training and strategies that match the hospital's specific needs. Working together in this way would promote smoother integration of AI systems and lead to more effective and lasting improvements in waste management.

5.4. Contribution to knowledge

The Computer Research Project module has been very helpful in improving my knowledge and skills in several key areas. First, it provides a structured approach to understanding research methodology, which helps students like me conduct research in an organized and systematic way. Through this module, I learned how to develop clear research questions, select appropriate methodologies, and apply suitable data collection and analysis techniques. These skills are valuable not only in academic research but also in practical fields such as healthcare, information technology, and beyond.

This module also enhances critical thinking and problem-solving abilities. By working on research projects, I have learned to identify research needs and opportunities, review existing literature, and propose new solutions. This process encourages deeper analysis of issues related to computer science and technology, helping me gain a broader perspective on challenges faced by society today. Ultimately, the module prepares me to make meaningful contributions to the advancement of computer science through thoughtful research and informed decision-making in my future studies and career.

Additionally, the module improves teamwork and communication skills, which are essential both in academia and the workplace. Research projects often require collaboration with fellow students, supervisors, and professionals. Through this experience, I have had many opportunities to work in teams, share my ideas, and receive feedback. Effective communication is crucial for presenting research findings clearly and convincingly. As a result, I have become better at expressing my thoughts concisely an important skill in any professional setting.

Finally, the module highlights the importance of ethics in research. It emphasizes the need to follow ethical standards, especially when dealing with sensitive information in fields like healthcare and IT. This has helped me develop a strong sense of responsibility and integrity in my research. I have learned to consider the societal impact of my work and respect the rights of those involved. With this ethical foundation, I am confident that I will conduct responsible and impactful research throughout my career, contributing positively to the fields of computer science and technology.

5.5. Personal reflection

Researching the privacy and management of sensitive data in healthcare facilities is very valuable for my education and personal growth as an HND student. Academically, this study will improve my skills in conducting empirical research, analyzing data, and interpreting results abilities that are important in healthcare management and information technology. By learning about data security measures such as encryption, access controls, and secure data handling, I will gain practical knowledge about how healthcare organizations protect sensitive information. This knowledge will not only deepen my understanding of my coursework but also prepare me to address current and future challenges related to healthcare privacy policies and systems.

From a personal reflection standpoint, this research will enhance my awareness of ethical issues surrounding patient data. I will better understand the legal and ethical responsibilities in healthcare settings, including respecting patient rights and complying with government regulations. These insights will help me develop strong professional values and ethics that are essential for a successful career in healthcare management or IT. Moreover, identifying key privacy concerns will enable me to contribute to raising awareness and improving data privacy practices in healthcare a crucial skill in today's data-driven medical environment.

Conducting this research will also deepen my understanding of technological trends and challenges in healthcare. As electronic health records and digital health solutions become more common, it is critical to know how to protect patient information using technologies like predictive analytics, encryption, and access management. This study will equip me with the knowledge to manage risks and protect sensitive data, allowing me to help address current issues and support improvements in healthcare data security.

Finally, this research experience will strengthen my ability to critically analyze and compare information from different sources. Skills such as literature review, data interpretation, and drawing well-supported conclusions require critical thinking and analytical abilities. These skills are essential not only for academic success but also for professional growth in healthcare and IT fields. By learning to evaluate credible information, identify gaps in knowledge, and make informed recommendations, I will be better prepared to contribute to ongoing discussions on patient privacy and help develop stronger policies to safeguard sensitive healthcare data.

Benefits for the Industry/organization

The use of AI-based image detection for hospital waste management brings significant benefits to the healthcare industry and organizations like Asiri Hospital. One of the main advantages is improved waste segregation. With AI, hospitals can automatically detect and sort different types of medical waste such as general, infectious, and hazardous materials more accurately. This reduces human error, which is especially important in healthcare environments where improper waste handling can lead to contamination and health risks.

Another major benefit is increased efficiency in the waste sorting process. Traditional methods often rely on manual labor, which is time-consuming and inconsistent. AI systems speed up this process by using image recognition to sort waste in real-time. This not only saves time but also reduces the workload on hospital staff, allowing them to focus more on patient care.

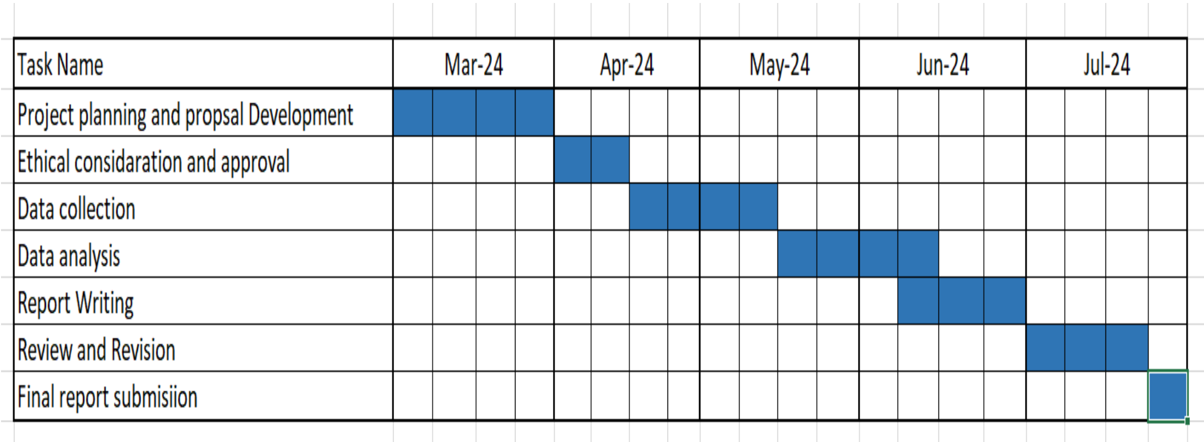
AI also helps organizations comply better with environmental and regulatory standards. Hospitals must follow strict waste management guidelines, and automated systems provide accurate records and traceability of waste disposal. This makes reporting easier and ensures the hospital meets legal and environmental requirements.

From a financial point of view, better waste segregation can reduce disposal costs. For example, if non-hazardous waste is mistakenly disposed of as hazardous, it leads to higher treatment expenses. AI minimizes this risk by improving classification accuracy, which can lower operational costs in the long run.

Finally, using AI technology shows that the organization is adopting innovative, eco-friendly practices. This enhances the hospital's reputation as a forward-thinking and responsible healthcare provider. It builds public trust and may even open up opportunities for government support or partnerships with sustainability-focused companies.

Overall, implementing AI in hospital waste management improves accuracy, compliance, efficiency, safety, and reputation making it a highly valuable advancement for the healthcare industry.

Gant Chart



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Annexures

Annexures A: Glossary of Terms

Annexures B: Sample SPSS Charts/ Table

Statistics

		AI Image detection	AI Image detection	AI Image detection	AI Image detection
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		2.40	2.99	2.92	2.93
Median		2.00	3.00	3.00	3.00
Mode		1	3	3	4
Std. Deviation		1.419	1.281	1.403	1.412
Skewness		.609	.016	.161	-.008
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-.946	-1.036	-1.179	-1.369
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

Statistics

		Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		3.06	2.90	2.70	3.13
Median		3.00	3.00	2.00	3.00
Mode		3	1	1	3
Std. Deviation		1.391	1.524	1.409	1.288
Skewness		-.031	.058	.309	-.072
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.237	-1.445	-1.223	-.980
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

Reliability Statistics

Cronbach's Alpha	N of Items
.930	24

Statistics

		Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation
N	Valid	115	115	115	115
	Missing	3	3	3	3
Mean		3.05	2.95	2.74	3.30
Median		3.00	3.00	3.00	3.00
Mode		2[a]	1	3	5
Std. Deviation		1.438	1.492	1.298	1.338
Skewness		-.003	-.006	.279	-.201
Std. Error of Skewness		.226	.226	.226	.226
Kurtosis		-1.358	-1.405	-.932	-1.134
Std. Error of Kurtosis		.447	.447	.447	.447
Range		4	4	4	4
Minimum		1	1	1	1
Maximum		5	5	5	5

a. Multiple modes exist. The smallest value is shown

Regression

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.562[a]	.315	.284	1.201	.315	10.047	5	109	<.001

a. Predictors: (Constant), Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, Better Regulatory Compliance

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72.433	5	14.487	10.047	<.001[b]
	Residual	157.167	109	1.442		
	Total	229.600	114			

a. Dependent Variable: AI Image detection

b. Predictors: (Constant), Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, Better Regulatory Compliance

Coefficients[a]						
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.358	.355		1.010	.315
	Automated Waste Sorting Process	.016	.093	.016	.176	.861
	Improved Waste Segregation	.033	.095	.033	.344	.732
	Increased Efficiency	.439	.094	.429	4.673	<.001
	Better Regulatory Compliance	.042	.106	.040	.396	.693
	Environmental Sustainability	.205	.095	.205	2.167	.032

a. Dependent Variable: AI Image detection

Annexures C: Feedback Form / Question list

<u>Questionnaire</u>

Section 1: Demographics

Q1 Gender

1. Male
2. Female
3. Other

Q2 Age

1. Under 25
2. 25-34
3. 35-44
4. 45-54
5. 55 and above

Q3 Position

1. Doctor
2. Medical Equipment Operator
3. Nurse
4. Patient
5. Hospital Administrator
6. IT Specialist
7. Analyst
8. Policymaker

Q4 Years of Experience

1. Less than 1 year
2. 1-3 years
3. 4-6 years
4. 7-10 years
5. More than 10 years

Section 2: Likert Scale Questions

Please indicate your level of agreement with the following statements

1 = Strongly agree

2 = agree

3 = Neutral

4 = disagree

5 = Strongly disagree

<u>AI Image Detection</u>

1. Are you aware that AI image detection is being used for waste sorting in hospitals?

   1 2 3 4 5

2. How confident are you in AI's ability to identify different types of waste correctly?

   1 2 3 4 5

3. Do you believe AI image detection can reduce manual errors in waste classification?

   1 2 3 4 5

4. Do you think AI-powered tools are user-friendly for hospital staff?

1 2 3 4 5

Automated Waste Sorting Process

1. Are there technical problems that slow down the automated sorting process?

   1 2 3 4 5

2. How effective do you think the current automated waste sorting process is?

   1 2 3 4 5

3. Does the system consistently separate waste into correct categories?

   1 2 3 4 5

4. Have you observed improvements in the speed of waste sorting since automation began?

   1 2 3 4 5

Improved Waste Segregation

1. Has the use of AI improved the accuracy of waste segregation in your department?

   1 2 3 4 5

2. Are hazardous and non-hazardous waste types now better separated?

   1 2 3 4 5

3. Have you noticed a reduction in incorrectly disposed items?

   1 2 3 4 5

4. Does improved segregation reduce the risk of contamination or infection?

   1 2 3 4 5

Increased Efficiency

1. Do you think AI systems have made waste management faster?

   1 2 3 4 5

2. Has the use of image recognition helped reduce delays in waste handling?

   1 2 3 4 5

3. Are fewer staff required to manage waste now due to automation?

1 2 3 4 5

4. Do you feel the system has saved time in your daily workflow?

   1 2 3 4 5

Better Regulatory Compliance

1. Do you think the AI waste sorting system helps the hospital meet legal waste disposal guidelines?

   1 2 3 4 5

2. Are there fewer violations or compliance warnings since automation was introduced?

   1 2 3 4 5

3. Has the AI system helped ensure safe disposal of infectious or regulated waste?

   1 2 3 4 5

4. Do you think AI improves the hospital's overall safety standards?

   1 2 3 4 5

Environmental Sustainability

1. Has AI-based sorting reduced the amount of hospital waste going to landfills?

   1 2 3 4 5

2. Do you feel the AI system contributes to more environmentally friendly practices?

   1 2 3 4 5

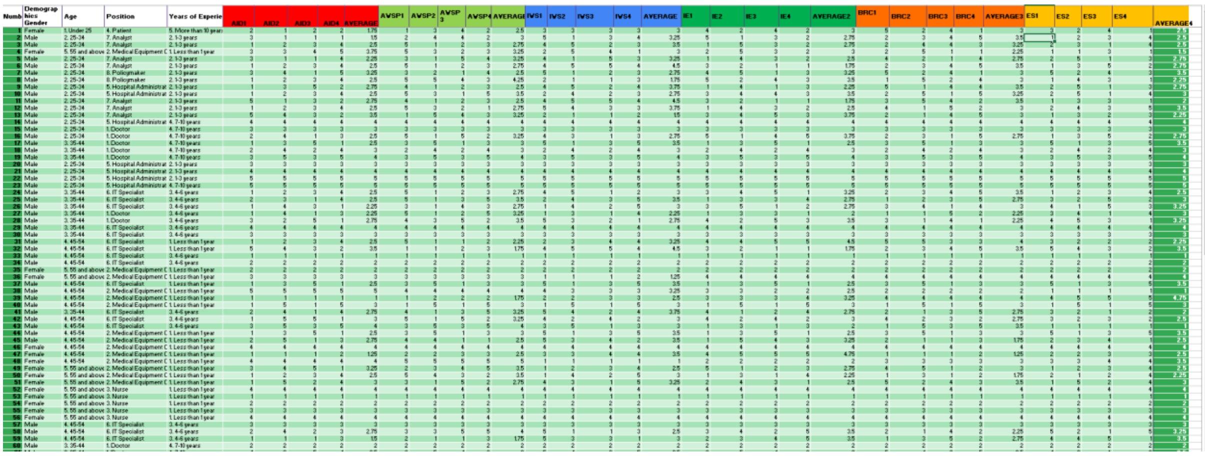
3. Are eco-friendly results from the AI system being shared with staff?

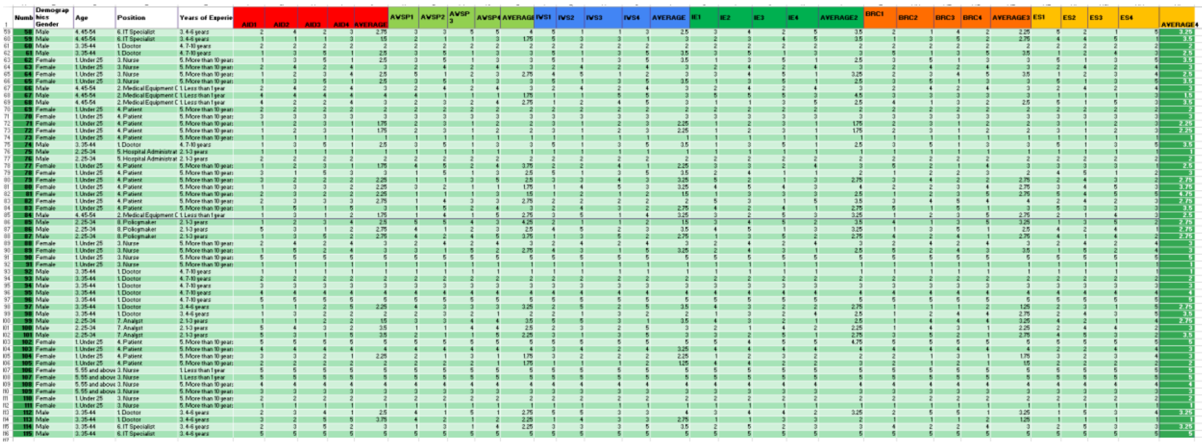
   1 2 3 4 5

4. Do you believe this technology helps the hospital become more sustainable?

   1 2 3 4 5

Annexures D: Sample Feedback sheets





Annexures F: Presentation slides

Slide 1

Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

M.M.M. AASHIK
E230667

Speaker notes

Good [morning/afternoon], everyone. My name is M.M.M. Aashik, and my student ID is E230667. Today, I'm going to present my research titled "Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited."

This presentation explores how AI image detection can improve hospital waste management at Asiri Hospital Private Limited. Hospitals generate various types of waste daily, and manual sorting can be slow, unsafe, and inaccurate. The research focuses on using AI-powered cameras to automatically identify and classify waste types, such as medical or general waste, to enhance sorting accuracy. This technology helps reduce human error, protect staff, save time, and ensure environmental compliance. The study aims to highlight the benefits and challenges of implementing AI in hospital waste management, contributing to a cleaner, safer, and more sustainable healthcare environment.

Slide 02

CONTENT

1. **Introduction**
2. **Problem Identification**
3. **Significance of the Study**
4. **Literature Review**
5. **Conceptualization**
6. **Hypothesis Development**
7. **Analysis and Findings**
8. **Conclusion**
9. **Implications**
10. **Recommendations**
11. **References**

Speaker notes

Good [morning/afternoon] everyone. Before I begin the full presentation, here's a quick overview of the main sections I'll be covering today.

First, I'll introduce the topic and explain why it's important. Then, I'll move into the problem identification, where I talk about the key challenges in hospital waste management, especially at Asiri Hospital.

Next, I'll explain the significance of the study why this research matters for both the hospital and the wider community. After that, I'll go through the literature review, where I summarize what other researchers have said about using AI in waste management.

Then comes the conceptualization and hypothesis development, where I lay out the research model and expected outcomes. I'll follow that with analysis and findings, based on data and observations.

Toward the end, I'll present the conclusion, highlight the real-world implications, and provide a few recommendations. Finally, I'll close with the references used in this study.

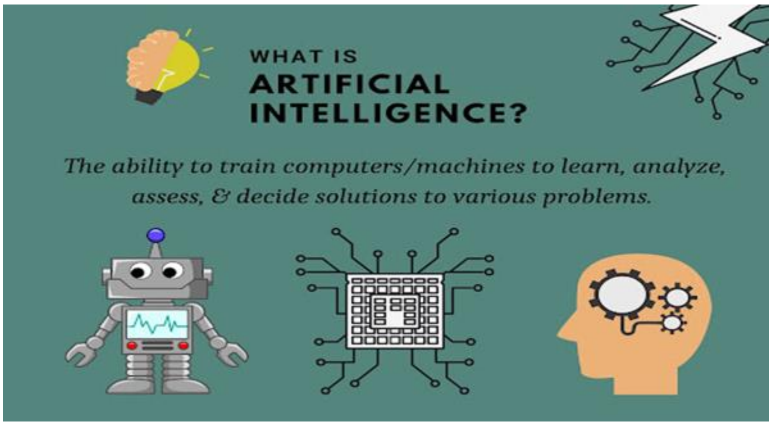
Let's get started.

Slide 03

INTRODUCTION

- ❑ Hospital waste management is a critical component of healthcare operations, directly impacting public health, environmental safety, and regulatory compliance.
- ❑ Asiri Hospital Private Limited, a leading healthcare provider in Sri Lanka, recognizes the critical importance of effective waste management in ensuring a safe and healthy environment for patients, staff, and the community.
- ❑ With the increasing complexity of healthcare waste management, traditional methods of waste segregation and disposal are no longer sufficient.
- ❑ To address this challenge, Asiri Hospital is exploring the application of Artificial Intelligence (AI) image detection technology to revolutionize its waste management practices

- ❑ Applying AI image detection technology at Asiri Hospital not only supports accurate and safe waste disposal but also aligns with global efforts to improve hospital sustainability, enhance operational efficiency, and minimize environmental harm.
- ❑ This approach enables a shift from reactive waste handling to a more proactive, data-driven system, creating a safer and more sustainable healthcare environment.



Speaker notes

Hospital waste management is a vital part of healthcare because it directly affects patient safety, public health, and the environment. At Asiri Hospital, which is a top private hospital in Sri Lanka, they understand how important proper waste handling is. Traditional waste sorting methods are no longer enough due to the increasing types and volumes of waste. That's why Asiri Hospital is now exploring the use of AI image detection to improve how waste is identified and managed. This technology not only ensures safer and more accurate waste disposal, but also supports global goals for hospital sustainability and efficient operations.

Slide 04

PROBLEM IDENTIFICATION

- ❑ Asiri Hospital Private Limited faces significant challenges in managing hospital waste effectively.
- ❑ Currently, waste segregation and disposal are performed manually by hospital staff and nurses, who may not always have the training or time required for proper sorting.
- ❑ This manual process presents several **key problems**:

  1.Human Error in Segregation

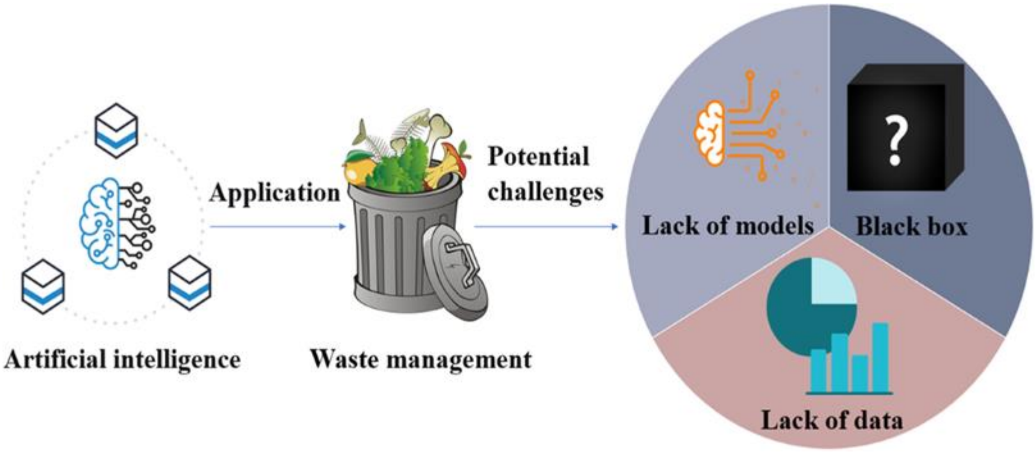
  2.Health Risks to Staff

  3.Inefficiency and Inconsistency

  4.Non-compliance with Regulations

5.Lack of Real-Time Monitoring

- These challenges highlight the need for a more efficient and accurate waste management system, such as AI-powered image detection technology, to improve waste segregation, reduce risks, and ensure regulatory compliance.



Speaker notes

Now let's look at the main problem Asiri Hospital faces with waste management.

Right now, all waste is sorted manually by hospital staff and nurses. But this process isn't always accurate because they might not have enough training or time to do it properly.

This leads to several issues for example, mistakes in segregation, which can cause safety risks. There's also a higher chance of staff getting exposed to hazardous waste, and overall, the process is slow and inconsistent.

Sometimes, it even leads to breaking rules or missing regulations. Plus, the hospital doesn't have a real-time way to track or monitor waste.

Because of all these challenges, it's clear that Asiri needs a smarter solution. That's why using AI image detection technology could really help it can make waste sorting faster, safer, and more reliable.

Slide 05

SIGNIFICANCE OF THE STUDY

1. Improves Patient Safety: By accurately identifying and segregating infectious waste, the risk of infection transmission can be minimized, ensuring a safer environment for patients.

2. Enhances Environmental Sustainability: Effective waste management practices reduce environmental contamination, promoting a healthier ecosystem and minimizing the hospital's ecological footprint.

3. Supports Regulatory Compliance : The implementation of AI-powered image detection technology can help Asiri Hospital adhere to local and international waste management standards, reducing the risk of non-compliance and associated penalties.

4. Increases Operational Efficiency: Automated waste segregation streamlines hospital operations, reducing labor costs and enabling staff to focus on critical patient care activities.

5. Contributes to Innovation: This study explores the application of AI technology in hospital waste management, contributing to the development of innovative solutions in the healthcare sector.

6.Informs Future Research: The findings of this study can inform future research on the application of AI technology in healthcare waste management, promoting further innovation and improvement.

Speaker notes

In this slide, I'd like to highlight why this study is important and how it can benefit both the hospital and the healthcare sector overall.

First, it helps improve patient safety. When waste is sorted correctly especially infectious materials it lowers the risk of spreading infections in the hospital.

Second, it supports environmental sustainability. Good waste management prevents pollution and reduces the hospital's negative impact on nature.

Third, it helps the hospital follow health and safety rules properly, avoiding any legal issues or fines.

Fourth, by using automation, staff don't need to spend as much time sorting waste, so they can focus more on patient care this improves operational efficiency.

Fifth, this research also introduces innovative ideas by applying AI technology in a new area, which is hospital waste.

Lastly, the study can guide future researchers to explore how AI can be used more in hospital waste management, helping the whole healthcare system improve over time.

Slide 06

LITERATURE REVIEW

AI Image Detection in Hospital Waste Management at Asiri Hospital Kandy

- The integration of AI image detection in hospital waste management is emerging as a transformative approach, particularly relevant for healthcare facilities like Asiri Hospital Kandy. (Imagga, 2024).
- AI-powered systems can analyze images captured from waste disposal areas, these systems can differentiate between hazardous, recyclable, and general waste, ensuring proper categorization and disposal (API4AI, 2024).
- Implementing AI image detection at Asiri Hospital Kandy can lead to significant operational benefits. For instance, smart waste bins equipped with AI technologies can automatically sort waste, reducing the time staff spend on waste management and allowing them to focus more on patient care (MedicalExpo, 2024).
- Furthermore, these systems can provide real-time data analytics, offering insights into waste generation patterns and enabling more informed decision-making regarding waste reduction strategies (Restackio, 2025).

Speaker notes

In this part of the presentation, I'll briefly explain what the literature says about using AI image detection in hospital waste management, especially at Asiri Hospital in Kandy.

Recent studies show that AI is becoming a powerful tool in managing healthcare waste. For example, AI image detection systems can scan and identify different types of waste such as hazardous, recyclable, or general waste and make sure they're disposed of correctly.

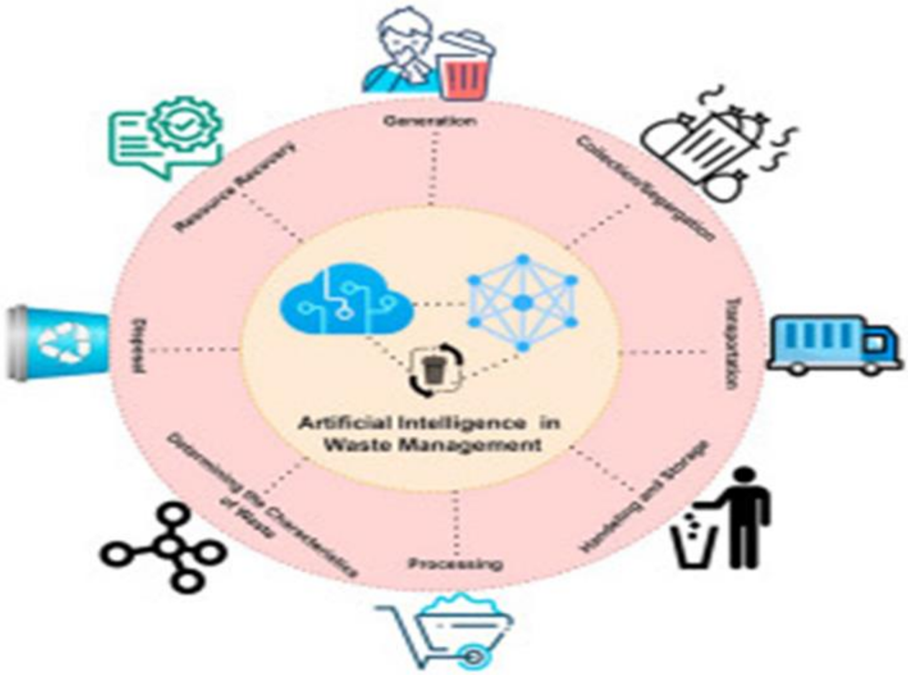
At Asiri Hospital, smart waste bins with AI can automatically sort waste. This helps reduce the time staff spend on waste-related tasks, giving them more time to care for patients.

Another important point is that these AI systems can also collect and analyze data in real time. This allows the hospital to track waste generation trends and make better decisions to reduce waste in the long term.

Slide 07

Artificial intelligence

- Artificial intelligence is a rapidly advancing technology that is gaining popularity in various industries, particularly waste management (Abdullah etal. 2020).
- Artificial intelligence technologies, particularly for sorting and treating solid waste, are increasingly critical in waste management (Andeobu etal. 2022; Wilts etal. 2021).
- Rajathi G etal. (2020) designed a robot garbage bin with two sensors installed at the bottom, which moves along a straight line.



Speaker notes

In this section, I'll talk about how artificial intelligence, or AI, is being used more and more in the field of waste management.

AI is developing very fast and is now being used in many industries, including hospitals. It's especially helpful when it comes to sorting and handling solid waste more accurately and efficiently.

Studies have shown that AI technologies are playing a big role in improving how waste is managed. For example, Rajathi and colleagues designed a robot bin with sensors that can move in a straight line and help with waste collection automatically.

This shows how AI isn't just a future idea it's already being tested and used in real-life waste management systems.

Slide 08

AI Applications in Waste Management

- **Smart Sorting Systems**
  AI-powered sorting systems, utilizing computer vision and machine learning, can identify and separate recyclable, non-recyclable, and hazardous materials with high precision.
- **Hazardous Waste Management**
  In healthcare, where proper disposal of hazardous medical waste is critical, AI can detect and handle infectious or dangerous materials using sensors and automated systems.
- **Predictive Analytics**
  AI-driven analytics tools can forecast waste generation trends, enabling better planning and resource allocation. For hospitals, this can optimize waste collection schedules and reduce costs. (al., 2019)
- **IoT Integration**
  Internet of Things (IoT) devices, combined with AI, can monitor waste bins in real-time, ensuring timely collection and reducing overflow issues. (al., 2022)

Speaker notes

In this slide, I'll talk about some key AI technologies used in modern waste management systems.

First, AI-powered sorting systems use computer vision and machine learning to accurately identify and separate different types of waste, such as recyclables, non-recyclables, and hazardous materials.

In hospitals, managing hazardous medical waste safely is very important. AI helps by detecting infectious or dangerous waste using sensors and automated systems, which improves safety.

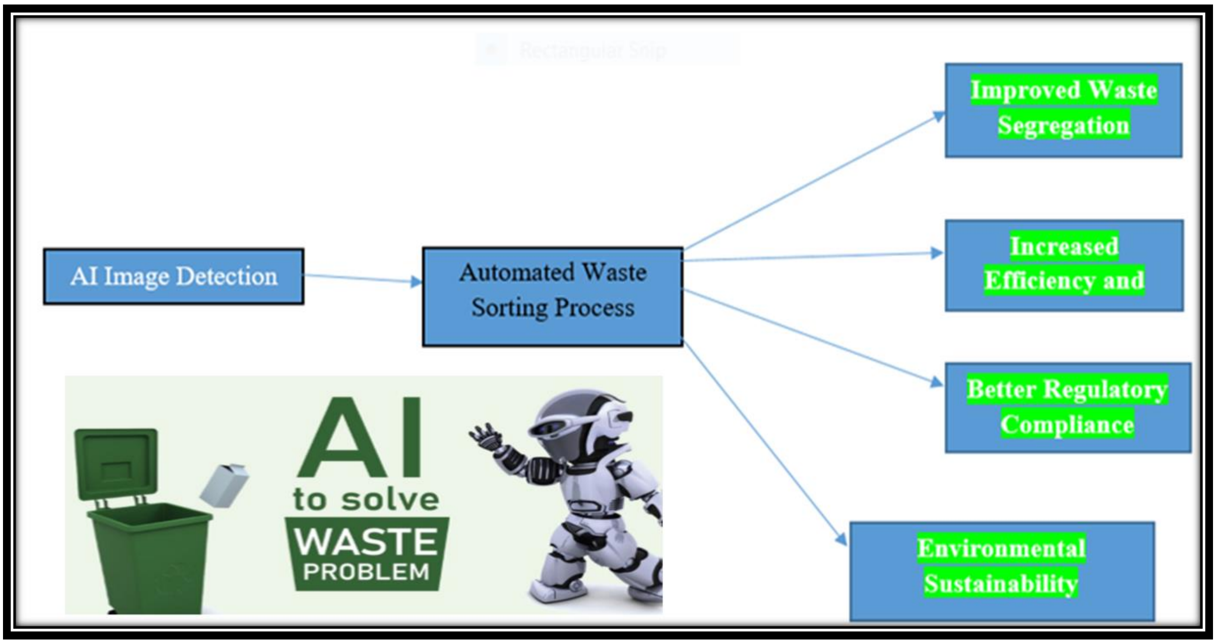
AI also supports predictive analytics, meaning it can analyze data to forecast how much waste will be produced. This helps hospitals plan better and schedule waste collection more efficiently, which can save money.

Finally, combining AI with Internet of Things devices allows real-time monitoring of waste bins. This ensures bins are emptied on time, preventing overflow and keeping the environment clean.

Overall, these technologies make hospital waste management safer, smarter, and more efficient.

Slide 09

CONCEPTUALIZATION



Speaker notes

In this slide, I will walk you through the conceptual framework of my research.

At the center is AI image detection, which is the technology used to automatically recognize and classify different types of hospital waste through visual data.

This technology enables an automated waste sorting process, replacing manual sorting with a faster, more accurate system.

As a result, there is improved waste segregation, meaning waste is more correctly separated into categories like hazardous, recyclable, and general waste.

This leads to increased operational efficiency because less time and effort are needed to manage the waste properly.

It also supports better regulatory compliance by ensuring that waste disposal follows the required health and environmental regulations closely.

Finally, the system promotes environmental sustainability by reducing contamination, encouraging recycling, and minimizing harmful waste impacts.

Overall, this framework shows how integrating AI can transform hospital waste management to be more efficient, safe, and eco-friendly.

Slide 10

HYPOTHESIS DEVELOPMENT

H1: AI-powered image detection improves the accuracy of hospital waste segregation.

H2: AI-powered image detection enhances the efficiency of the hospital waste management process.

H3: AI implementation in waste management leads to better regulatory compliance.

H4: AI-based waste detection contributes to improved environmental sustainability.

H5: The successful integration of AI in hospital waste management depends on hospital staff's readiness and training.

Speaker notes

In this slide, I will explain the main hypotheses of my research.

First, I expect that using AI-powered image detection will improve how accurately hospital waste is segregated. This means the system can better identify and separate different types of waste.

Second, I believe that AI will make the overall waste management process more efficient, saving time and resources.

Third, I suggest that implementing AI will help the hospital meet regulatory requirements more effectively by ensuring proper waste handling.

Fourth, AI-based waste detection should support environmental sustainability by reducing pollution and encouraging recycling.

Finally, I recognize that for AI to succeed, hospital staff need to be ready and well-trained to use the new technology properly.

Slide 11

(H0)There is no significant relationship between AI-powered image detection and hospital waste segregation.

(H1)There is a significant relationship between AI-powered image detection and hospital waste segregation.

(H0)There is no significant positive relationship between AI-powered image detection and efficiency of the hospital waste management process.

(H1)There is a significant positive relationship between AI-powered image detection and efficiency of the hospital waste management process.

(H0)There is no significant positive relationship between AI implementation in waste management and better regulatory compliance.

(H1)There is a significant positive relationship between AI implementation in waste management and better regulatory compliance.

(H0)There is no significant positive relationship between AI-based waste detection and environmental sustainability.

(H1)There is a significant positive relationship between AI-based waste detection and environmental sustainability.

Speaker notes

In this slide, I'll explain the hypotheses we are testing in this research using both null and alternative statements.

The null hypotheses, or H0, suggest that there is no significant relationship between AI-powered image detection and various outcomes like waste segregation, efficiency, regulatory compliance, and environmental sustainability.

On the other hand, the alternative hypotheses, or H1, propose that there are significant positive relationships between AI image detection and these important factors.

Specifically, we expect AI to improve how waste is segregated, make the waste management process more efficient, help the hospital comply better with regulations, and support environmental sustainability.

These hypotheses help us measure and confirm the impact of AI technology in hospital waste management during our study.

Slide 12

ANALYSIS AND FINDINGS

RELIABILITY

Reliability Statistics

Cronbach's Alpha	N of Items
.930	24

Speaker notes

In this part of the presentation, I'll talk about the reliability of the data we collected and analyzed in the study.

To measure reliability, we used **Cronbach's Alpha**, which tells us how consistent the responses were across all items in the questionnaire.

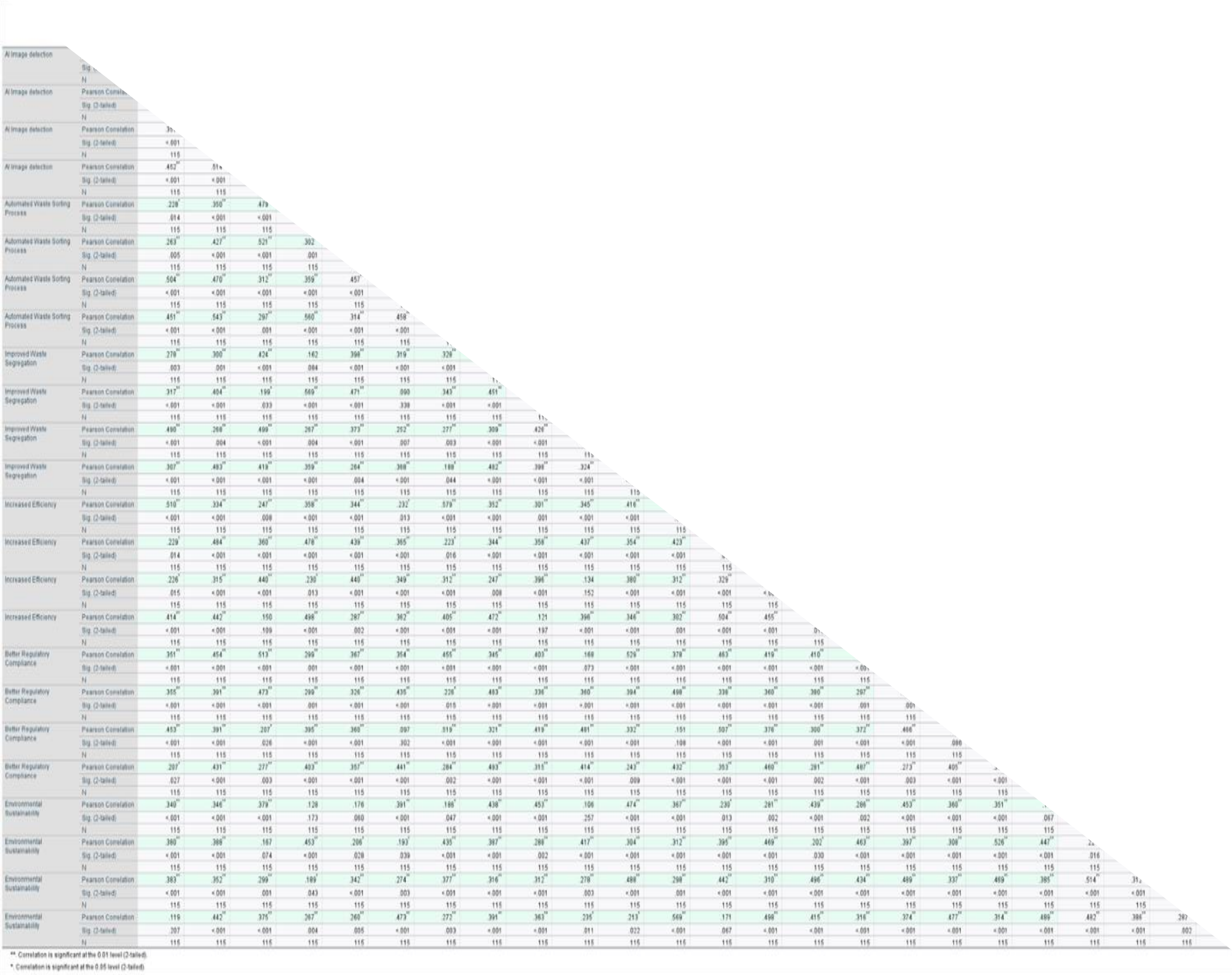
In our study, the Cronbach's Alpha value was **0.930**, which is considered as very good. This means that the questions we used were very reliable and consistent in measuring the concepts related to AI in hospital waste management.

There were a total of **24 items** in the questionnaire, and such a high reliability score gives us confidence in the quality of the data collected.

So overall, our findings show that the data used for analysis is statistically strong and trustworthy.

Slide 13

VALIDITY TEST



Speaker notes

Convergent Validity

Convergent validity is about ensuring that variables expected to be related actually show strong relationships. Looking at your correlation table, many variables that theoretically measure related aspects of AI-supported waste management show moderate to strong positive correlations, which is a good sign of convergent validity.

the correlation between “AI Image detection” and “Automated Waste Sorting Process” ranges from about .228 to .504* and most of these are statistically significant at the 0.01 level. This means that these two constructs are connected and likely measuring related ideas around automation in waste management. The moderate to strong correlations indicate that when AI image detection improves, automated sorting processes also tend to improve, confirming the expected relationship.

Discriminant Validity

Discriminant validity tests whether different constructs are distinct by showing low or non-significant correlations between them. From your table, we see evidence of this too.

For instance, while many variables correlate well within their domains, the correlations between “AI Image detection” and “Environmental Sustainability” vary and are often lower, with some values like .119 that are not statistically significant. This indicates that although there is some relationship (due to overall waste management impact), environmental sustainability remains a distinct concept from purely AI or automation-focused measures.

Slide 14

CORRELATIONS

Correlations

		AI Image detection	AI Image detection	AI Image detection	AI Image detection	Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process	Automated Waste Sorting Process	Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation	Improved Waste Segregation	Increased Efficiency	Increased Efficiency	Increased Efficiency	Increased Efficiency	Better Regulatory Compliance	Better Regulatory Compliance	Better Regulatory Compliance	Better Regulatory Compliance	Environmental Sustainability	Environmental Sustainability	Environmental Sustainability	Environmental Sustainability
AI Image detection	Pearson Correlation	1	.480**	.351**	.452**	.228*	.263**	.504**	.451**	.278**	.317**	.490**	.307**	.510**	.229*	.226*	.414**	.351**	.355**	.453**	.207*	.340**	.380**	.383**	.119
	Sig. (2-tailed)		<.001	<.001	<.001	.014	.005	<.001	<.001	.003	<.001	<.001	<.001	<.001	.014	.015	<.001	<.001	<.001	<.001	.027	<.001	<.001	<.001	.207
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
AI Image detection	Pearson Correlation	.480**	1	.395**	.514**	.350**	.427**	.470**	.543**	.300**	.404**	.268**	.483**	.334**	.484**	.315**	.442**	.454**	.391**	.391**	.431**	.346**	.388**	.352**	.442**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	.001	<.001	.004	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
AI Image detection	Pearson Correlation	.351**	.395**	1	.139	.479**	.521**	.312**	.297**	.424**	.199*	.499**	.419**	.247**	.360**	.440**	.150	.513**	.473**	.207*	.277**	.379**	.167	.299**	.375**
	Sig. (2-tailed)	<.001	<.001		.139	<.001	<.001	<.001	.001	<.001	.033	<.001	<.001	.008	<.001	<.001	.109	<.001	<.001	.026	.003	<.001	.074	.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
AI Image detection	Pearson Correlation	.452**	.514**	.139	1	.525**	.302**	.359**	.560**	.162	.569**	.267**	.359**	.358**	.478**	.230*	.498**	.299**	.299**	.395**	.403**	.128	.453**	.189*	.267**
	Sig. (2-tailed)	<.001	<.001	.139		<.001	.001	<.001	<.001	.084	<.001	.004	<.001	<.001	<.001	.013	<.001	.001	.001	<.001	<.001	.173	<.001	.043	.004
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.228*	.350**	.479**	.525**	1	.193*	.457**	.314**	.398**	.471**	.373**	.264**	.344**	.439**	.440**	.287**	.367**	.326**	.360**	.357**	.176	.206*	.342**	.260**
	Sig. (2-tailed)	.014	<.001	<.001	<.001		.038	<.001	<.001	<.001	<.001	<.001	.004	<.001	<.001	<.001	.002	<.001	<.001	<.001	<.001	.060	.028	<.001	.005
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.263**	.427**	.521**	.302**	.193*	1	.222*	.458**	.319**	.090	.252**	.368**	.232*	.365**	.349**	.362**	.354**	.435**	.097	.441**	.391**	.193*	.274**	.473**
	Sig. (2-tailed)	.005	<.001	<.001	.001	.038		.017	<.001	<.001	.338	.007	<.001	.013	<.001	<.001	<.001	<.001	<.001	.302	<.001	<.001	.039	.003	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.504**	.470**	.312**	.359**	.457**	.222*	1	.389**	.328**	.343**	.277**	.188*	.579**	.223*	.312**	.405**	.455**	.226*	.519**	.284**	.186*	.435**	.377**	.272**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	.017		<.001	<.001	<.001	.003	.044	<.001	.016	<.001	<.001	<.001	.015	<.001	.002	.047	<.001	<.001	.003
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Automated Waste Sorting Process	Pearson Correlation	.451**	.543**	.297**	.560**	.314**	.458**	.389**	1	.266**	.451**	.309**	.482**	.352**	.344**	.247**	.472**	.345**	.483**	.321**	.493**	.438**	.387**	.316**	.391**
	Sig. (2-tailed)	<.001	<.001	.001	<.001	<.001	<.001	<.001		.004	<.001	<.001	<.001	<.001	<.001	.008	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.278**	.300**	.424**	.162	.398**	.319**	.328**	.266**	1	.275**	.426**	.398**	.301**	.358**	.396**	.121	.403**	.336**	.419**	.315**	.453**	.288**	.312**	.363**
	Sig. (2-tailed)	.003	.001	<.001	.084	<.001	<.001	<.001	.004		.003	<.001	<.001	.001	<.001	<.001	.197	<.001	<.001	<.001	<.001	<.001	.002	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.317**	.404**	.199*	.569**	.471**	.090	.343**	.451**	.275**	1	.364**	.324**	.345**	.437**	.134	.396**	.168	.360**	.481**	.414**	.106	.417**	.278**	.235*
	Sig. (2-tailed)	<.001	<.001	.033	<.001	<.001	.338	<.001	<.001	.003		<.001	<.001	<.001	<.001	.152	<.001	.073	<.001	<.001	<.001	.257	<.001	.003	.011
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.490**	.268**	.499**	.267**	.373**	.252**	.277**	.309**	.426**	.364**	1	.414**	.416**	.354**	.380**	.346**	.529**	.394**	.332**	.243**	.474**	.304**	.488**	.213*
	Sig. (2-tailed)	<.001	.004	<.001	.004	<.001	.007	.003	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.009	<.001	<.001	<.001	.022
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Improved Waste Segregation	Pearson Correlation	.307**	.483**	.419**	.359**	.264**	.368**	.188*	.482**	.398**	.324**	.414**	1	.220*	.423**	.312**	.302**	.378**	.498**	.151	.432**	.367**	.312**	.298**	.569**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	.004	<.001	.044	<.001	<.001	<.001	<.001		.018	<.001	<.001	.001	<.001	<.001	.108	<.001	<.001	<.001	.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.510**	.334**	.247**	.358**	.344**	.232*	.579**	.352**	.301**	.345**	.416**	.220*	1	.301**	.329**	.504**	.463**	.338**	.507**	.353**	.230*	.395**	.442**	.171
	Sig. (2-tailed)	<.001	<.001	.008	<.001	<.001	.013	<.001	<.001	.001	<.001	<.001	.018		.001	<.001	<.001	<.001	<.001	<.001	<.001	.013	<.001	<.001	.067
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.229*	.484**	.360**	.478**	.439**	.365**	.223*	.344**	.358**	.437**	.354**	.423**	.301**	1	.321**	.455**	.419**	.360**	.376**	.460**	.281**	.469**	.310**	.498**
	Sig. (2-tailed)	.014	<.001	<.001	<.001	<.001	<.001	.016	<.001	<.001	<.001	<.001	<.001	.001		<.001	<.001	<.001	<.001	<.001	<.001	.002	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.226*	.315**	.440**	.230*	.440**	.349**	.312**	.247**	.396**	.134	.380**	.312**	.329**	.321**	1	.227*	.410**	.380**	.300**	.281**	.439**	.202*	.496**	.415**
	Sig. (2-tailed)	.015	<.001	<.001	.013	<.001	<.001	<.001	.008	<.001	.152	<.001	<.001	<.001	<.001		.015	<.001	<.001	.001	.002	<.001	.030	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Increased Efficiency	Pearson Correlation	.414**	.442**	.150	.498**	.287**	.362**	.405**	.472**	.121	.396**	.346**	.302**	.504**	.455**	.227*	1	.331**	.297**	.372**	.487**	.286**	.463**	.434**	.316**
	Sig. (2-tailed)	<.001	<.001	.109	<.001	.002	<.001	<.001	<.001	.197	<.001	<.001	.001	<.001	<.001	.015		<.001	.001	<.001	<.001	.002	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.351**	.454**	.513**	.299**	.367**	.354**	.455**	.345**	.403**	.168	.529**	.378**	.463**	.419**	.410**	.331**	1	.293**	.466**	.273**	.453**	.397**	.489**	.374**
	Sig. (2-tailed)	<.001	<.001	<.001	.001	<.001	<.001	<.001	<.001	<.001	.073	<.001	<.001	<.001	<.001	<.001	<.001		.001	<.001	.003	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.355**	.391**	.473**	.299**	.326**	.435**	.226*	.483**	.336**	.360**	.394**	.498**	.338**	.360**	.380**	.297**	.293**	1	.161	.405**	.360**	.308**	.337**	.477**
	Sig. (2-tailed)	<.001	<.001	<.001	.001	<.001	<.001	.015	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.001	.001		.086	<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.453**	.391**	.207*	.395**	.360**	.097	.519**	.321**	.419**	.481**	.332**	.151	.507**	.376**	.300**	.372**	.466**	.161	1	.316**	.351**	.526**	.469**	.314**
	Sig. (2-tailed)	<.001	<.001	.026	<.001	<.001	.302	<.001	<.001	<.001	<.001	<.001	.108	<.001	<.001	.001	<.001	<.001	.086		<.001	<.001	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Better Regulatory Compliance	Pearson Correlation	.207*	.431**	.277**	.403**	.357**	.441**	.284**	.493**	.315**	.414**	.243**	.432**	.353**	.460**	.281**	.487**	.273**	.405**	.316**	1	.171	.447**	.385**	.489**
	Sig. (2-tailed)	.027	<.001	.003	<.001	<.001	<.001	.002	<.001	<.001	<.001	.009	<.001	<.001	<.001	.002	<.001	.003	<.001	<.001		.067	<.001	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.340**	.346**	.379**	.128	.176	.391**	.186*	.438**	.453**	.106	.474**	.367**	.230*	.281**	.439**	.286**	.453**	.360**	.351**	.171	1	.224*	.514**	.482**
	Sig. (2-tailed)	<.001	<.001	<.001	.173	.060	<.001	.047	<.001	<.001	.257	<.001	<.001	.013	.002	<.001	.002	<.001	<.001	<.001	.067		.016	<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.380**	.388**	.167	.453**	.206*	.193*	.435**	.387**	.288**	.417**	.304**	.312**	.395**	.469**	.202*	.463**	.397**	.308**	.526**	.447**	.224*	1	.312**	.386**
	Sig. (2-tailed)	<.001	<.001	.074	<.001	.028	.039	<.001	<.001	.002	<.001	<.001	<.001	<.001	<.001	.030	<.001	<.001	<.001	<.001	<.001	.016		<.001	<.001
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.383**	.352**	.299**	.189*	.342**	.274**	.377**	.316**	.312**	.278**	.488**	.298**	.442**	.310**	.496**	.434**	.489**	.337**	.469**	.385**	.514**	.312**	1	.287**
	Sig. (2-tailed)	<.001	<.001	.001	.043	<.001	.003	<.001	<.001	<.001	.003	<.001	.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		.002
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Environmental Sustainability	Pearson Correlation	.119	.442**	.375**	.267**	.260**	.473**	.272**	.391**	.363**	.235*	.213*	.569**	.171	.498**	.415**	.316**	.374**	.477**	.314**	.489**	.482**	.386**	.287**	1
	Sig. (2-tailed)	.207	<.001	<.001	.004	.005	<.001	.003	<.001	<.001	.011	.022	<.001	.067	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.002	
	N	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Speaker notes

This report explores the relationships between several factors involved in AI-based waste management at Asiri Hospital. Correlation is a statistical measure that shows how two variables are connected, with values ranging from -1 to +1. A positive value means that as one factor improves, the other tends to improve as well, while a negative value indicates an opposite trend. In this study, a moderate positive correlation of about 0.48 was found between AI image detection and the automated waste sorting process, suggesting that better AI detection supports improved sorting. Similarly, Finally, better regulatory compliance was found to have a positive correlation of about 0.42 with increased efficiency, showing that following regulations well contributes to more efficient waste management.

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REGRESSION

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.562[a]	.315	.284	1.201	.315	10.047	5	109	<.001

a. Predictors: (Constant), Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, Better Regulatory Compliance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72.433	5	14.487	10.047	<.001[b]
	Residual	157.167	109	1.442		
	Total	229.600	114			

a. Dependent Variable: AI Image detection

b. Predictors: (Constant), Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, Better Regulatory Compliance

Speaker notes

The model summary shows how well the selected factors explain the outcome in the study. The value "R" is 0.562, which represents the strength of the relationship between the predictors and the result. The "R Square" is 0.315, meaning about 31.5% of the variation in the outcome can be explained by the five factors included in the model: Environmental Sustainability, Automated Waste Sorting Process, Increased Efficiency, Improved Waste Segregation, and Better Regulatory Compliance. by the model, with a smaller value indicating better accuracy. The "Change Statistics" indicate that the change in R Square is 0.315, and this change is statistically significant with an F Change value of 10.047 and a p-value less than 0.001, meaning the model’s ability to explain the outcome is unlikely due to chance.

The ANOVA table helps us understand how well the regression model explains changes in the dependent variable, which in this case is AI Image Detection. The Sum of Squares indicates the total variation in the data, where the Regression Sum of Squares (72.433) shows the variation explained by the model using five predictors, and the Residual Sum of Squares (157.167) represents the unexplained variation or errors.

The coefficients table shows how each predictor variable affects the dependent variable, AI Image Detection, in the regression model. The unstandardized coefficients (B) represent the actual change in AI Image Detection for a one-unit change in each predictor, while holding other variables constant. For example, the coefficient for Increased Efficiency is 0.439, meaning that for each unit increase in efficiency, AI Image Detection is expected to increase by 0.439 units.

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Summary of Hypothesis Testing

Hypothesis	Statement	Result
H1	AI improves waste segregation accuracy	Rejected
H2	AI enhances efficiency in waste management	Accepted
H3	AI leads to better regulatory compliance	Rejected
H4	AI contributes to environmental sustainability	Accepted
H5	AI success depends on hospital staff’s readiness and training	Rejected

The study aimed to test five hypotheses related to the effectiveness of AI image detection in hospital waste management. The results showed that AI significantly improved operational efficiency and supported environmental sustainability, as both H2 and H4 were accepted. These findings highlight AI’s ability to streamline waste handling processes and contribute to greener practices. However, hypotheses H1, H3, and H5 were rejected. This means that AI alone did not significantly enhance waste segregation accuracy, regulatory compliance, or rely heavily on staff readiness and training. These areas may still depend more on human judgment, proper implementation policies, and institutional procedures rather than just technology alone. Overall, the research suggests that while AI has clear benefits, its full impact depends on how well it is integrated with other operational and regulatory systems in the hospital.

Speaker notes

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CONCLUSION

- ❑ The application of AI image detection in hospital waste management presents a transformative opportunity for Asiri Hospital Private Limited to enhance safety, efficiency, and environmental responsibility.
- ❑ The current manual waste segregation process is prone to human error, health risks, and regulatory non-compliance, By implementing AI-powered image recognition, the hospital can automate waste classification, ensuring accurate disposal of hazardous and non-hazardous materials in real-time.
- ❑ This smart system not only improves operational workflows but also supports compliance with Sri Lanka's environmental and health regulations.
- ❑ It reduces costs, lowers infection risks for healthcare workers, and contributes to sustainable waste management practices.
- ❑ Moreover, it empowers hospital administrators with real-time data for monitoring and decision-making.
- ❑ As healthcare demands grow and sustainability becomes a priority, adopting AI-driven solutions positions Asiri Hospital as a leader in smart healthcare innovation in Sri Lanka.
- ❑ With proper planning, training, and continuous system improvement, this technology can set a new benchmark in hospital waste management practices for the entire region.

Speaker notes

This slide explains why AI image detection is important for hospital waste management at Asiri Hospital.

Currently, waste sorting is done manually, which can lead to errors and health risks. AI can automate this process, helping to accurately separate hazardous and non-hazardous waste in real time.

This not only makes the process more efficient and safe but also helps the hospital follow Sri Lankan regulations better. It lowers costs, reduces infection risks, and supports eco-friendly practices.

AI also provides real-time data for better decision-making. With proper staff training and updates, this system can set a new standard in hospital waste management across the region.

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IMPLICATION

1. **Operational Efficiency**

AI-powered waste classification will streamline segregation processes, reduce dependency on manual labor, and minimize human errors. This leads to faster, more accurate disposal, allowing hospital staff to focus more on patient care than on administrative or janitorial tasks.

2. Environmental Impact

Accurate segregation improves recycling rates and reduces the volume of hazardous waste sent to incineration or landfill. This supports Asiri Hospital's commitment to sustainable healthcare and contributes to broader national and global goals for environmental protection and carbon footprint reduction.

3. Regulatory Compliance and Safety

By ensuring that bio hazardous and pharmaceutical waste is properly identified and handled, the hospital can more easily comply with the Central Environmental Authority (CEA) and Ministry of Health regulations. It also enhances occupational safety, reducing risk of infection or injury for healthcare workers.

4. Cost Savings

Improved waste classification can reduce costs associated with incorrect disposal, such as regulatory fines, unnecessary hazardous waste treatment, and third-party contractor overuse. Long-term savings may also come from reduced health and environmental liabilities..

5. Technological Advancement and Innovation

This initiative places Asiri Hospital at the forefront of healthcare innovation in Sri Lanka, opening up further opportunities for digital transformation, such as smart hospital systems, predictive maintenance, and AI-driven diagnostics.

6. Data-Driven Decision Making

The AI system will collect and log waste data in real time, allowing hospital administrators to analyze trends, monitor compliance, and make evidence-based improvements to waste management policies and infrastructure.

7. Organizational Change and Staff Adaptation

Introducing AI will necessitate a cultural shift within the hospital environment. Staff training and mindset changes will be essential to ensure smooth integration and trust in the new system.

Speaker notes

This slide explains the main benefits of using AI in hospital waste management at Asiri Hospital.

AI makes waste sorting quicker and more accurate, allowing staff to focus more on patient care. It also improves recycling and reduces harmful waste, supporting environmental goals.

The system helps follow health and safety rules, keeping staff safe and avoiding fines. It also cuts costs by reducing waste treatment errors and unnecessary contractor use.

This move brings innovation to the hospital and opens the door for more tech improvements. AI will also give useful real-time data to help improve waste policies.

Lastly, staff will need training to adjust, but with the right support, this change will make Asiri Hospital more efficient and modern.

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RECOMMENDATION

- Use of Pre-Trained AI Models with Transfer Learning
- Integration with Smart Waste Bins
- Continuous Training and Model Updates
- The AI model should be continuously trained with updated image datasets to account for new or rare waste types.
- Staff Training and Engagement
- Real-Time Monitoring and Reporting Dashboard
- Collaborate with Health Tech Experts and AI Developers
- Align with Sri Lanka's Health and Environmental Regulations

Speaker notes

In this slide, I'll share a few key recommendations for successfully using AI in hospital waste management.

First, using pre-trained AI models with transfer learning will help speed up development and improve accuracy from the start.

Next, we should connect the system with smart waste bins that can automatically identify and sort waste.

It's important to keep the AI model updated by training it regularly with new waste images, especially for unusual or rare items.

Staff training is also essential, so everyone understands how to use the system and trusts its results.

A real-time dashboard should be added to monitor waste handling and generate useful reports for hospital management.

Working closely with healthcare tech experts and AI developers will ensure the system is reliable and tailored to hospital needs.

Lastly, everything must follow Sri Lanka's health and environmental rules to ensure safety and legal compliance.

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Speaker notes

This slide shares the key references used in my research. Studies by Abdullah & Abdullah and Hussain & Khan showed how AI helps improve hospital waste segregation. Cheng, Li, Jiang, and Yang explained how AI supports environmental health and medical waste handling. Lee & Lee talked about using AI with IoT, which led to the smart bin idea. Singh & Sharma, and Rajendran & Suresh highlighted how AI boosts sorting accuracy. Lastly, the AI for Healthcare site gave useful updates on industry practices. Altogether, these sources gave strong academic and practical support for the project.

Annexures F: Project proposal

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THE RESEARCH PROPOSAL

Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

By

M.M.M AASHIK
E230667

Research Proposal Submitted in accordance with the requirements for the

COMPUTING RESEARCH PROJECT MODULE OF

PEARSON'S HND IN COMPUTING PROGRAMME

at the

ESOFT METRO CAMPUS

Name of research Tutor: Ms.Imalka

ABSTRACT

This research proposal focuses on exploring how artificial intelligence (AI), particularly image detection technology, can be utilized to enhance the waste management system at Asiri Hospital in Kandy. Hospitals generate a wide variety of waste every day, including general waste, infectious materials, sharps, pharmaceuticals, and other hazardous substances. Proper segregation of this waste is critical for ensuring patient and staff safety, minimizing environmental impact, and complying with health regulations. However, manual segregation is often prone to human error, inefficiencies, and inconsistencies.

The core objective of this study is to evaluate the potential of AI-powered image recognition systems to identify and classify different types of medical waste automatically and in real time. By analyzing visual data captured through cameras or sensors placed in waste disposal areas, the system can distinguish between various waste categories such as biohazardous waste, recyclable materials, and general waste based on trained algorithms. This process can significantly improve the accuracy and speed of waste sorting, reduce risks of contamination, and minimize dependency on manual labor.

In addition to investigating the technical performance of such systems, the research will explore the practical challenges involved in implementing AI in a hospital environment. These may include the need for reliable hardware infrastructure, integration with existing hospital waste protocols, staff training, data privacy concerns, and initial investment costs. The study also aims to highlight the broader benefits of intelligent waste management, such as reducing hospital-associated infections, enhancing worker safety, and supporting environmentally sustainable practices.

Moreover, this proposal recognizes the ethical and regulatory considerations surrounding AI use in healthcare settings. It will analyze whether AI systems uphold transparency, accountability, and privacy standards, especially in high-stakes environments like hospitals.

The research intends to provide a well-rounded examination of AI’s role in modernizing hospital waste management. The findings are expected to offer useful insights for healthcare managers, waste management professionals, and policy decision-makers. Ultimately, the study aims to support the adoption of smarter, safer, and more sustainable waste handling practices within the healthcare sector.

SECTION 01 - INTRODUCTION

1.1. Introduction

Hospitals and healthcare centers are very important for keeping people healthy. They help by giving treatments, doing surgeries, and offering care that prevents sickness. But while doing all these good things, hospitals also make a lot of waste. This waste can be dangerous if not managed properly. Things like used syringes, gloves, broken machines, and everyday rubbish must be thrown away in the right way. If hospital waste is not sorted and handled correctly, it can harm people, spread diseases, and damage the environment.

One of the top hospitals in Sri Lanka is Asiri Hospital Private Limited in Kandy. This hospital is well-known for giving good medical care and using modern technology. Just like other hospitals, Asiri produces many types of waste every single day. Some waste is biomedical, like used needles and personal protective equipment (PPE). Some are electronic, like old machines. And there is also general waste, like papers or food wrappers. Right now, most of this waste is sorted by people using their hands. This method is slow, and people can make mistakes. When waste is put in the wrong bin, it can lead to health and safety problems.

This research is about using Artificial Intelligence (AI) to help sort hospital waste in a smarter and faster way. AI is a computer system that can think and learn like a human. One part of AI is image detection. It means using smart cameras to look at something and understand what it is. For example, a camera can see if an item is a used glove or a plastic bottle, and then send it to the correct bin.

By using AI image detection in Asiri Hospital, the sorting of waste can be done automatically. This makes the process faster, safer, and more accurate. It helps to make sure dangerous waste is not mixed with normal waste. It can also help increase recycling and reduce the amount of waste that goes into landfills. This supports the hospital's goal to be more eco-friendly.

But there are also some challenges. Installing AI systems can be expensive. The hospital will need to buy special cameras and computers. Also, the staff will need to learn how to use the system. Another concern is privacy. Since the system uses cameras, it is important to make sure it doesn’t record people or break their privacy.

This research will study how AI can be used in Asiri Hospital's waste system. It will look at the benefits, like better sorting and safety, but also the difficulties, like cost and privacy. The goal is to give advice to hospital managers and government leaders. If the AI system works well, other hospitals in Sri Lanka might also use it.

In the end, this study hopes to help Asiri Hospital become safer, smarter, and more environmentally friendly by using AI for better waste management.

Figure 1 ai to solve waste problem

1.2. Purpose of research

The purpose of this research is to explore and evaluate the application of AI image detection technology for improving hospital waste management practices at Asiri Hospital Private Limited. Hospital waste, especially biomedical and hazardous materials, requires accurate classification and disposal to ensure safety, regulatory compliance, and environmental protection. This research is grounded in the growing need for smarter, more efficient hospital waste management systems in the face of increasing medical waste and tightening environmental regulations. With hospitals like Asiri Hospital generating a significant volume of waste daily, the traditional methods of waste sorting primarily reliant on human labor are becoming increasingly inadequate. These conventional practices often struggle with misclassification, time delays, and exposure risks to frontline workers.

AI-based image detection offers an innovative approach to overcome these limitations. By using intelligent visual recognition systems, hospitals can automate the identification of different waste categories such as sharps, infectious materials, plastics, or recyclables in real time. This not only improves accuracy but also speeds up the entire sorting and disposal process, ensuring that hazardous items are not mistakenly sent to general waste bins.

The research will not only assess the technical efficiency of such AI systems but also delve into the practical implementation aspects, such as infrastructure compatibility, cost considerations, and training needs for hospital staff. Ethical implications, including privacy of visual data and accountability for system errors, will also be addressed.

Ultimately, this investigation aims to demonstrate how adopting AI image detection can transform waste handling into a safer, more sustainable, and regulation-compliant process. The findings are expected to guide both hospital management and policy developers in making informed decisions about deploying AI technologies for healthcare environmental management.

This study aims to investigate how AI-powered image recognition can automate and enhance the waste sorting process, reduce human error, and improve operational efficiency within the hospital's waste management system. By identifying the effectiveness, challenges, and potential benefits of integrating AI into this process, the research provides insights into how technology can support sustainable and safe waste handling practices in a healthcare setting.

1.3. Significance of the Research

This research will provide valuable insights into the potential of AI in transforming hospital waste management. By automating waste sorting, Asiri Hospital can improve efficiency, reduce costs, and minimize environmental impact. The study will also contribute to the broader adoption of AI technologies in the healthcare sector, setting a precedent for sustainable waste management practices.

1. Improved Waste Sorting and Classification

The study will demonstrate how AI-powered image detection systems can significantly enhance the accuracy and efficiency of sorting medical and non-medical waste. This results in better waste classification, reducing the chances of hazardous materials being mixed with regular waste, thus improving safety for both hospital staff and patients.

2. Enhanced Operational Efficiency

By automating the waste sorting process, the AI system can reduce the time spent by hospital staff on manual waste management tasks. The result will be a more streamlined waste management system, which can contribute to better utilization of hospital resources and personnel.

3. Cost Savings for the Hospital

The reduction in manual labor and the improvement in waste sorting accuracy can lead to cost savings for the hospital. With fewer errors in waste handling, the hospital can reduce fines for improper disposal and avoid additional costs for waste treatment and disposal services.

4. Compliance with Environmental Regulations

Hospitals are required to comply with stringent regulations regarding medical waste disposal. This study will show how AI can aid in ensuring that hospital waste management systems are compliant with these regulations, minimizing the risk of legal and environmental violations. This is crucial for maintaining the hospital's reputation and ensuring the safety of surrounding communities.

5. Sustainability and Environmental Impact

Effective waste management has a direct impact on sustainability efforts. By ensuring proper segregation of waste, AI systems help minimize the environmental footprint of the hospital. The study can contribute to the broader goals of sustainability within the healthcare sector by promoting eco-friendly waste disposal practices.

6. Scalability and Adaptability

The results of this study will show how AI image detection can be applied not only in Asiri Hospital but also in other healthcare institutions. The scalable nature of AI systems can make them a viable solution for hospitals of different sizes, enhancing the overall healthcare waste management landscape.

7. Improved Staff and Patient Safety

By preventing hazardous waste from being improperly handled or disposed of, the AI system ensures a safer environment for hospital staff and patients. It also minimizes the risk of exposure to potentially infectious materials, contributing to better overall health and safety protocols.

8. Contribution to AI and Healthcare Research

The study will add to the growing body of knowledge on the application of AI in healthcare, particularly in waste management. It will serve as a case study for future research and development of AI applications in hospital operations and environmental health.

9. Data-Driven Decision Making

The integration of AI in waste management provides the hospital with data-driven insights on waste production, types, and disposal patterns. This allows for better decision-making in terms of resource allocation, waste reduction, and operational improvements.

10. Future Technological Integration

This study will lay the groundwork for further exploration into AI technologies and their potential to revolutionize hospital operations beyond waste management, such as in patient care, administrative functions, and operational logistics.

1.4. Research objectives

The primary objective of this research is to explore the application of AI-powered image detection technology to improve the efficiency and effectiveness of hospital waste management at Asiri Hospital Private Limited.

1.5. Research other objectives

Other Objectives,

1. To evaluate the current hospital waste management practices at Asiri Hospital Private Limited
2. To investigate the potential of AI image detection for automating waste sorting in a hospital environment
3. To assess the benefits of AI implementation in hospital waste management
4. To identify the challenges and barriers to the integration of AI image detection technology into Asiri Hospital's waste management system
5. To evaluate the impact of AI-powered waste management on environmental sustainability and regulatory compliance
6. To propose AI-driven strategies for enhancing sustainability in hospital waste management.

1.6. Research questions

The proposed research aims to explore the potential of AI image detection technology in improving the hospital waste management system at Asiri Hospital Private Limited. The following research questions will guide the investigation into the feasibility, benefits, and challenges of implementing AI-powered waste segregation:

1. What are the current challenges faced by Asiri Hospital in managing and segregating hospital waste?
2. How can AI image detection technology be integrated into the hospital's existing waste management system?
3. What is the accuracy of AI image detection in identifying and categorizing different types of hospital waste compared to manual sorting?
4. What are the potential benefits of using AI image detection for hospital waste management at Asiri Hospital?
5. What are the potential challenges and limitations of implementing AI image detection for waste management in a hospital setting?

1.7. Background of the issue

Waste management in healthcare settings, particularly in hospitals, is an ongoing challenge. Effective waste segregation, disposal, and recycling are essential to minimize the environmental impact of waste, ensure public health safety, and comply with stringent health regulations. Asiri Hospital Private Limited, one of the leading healthcare institutions in Sri Lanka, generates a significant amount of medical and non-medical waste daily. Mismanagement of this waste can result in serious environmental pollution, health hazards, and legal consequences.

The increasing volume of hospital waste has raised concerns about environmental pollution and public health risks. Improper disposal of medical waste can lead to contamination, disease transmission, and legal consequences. Many hospitals, including Asiri Hospital, face challenges in managing waste effectively due to high patients turnover and the complexity of segregating different types of waste. Managing waste in hospital environments is a multifaceted task that demands a structured and reliable system, especially as waste volumes continue to grow with rising patient admissions and increasing use of disposable medical supplies. Traditional waste handling methods depend heavily on human judgment and manual labor, which can lead to errors in classification, increased exposure to biohazards, and non-compliance with waste disposal laws.

In institutions like Asiri Hospital, where both the quantity and variety of waste types are high, there is an urgent need for advanced tools that support timely and accurate sorting. AI-based image recognition technology provides a promising approach to overcome these challenges by automating the detection and categorization of waste materials based on visual features. Through machine learning algorithms trained to recognize different waste types, hospitals can streamline the segregation process and minimize the risk of cross-contamination.

Moreover, automated waste detection systems can operate continuously, requiring less human intervention, which helps in maintaining hygiene standards and reducing the burden on staff. This also contributes to environmental sustainability by ensuring that recyclable and hazardous waste are not improperly mixed or discarded. In the long term, integrating AI into hospital waste management could lead to cost savings, better regulatory compliance, and improved safety for healthcare workers and patients alike.

This research highlights the potential of AI in addressing persistent inefficiencies in waste management at Asiri Hospital, with the broader aim of promoting a more intelligent, safe, and environmentally responsible healthcare system.

AI-driven image detection offers a potential solution by automating waste classification and enabling precise sorting, thereby improving efficiency and sustainability in hospital waste management

1.8. Background of the Sri Lankan Healthcare industry

The healthcare industry in Sri Lanka plays a vital role in providing accessible and cost-effective medical services to its population. The government has historically prioritized public healthcare, investing in infrastructure, human resources, and public health initiatives to improve national health outcomes (Govindaraj, 2014). Sri Lanka’s healthcare system operates through a dual structure comprising public and private healthcare providers. The public sector manages a vast network of hospitals, clinics, and primary care facilities that offer free or subsidized services, while the private sector represented by hospitals like Asiri Hospital caters to patients seeking specialized care and advanced medical technologies (Govindaraj, 2014).

Asiri Hospital in Kandy is part of this expanding private healthcare network, delivering high-quality medical care and embracing technological innovation. One such innovation gaining traction is the implementation of AI-powered image detection systems, particularly in operational areas like hospital waste management. With growing concerns about biomedical waste handling, environmental safety, and regulatory compliance, hospitals are exploring artificial intelligence as a tool for optimizing waste segregation and minimizing human error.

Sri Lanka's health sector has already begun integrating digital health tools such as electronic medical records, telemedicine, and data analytics. Building on this foundation, AI image detection offers a new frontier in automating routine but critical tasks such as identifying and classifying various waste types ranging from general to hazardous medical waste. The use of AI in hospitals like Asiri Kandy aligns with the broader national goal of leveraging technology to enhance healthcare service delivery, promote sustainability, and protect both patients and healthcare workers from waste-related risks.

This shift toward AI-driven operational efficiency reflects Sri Lanka's commitment to innovative healthcare solutions, reinforcing core values such as universal access, quality care, and responsible environmental management.

1.9. Research Location

The research will be conducted at Asiri Hospital, located in the scenic city of Kandy in central Sri Lanka. Asiri Hospital Kandy is part of the renowned Asiri Health group, which is recognized for its commitment to delivering high-quality, patient-centered medical care across the country. Known for its state-of-the-art infrastructure, advanced diagnostic and surgical capabilities, and highly skilled medical professionals, Asiri Hospital stands out as a leading private healthcare provider in the region.

The hospital offers a full range of healthcare services, including primary, secondary, and tertiary care, supported by modern medical equipment and digital healthcare systems. In line with its vision for continuous improvement and technological advancement, Asiri Hospital Kandy has shown a growing interest in adopting AI-based technologies to enhance operational efficiency and clinical safety.

This makes it a highly relevant and suitable setting for this research, which explores the application of AI image detection in hospital waste management. The hospital's active pursuit of innovation and quality improvement aligns well with the study's objective of assessing how artificial intelligence can support accurate waste categorization, improve regulatory compliance, and promote environmental sustainability in the healthcare sector. The research at Asiri Hospital will contribute valuable insights into how private healthcare institutions in Sri Lanka can effectively integrate AI to solve complex operational challenges.

1.10. Problem Identification

Waste management in healthcare settings is an inherently complex and critical issue, particularly in large hospitals like Asiri Hospital Private Limited, where diverse types of waste are generated daily. The challenge lies not only in managing the vast volume of waste but also in ensuring that each type is correctly identified, segregated, and disposed of according to health and environmental standards. In high-capacity healthcare environments, waste streams can include everything from general refuse to infectious materials, pharmaceuticals, chemicals, and electronic components. Each of these categories requires specialized handling procedures to avoid cross-contamination, environmental degradation, and public health risks. In the case of Asiri Hospital, the reliance on manual waste segregation processes not only places a significant burden on staff but also increases the likelihood of human error, resulting in potentially hazardous consequences.

Given the scale and complexity of hospital operations, traditional waste management systems struggle to meet evolving demands for safety, sustainability, and compliance. The absence of intelligent systems to support waste classification and disposal results in delays, inefficiencies, and missed opportunities for recycling or safe hazardous waste handling. Moreover, staff exposed to improperly sorted medical waste face elevated occupational health risks, including infection and injury.

Integrating artificial intelligence particularly image detection and real-time monitoring into the hospital’s waste management practices offers a viable solution. AI systems can be trained to recognize different waste types based on visual patterns and automate the sorting process, significantly reducing the burden on human operators. This would not only help reduce errors and costs but also enhance regulatory compliance and reduce the hospital's environmental footprint.

Through this research, a deeper understanding of how AI-driven technologies can modernize and optimize waste management at Asiri Hospital will be established. It will provide a foundation for implementing safer, more efficient, and environmentally responsible practices in Sri Lanka's healthcare sector.

The manual sorting of hospital waste at Asiri Hospital is inefficient, leading to misclassification, increased costs, and non-compliance with environmental regulations. Inadequate waste management contributes to pollution and poses risks to hospital staff, patients, and the community. The lack of advanced technological intervention in waste management highlights the need for AI-based automation to address these challenges.

SECTION 2 – LITERATURE REVIEW

2.1. Literature Review

Artificial intelligence (AI) has attracted attention because it has the potential to completely transform the way waste is disposed of, recycled, and classified. The developments, uses, challenges, and limitations of AI-based waste management are examined in this literature review, with a focus on the implications for medical institutions such as Asiri Hospital

2.1.0. AI Image Detection in Hospital Waste Management at Asiri Hospital Kandy

The integration of AI image detection in hospital waste management is emerging as a transformative approach, particularly relevant for healthcare facilities like Asiri Hospital Kandy. This technology employs computer vision and machine learning algorithms to automatically identify and classify various types of medical waste, enhancing the efficiency and safety of waste segregation processes (Imagga, 2024).

AI-powered systems can process vast amounts of visual data in real-time, surpassing human capabilities in speed and accuracy. By analyzing images captured from waste disposal areas, these systems can differentiate between hazardous, recyclable, and general waste, ensuring proper categorization and disposal (API4AI, 2024). This automation reduces the risk of human error, minimizes exposure to hazardous materials, and ensures compliance with health and environmental regulations.

Implementing AI image detection at Asiri Hospital Kandy can lead to significant operational benefits. For instance, smart waste bins equipped with AI technologies can automatically sort waste, reducing the time staff spend on waste management and allowing them to focus more on patient care (MedicalExpo, 2024). Furthermore, these systems can provide real-time data analytics, offering insights into waste generation patterns and enabling more informed decision-making regarding waste reduction strategies (Restackio, 2025).

However, the deployment of AI image detection systems must be approached with consideration for data privacy and ethical concerns. Ensuring that the AI systems do not inadvertently capture sensitive information and that data is handled in compliance with privacy regulations is paramount. Additionally, staff training and change management are crucial to ensure the successful adoption of AI-based waste systems (Labellerr, 2023).

AI image detection presents a viable and forward-thinking approach to hospital waste management at Asiri Hospital Kandy. By automating waste segregation, enhancing compliance, and providing actionable insights, this technology can significantly improve operational efficiency and environmental sustainability. However, its success depends on strategic implementation, robust data governance, and continuous stakeholder engagement.

2.1.1. Artificial intelligence

Artificial intelligence is a rapidly advancing technology that is gaining popularity in various industries, particularly waste management (Abdullah etal. 2020). The incorporation of artificial intelligence and robotics in the design and operation of urban waste treatment plants can revolutionize how solid waste is managed, leading to increased operational efficiency and more sustainable waste management practices (Goutam Mukherjee etal. 2021; Yigitcanlar and Cugurullo 2020). Artificial intelligence technologies, particularly for sorting and treating solid waste, are increasingly critical in waste management (Andeobu etal. 2022; Wilts etal. 2021). Therefore, artificial intelligence is critical in developing sustainable waste management models, particularly for transitioning to a “zero waste circular economy” while considering social, economic, and environmental factors (Osman etal. 2022). Waste management should be considered when examining the problems facing different geo-graphic areas and economic sectors, including smart cities. Artificial intelligence (AI) is increasingly acknowledged as a transformative force in waste management, with numerous studies highlighting its role in advancing sustainability goals. A 2024 MDPI review emphasizes that AI methods like machine learning and deep learning are essential to implementing circular economy strategies, mapping waste flows, and optimizing resource use at local, regional, and national scales

In urban settings, AI-driven innovations such as intelligent bins, robotic sorting lines, and predictive waste monitoring systems are rapidly gaining traction. Empirical research demonstrates that neural network image classifiers can accurately sort waste materials with over 90% accuracy, significantly reducing human error and streamlining recycling workflows . These technologies not only improve operational efficiency, but also support broader social and environmental objectives by minimizing landfill contributions and promoting resource recovery.

Moreover, a Reuters commentary highlights how AI is already directing robotic waste sorting in recycling centers and powering digital platforms like Plastic Bank. These systems incentivize recycling and enhance supply chain efficiency key drivers in transitioning toward a low-waste circular economy

Case studies exploring AI integration into urban infrastructure showcase the combination of AI and IoT for real-time waste stream analysis, dynamic route optimization, and automated material classification all contributing to smarter, cleaner cities

For instance, researchers have proposed various models for sustainable waste management, such as a model for meg-acities that considers waste treatment, recycling, and reuse options (Liamputtong 2009).

2.1.2. Artificial intelligence in waste management

The utilization of artificial intelligence has the potential to bring about a revolution in municipal waste management by enhancing the effectiveness of waste collection, processing, and classification. Artificial intelligence-based technologies like intelligent garbage bins, classification robots, predictive models, and wireless detection enable the monitoring of waste bins, predict waste collection, and optimize the performance of waste processing facilities. The details are by leveraging artificial intelligence, municipalities bin reduce costs, improve safety, and reduce environmental impacts associated with waste management. Smart bin systems Conventional garbage bins solely collect waste, and sanitation workers must carry out manual inspections to assess the trash level in the bins.

This approach is not efficient for routine waste disposal inspections. Moreover, due to the frequent filling of the containers, disease-causing organisms and insects tend to breed on them (Noiki etal. 2021). There-fore, designing intelligent garbage bin monitoring systems to manage garbage is essential in constructing smart cities. Numerous research studies on intelligent garbage bins have focused on two key functions: automatic waste classification and monitoring. These studies offer a potential solution for cities to achieve an effective garbage collection system. An intelligent garbage bin can be created by utilizing a system on a chip produced by the Expressive systems (ESP 8266) module, automatically detecting objects and setting thresholds within the bin. The information gathered can then be transmitted to another node for further analysis and processing (Praveen etal. 2020b). For example, Praveen etal. (2020a) designed a garbage bin with two main pin the trigger pin connected to the sensor and the echo pin. An ultrasonic sensor is placed at the top and bottom of the cover.

Rajathi G etal. (2020) designed a robot garbage bin with two sensors installed at the bottom, which moves along a straight line. An obstacle sensor is embedded on one side of it, which can sense black and emit a buzzer sound to indicate that the garbage has stopped storing for some time. In addition, an ultrasonic sensor can be placed at the bin's edge to detect the waste level (Mbom etal. 2022). The status of the container will be updated on the web page via the wireless fidelity module, showing whether it is full or empty. Some researchers design bins that separate and monitor garbage using Arduino and wireless fidelity (Samann 2017). It has an automatic metal and non-metal separator.

Using NodeMCU, the bin's water level can be monitored in real time and sent to the cloud for further analysis and processing (Saranya etal. 2020). In summary, the research on smart garbage bins mainly focuses on automatically monitoring the garbage filling level and notifying users in time. The information is primarily received by sensors and transmitted through the network. Intelligent bin systems can potentially increase the efficiency of garbage collection, reduce the spread of diseases, and enhance the city's overall environment. However, the cost of implementing smart garbage bins is relatively high, making it challenging to promote them widely. To address this issue, the government could consider funding policies to reduce the cost of smart garbage bins, making them more accessible to the general public. Furthermore, the regular operation of these bins can be affected by environmental factors such as temperature and humidity. Thus, dedicated personnel must regularly check and maintain the garbage bins. Therefore, it is crucial to focus on developing and promoting smart garbage bins in the future.

Waste-sorting robots Garbage classification is strongly recommended for municipal solid waste management, and using robots can substantially enhance the efficiency of garbage classification. However, robots require advanced visual and operational skills to function in highly heterogeneous, complex, and unpredictable industrial environments for garbage classification (Koskinopoulou etal. 2021). Recent research has focused on improving the accuracy and efficiency of garbage classification robots, which requires the development of better sensors and cameras to identify different types of waste, as well as improved artificial intelligence algorithms for classifying waste. Utilizing hyperspectral images to locate the target region of interest is a promising approach (Xiao etal. 2020).

2.1.3. AI Applications in Waste Management

- **Smart Sorting Systems**

  AI-powered sorting systems, utilizing computer vision and machine learning, can identify and separate recyclable, non-recyclable, and hazardous materials with high precision. For instance, systems like Zen Robotics and AMP Robotics use sensors and AI algorithms to sort waste more efficiently than manual processes. (al, 2020)

- **Hazardous Waste Management**
  In healthcare, where proper disposal of hazardous medical waste is critical, AI can detect and handle infectious or dangerous materials using sensors and automated systems. AI also ensures compliance with environmental and safety regulations. (Gupta & Sharma, 2021)

- **Predictive Analytics**
  AI-driven analytics tools can forecast waste generation trends, enabling better planning and resource allocation. For hospitals, this can optimize waste collection schedules and reduce costs. (al., 2019)
- **IoT Integration**
  Internet of Things (IoT) devices, combined with AI, can monitor waste bins in real-time, ensuring timely collection and reducing overflow issues. (al., 2022)

2.1.4. How AI is being used in waste management by business

Facility managers may benefit from new AI-powered technologies that can efficiently detect and control the sources of site waste. Both of these solutions operate at a high level, assisting managers in making more sensible decisions, and they operate immediately in the production line, assisting floor employees in locating and eliminating waste. Machine Vision for Automated Waste Recognition and Sorting.

A London-based AI business called Grey parrot has developed one unique approach that combines robotics and AI advances. The business creates a machine vision tool that can recognize and classify various waste materials, including "glass, paper, cardboard, newspapers, cans, and different types of plastics." Workers can be given information from the sorting algorithm to help them more successfully separate waste goods into distinct trash streams that can be recycled more readily. The company's trash identification API may also be used in conjunction with a robot arm or other device to sort waste autonomously with little to no human intervention required. This technology paired with facility robots might considerably speed up garbage management while also making the process cheaper for organizations who now recycle but spend a large amount of time, labor, and money sorting rubbish for recycling. A comparable technology is provided by a startup called Winnow Vision and is intended for use in industrial kitchens and food processing plants. Their machine vision technology monitors and quantifies food waste by putting a cash value on all the materials and food that a company sends to the garbage before utilizing it all.

Reducing Waste by Improving Product Quality Products of poor quality can contribute significantly to waste. Low-quality materials and manufacturing flaws can produce faulty goods that companies have spent money on yet are unable to sell. Recycling and other initiatives can help recover some of the resources used in a product, but it is always more cost-effective to stop waste before it starts. Pattern recognition models and machine vision are used in AI quality control systems to identify faulty items earlier in the production process. These control systems can enhance waste-reduction production processes, such as the Lean manufacturing methodology, when paired with other Industry 4.0 technologies (such IoT devices).

Top-Down AI Approaches to Facility Waste Instead of being integrated directly into the manufacturing process like a machine vision waste detection system, an increasing number of companies now provide AI technologies that assist in top-down analysis of business processes. One of these firms is WINT Water Intelligence, which creates a water management system using AI. Leaks are one of the main causes of water waste, and a WINT AI solution helps combat them.

Because facility plumbing is sometimes intricate and difficult to monitor, tiny leaks may go unnoticed for extended periods of time, resulting in severe water wastage. AI pattern-matching makes it feasible to more efficiently track and find water leaks as they happen. Businesses might use the technology to drastically cut water waste without having to make big modifications to facility operations. Waste management is often a challenge for industrial facilities, but new AI tools can help reduce the labor necessary to minimize waste. Waste recognition and sorting systems, AI for quality control and facility monitoring technology may all help to reduce waste in a facility.

2.1.4.0. AI and Image Detection in Waste Segregation

AI image detection refers to the use of computer vision and deep learning algorithms to identify, classify, and interpret visual data. This technology is increasingly being utilized to automate the process of waste segregation, particularly in environments like hospitals, where accuracy and safety are paramount.

2.1.4.1. AI-Powered Image Recognition Systems

AI image recognition systems use machine learning and deep learning to help computers understand pictures. In hospitals, this technology can be trained to look at waste and decide what type it is, like general waste, recyclable items, or dangerous medical waste. These systems usually use special models called Convolutional Neural Networks (CNNs) that are really good at recognizing things in photos.

For example, if a hospital throws away used gloves, bandages, or syringes, the AI system can look at them through a camera and put them in the right bin. This is very helpful because sometimes people make mistakes when sorting waste, and that can cause health problems or pollution.

A study by Jain et al. (2020) showed that AI can be very accurate in sorting hospital waste. Their system used thousands of pictures of different types of medical and non-medical waste to train the AI. The results showed that it could correctly identify more than 90% of the waste types Thung, G. and Yang, M., 2017. Classification of trash for recyclability status. *Stanford CS229 Project*.. That means the system can really help reduce errors, save time, and keep hospitals cleaner and safer.

In simple words, AI can be a smart helper in hospitals to sort waste the right way. But hospitals need to make sure the system is trained well and used correctly to get good results.

2.1.5. Advantages of AI-Based Waste Segregation

- **Efficiency and Accuracy**

AI reduces human error and increases efficiency in waste sorting and recycling processes. By automating the classification of different types of waste, such as hazardous materials, recyclable materials, and medical waste, artificial intelligence (AI) technology can improve waste management at Asiri Hospital. It simplifies material storage and ensures efficient waste management by reducing human error, speeding up the process, and gradually increasing accuracy.

- **Cost-Effectiveness**

Automated systems cut labor costs and optimize resource use. By decreasing manual labour, boosting productivity, and improving waste disposal, Asiri Hospital can save money by implementing AI to automate waste sorting and management. More sustainable waste management techniques and financial savings result from this.

- **Time and Labor Efficiency**

AI-powered waste segregation reduces the manual labor required to identify and sort waste. This allows healthcare staff to focus on more critical tasks while ensuring that waste is disposed of in the correct manner.

- **Environmental Impact**

By optimizing waste management, AI can reduce the hospital's environmental footprint, making processes more sustainable. AI aids in reducing landfill dependency and improving recycling rates, contributing to sustainability goals.

- **Safety Improvements**

AI systems can minimize human exposure to hazardous materials, enhancing the safety of hospital staff.

- **Data-Driven Decisions**

By gathering information on waste types and disposal techniques, identifying areas for waste reduction strategy improvement, monitoring regulatory compliance, and enabling proactive changes to waste management policies for more efficient and sustainable practices, artificial intelligence (AI) can assist Asiri Hospital in analysing waste patterns.

- **Resource Optimization**

AI can predict the appropriate amount of resources required, optimise resource utilisation in waste management, increase cost-efficiency, guarantee timely waste processing, and uphold regulatory compliance.

- **Improved Compliance**

With regulatory frameworks often governing hospital waste disposal, AI systems can help ensure that waste is disposed of according to legal standards, reducing the risk of non-compliance. Hospitals must follow strict rules when handling medical waste to avoid health risks and legal issues. AI image detection systems can help make sure waste is sorted and disposed of correctly, following these rules. These systems can identify different types of waste like infectious or recyclable items, reducing the chances of mistakes. By improving accuracy, AI helps hospitals avoid breaking regulations, which could lead to fines or safety problems. It also supports better tracking and reporting of waste. In this way, AI helps maintain legal compliance and improves overall safety in hospital waste management.

- **Increased Accuracy**

Traditional methods of waste segregation rely on human judgment, which can lead to errors, especially in high-pressure hospital environments. AI systems, In hospitals, waste sorting is usually done by staff who must quickly decide which bin to use. This process depends on human judgment, and in busy or stressful situations, mistakes can happen. For example, hazardous items may be placed in the wrong bin, leading to health and safety risks. However, with the use of AI image detection systems, this problem can be reduced. Once the system is trained with enough examples of different waste types, it can identify and sort them automatically with much higher accuracy than manual methods. This means less chance of human error and better control over how waste is handled. At hospitals like Asiri Hospital in Kandy, using AI for waste segregation can lead to safer, cleaner, and more efficient operations. By correctly identifying items like used gloves, needles, or recyclable plastics, AI ensures that each waste type goes to the right place, supporting safety and compliance goals. once trained, can sort waste with much higher accuracy.

- **Reduction in Hazardous Waste Exposure**

In hospitals, handling waste incorrectly can be dangerous. If harmful or infectious materials are not separated properly, they can cause injuries or spread diseases to staff, patients, or the environment. AI image detection systems help solve this problem by automating the sorting process. Instead of depending only on people, the AI system can quickly and accurately identify different types of waste and sort them into the correct bins. This reduces the need for staff to touch or handle dangerous materials. At Asiri Hospital in Kandy, using AI in this way helps create a safer working environment by lowering the risk of exposure to harmful waste and improving overall hygiene standards.

2.1.6. AI-Based Waste Segregation in Healthcare

Several studies and pilot projects in hospitals have demonstrated the potential of AI and image detection for waste segregation.

European Hospitals (Nassif et al., 2020) A study by Nassif et al. (2020) explored the deployment of an AI-powered image recognition system in hospitals across Europe. In the study, hospitals utilized cameras and sensors installed in waste disposal areas to capture images of waste being disposed of. These images were then analyzed by AI models to classify the waste into categories like recyclable, infectious, and general waste. The system achieved an accuracy rate of 92% in sorting waste correctly. The researchers concluded that AI-powered waste management systems could significantly improve efficiency and accuracy in hospital waste segregation.

Asian Healthcare Facilities (Kiran et al., 2021) In a study conducted in Asia, hospitals implemented AI and IoT-based waste management systems. The waste bins in the healthcare facilities were equipped with cameras and sensors capable of detecting the type of waste being disposed of. The AI system identified hazardous medical waste, sharps, and general waste, categorizing them accordingly. The system also monitored the fullness of the bins and provided real-time feedback to hospital staff. The study highlighted that AI systems not only improved waste sorting accuracy but also contributed to better environmental sustainability by optimizing waste recycling processes.

U.S. Healthcare Settings (Bhagat et al., 2022) In the United States, hospitals have adopted AI systems for waste segregation as part of broader environmental sustainability efforts. Bhagat et al. (2022) found that AI-driven waste management systems were successful in identifying hazardous medical waste and preventing contamination. These systems used deep learning-based image recognition to sort medical waste, including needles, syringes, and contaminated materials. The study demonstrated that AI-based segregation systems reduced human errors and minimized the risk of improper disposal of dangerous materials.

2.1.7. Challenges and Limitations of AI-Based Waste Segregation in Healthcare

While AI-based waste segregation shows considerable promise, there are several challenges and limitations that must be addressed to ensure successful implementation in healthcare settings.

- **Data Quality and Dataset Availability**

AI systems rely on large datasets for accurate predictions and classifications, which may not always be available.AI systems require large, high-quality datasets to effectively train image recognition models. However, obtaining comprehensive and diverse datasets of hospital waste can be challenging, particularly given the wide variety of waste materials found in hospitals. Jain et al. (2020) noted that the success of AI models depends on the availability of well-labeled datasets that cover all waste types encountered in healthcare facilities. Hospitals may need to invest in curating these datasets to improve the accuracy of AI systems.

- **Integration with Existing Hospital Systems**

The integration of AI waste segregation systems with existing hospital infrastructure can be complex and costly. Many hospitals lack the necessary hardware, such as high-definition cameras or IoT-enabled sensors, to support AI systems effectively. Additionally, the AI systems must be integrated with the hospital's waste management protocols to ensure seamless operation. Sarkar et al. (2019) highlighted the technical challenges associated with integrating AI into existing healthcare systems, suggesting that hospitals should plan for substantial infrastructure upgrades to support AI implementation.

- **Real-Time Processing and Speed**

Hospitals require fast and efficient waste segregation to prevent overcrowding and contamination. While AI image detection systems are capable of classifying waste accurately, there may be delays in processing images, especially when dealing with large volumes of waste. Ensuring real-time processing with minimal latency is a key challenge for implementing AI solutions in healthcare waste management.

- **High Initial Costs**

The upfront investment required to implement AI image detection systems in hospitals can be significant. Costs include hardware (e.g., cameras, sensors), software, system integration, and staff training. One of the biggest challenges in using **AI image detection systems** for hospital waste management is the high cost at the beginning. To set up the system, hospitals need to buy special equipment like cameras and sensors, install software, and connect everything with existing systems. On top of that, staff need to be trained to use and maintain the new technology. At a hospital like **Asiri Hospital in Kandy**, this kind of setup can be expensive. While AI systems can help save money in the long run by making waste management faster and more accurate, the initial spending can be a big problem especially for hospitals with limited budgets. This financial barrier may slow down or limit the use of AI in some healthcare settings. While these systems are expected to reduce long-term operational costs by improving waste management efficiency, the initial investment may be a barrier for some healthcare facilities.

- **Technical Limitations**

Errors in waste classification and system malfunctions can occur, Even though AI image detection systems are smart, they are not perfect. In real hospital settings like Asiri Hospital in Kandy, waste can often be mixed or messy, making it harder for the system to correctly identify each item. Sometimes, the AI might misclassify waste or fail to detect certain materials, especially when items are damaged, dirty, or overlapping. Also, like any digital system, technical problems or software bugs can cause the system to stop working or give wrong results. These errors can lead to improper waste handling, which may create safety risks. So, while AI helps a lot, it still needs careful monitoring and regular updates to work properly in challenging hospital environments.especially when dealing with mixed or unstructured waste

- **Large Volume of Waste**

Asiri Hospital in Kandy handles a large number of patients every day, which leads to the production of a high volume of waste. This includes general waste, medical waste, and electronic waste. Managing this amount of waste has become a serious challenge for the hospital. In particular, medical waste is often hazardous and needs to be handled with special care to avoid risks to staff, patients, and the environment. Proper disposal of this type of waste requires advanced methods, trained staff, and reliable equipment. On top of that, the hospital must also follow strict health and safety regulations, which makes the task even more complicated. These rules are necessary to protect public health but they add pressure on hospital operations. Altogether, these factors make waste management at Asiri Hospital difficult and highlight the need for more efficient, automated solutions like AI-based systems.

- **Rising Costs**

Inefficient waste management at Asiri Hospital is leading to increased costs in several areas. This includes increased labor costs for waste management, waste of valuable resources such as recyclable materials, and higher landfill fees for mixed waste. By streamlining the process, increasing sorting accuracy, and reducing unnecessary resource use, AI-based waste management systems can help hospitals save a lot of money. The implementation of AI systems can be expensive, particularly for specialized sectors like healthcare.

2.1.7. Future Directions and Research Areas

The application of AI in waste segregation is still in its early stages, and further research is needed to enhance the scalability and effectiveness of AI-powered waste management systems. Some promising areas of future research include

- Improving Model Accuracy and Robustness

  Research is needed to improve the robustness of AI models, especially in dealing with ambiguous or mixed types of waste. Deep learning models could be further optimized to handle more complex waste categories or materials that are difficult to distinguish visually.

- Real-Time Monitoring and Feedback Systems

  Developing AI systems that provide real-time feedback to hospital staff regarding waste segregation could help improve compliance and operational efficiency. Future research could explore the integration of AI with IoT-based waste bins that not only detect waste types but also monitor bin fullness and waste collection schedules.

- Ethical and Privacy Considerations

  AI systems implemented in hospitals, such as the AI image detection system at Asiri Hospital Kandy, must adhere to strict standards concerning data privacy and security. Although this technology is used for waste segregation, it such as HIPAA in the U.S. or GDPR in Europe.

Conclusion

The literature review offers valuable insights into the application of AI image detection technology in hospital waste management, with a specific focus on its potential deployment at Asiri Hospital Kandy. The integration of AI into waste segregation processes emerges as a transformative innovation that can significantly enhance the efficiency, safety, and environmental sustainability of healthcare operations. Advanced image recognition systems, supported by machine learning algorithms, are capable of accurately identifying and classifying diverse types of medical waste in real time, which is essential for ensuring proper disposal and reducing risks associated with hazardous materials.

While these developments represent a major step forward in hospital waste management, the literature also highlights important challenges particularly those relating to data privacy, system accuracy, and operational integration. In the context of AI systems that may involve surveillance or image capture, it is essential to safeguard staff privacy and ensure that no personally identifiable information is inadvertently collected or misused. Moreover, the successful implementation of AI-driven waste detection systems requires secure and robust infrastructure, comprehensive staff training, and ongoing system maintenance to guarantee reliability and efficiency in a high-stakes healthcare environment.

The reviewed studies emphasize the need for high-quality training data and well-calibrated models to avoid misclassification of waste, which could lead to compliance violations or health hazards. Additionally, the lack of AI literacy among healthcare personnel and limited infrastructure in some regional hospitals may pose barriers to adoption, requiring strategic planning and phased implementation. At Asiri Hospital Kandy, these challenges can be addressed through targeted investments in technology, interdisciplinary collaboration, and policy development tailored to Sri Lanka’s healthcare context.

In conclusion, while the use of AI image detection in hospital waste management is still emerging, the literature clearly identifies its potential to transform existing practices by reducing human error, enhancing regulatory compliance, and contributing to a safer and more environmentally responsible healthcare system. However, these advantages can only be fully realized when accompanied by strong ethical guidelines, privacy safeguards, and continuous stakeholder engagement. As such, Asiri Hospital Kandy stands to benefit significantly from adopting AI-based waste management systems, provided that implementation is thoughtful, inclusive, and grounded in both technological and organizational readiness.

2.2. Conceptual framework

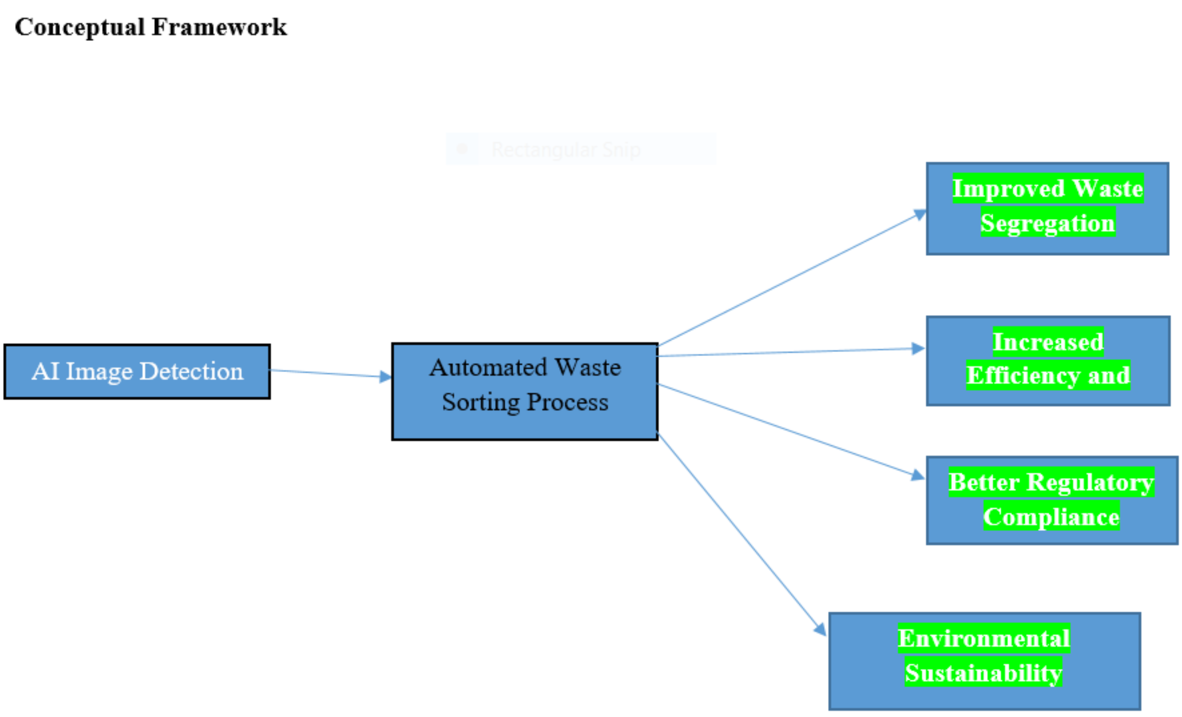

Figure 2 conceptual framework

2.3 Hypothesis

1. **H1:** AI-powered image detection improves the accuracy of hospital waste segregation.
2. **H2:** AI-powered image detection enhances the efficiency of the hospital waste management process.
3. **H3:** AI implementation in waste management leads to better regulatory compliance.
4. **H4:** AI-based waste detection contributes to improved environmental sustainability.
5. **H5:** The successful integration of AI in hospital waste management depends on hospital staff's readiness and training.

(H0) There is no significant relationship between AI-powered image detection and hospital waste segregation.

(H1) There is a significant relationship between AI-powered image detection and hospital waste segregation.

(H0) There is no significant positive relationship between AI-powered image detection and efficiency of the hospital waste management process.

(H1) There is a significant positive relationship between AI-powered image detection and efficiency of the hospital waste management process.

(H0) There is no significant positive relationship between AI implementation in waste management and better regulatory compliance.

(H1) There is a significant positive relationship between AI implementation in waste management and better regulatory compliance.

(H0) There is no significant positive relationship between AI-based waste detection and environmental sustainability.

(H1) There is a significant positive relationship between AI-based waste detection and environmental sustainability.

SECTION 3 – METHODOLOGY

3.0. Research Onion

Saunders' research onion outlines the various decisions you'll encounter when formulating a research methodology – this could be for your dissertation, thesis, or any other structured research project. As you navigate from the outer layers to the inner core of the onion, you'll be faced with a spectrum of choices that evolve from abstract and philosophical to strategic and pragmatic in nature. (Warren, 2021)

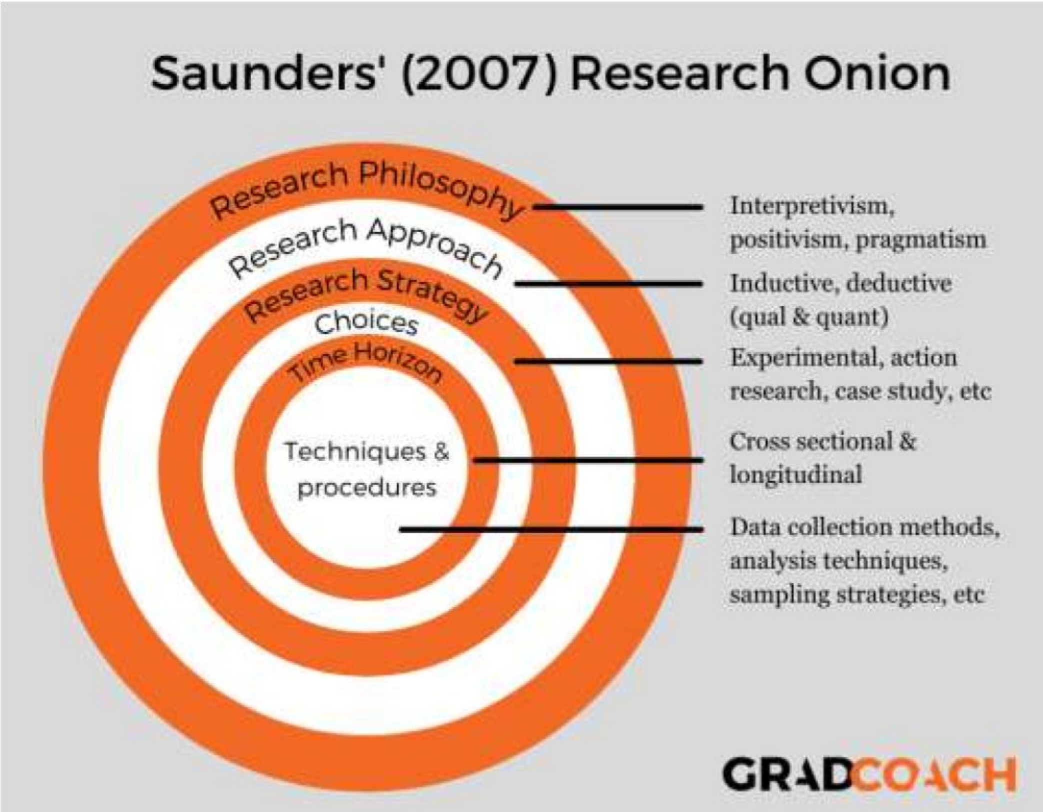

Figure 3 Research onion

3.1. Research philosophy

This is the foundation of any study as it describes the set of beliefs the research is built upon. It can be described from either an ontological or epistemological point of view. Three main research philosophies are Positivism, Interpretivism, and Pragmatism (Warren, 2021).

- **Positivism,** This philosophy takes the stance that knowledge exists outside of the subject being studied and can only be understood objectively, without the influence of personal opinions or viewpoints. It relies on empirical research based on measurement and observation.

- **Interpretivism,** This approach emphasizes the influence of social and cultural factors on individuals. It focuses on understanding people's thoughts and ideas within their socio-cultural context, requiring the researcher to play an active role in the study.

- **Pragmatism,** Pragmatism is about using the best tools possible to investigate phenomena, where knowledge is not fixed but constantly questioned and interpreted. It involves an element of researcher involvement and subjectivity, especially when drawing conclusions based on participants' responses and decisions.

Selected research philosophy

Positivism is a research philosophy based on the idea that knowledge is derived from observable and measurable facts. It emphasizes objective reality, quantifiable data, and scientific methods. When applying positivism to the use of AI image detection in hospital waste management, such as in Asiri Hospital Private Limited, the focus would be on empirically measuring the efficiency, accuracy, and outcomes of the AI system. Positivism research philosophy is an appropriate choice in this context since it is based on phenomena observed and analyzed objectively, which is in line with the quantitative nature of the study. Academics who adhere to positivism insist on applying the systematic and fair methods of data collection and analysis to identify generalizable patterns and associations within the scope of the research. AI image detection systems can be objectively tested and measured by quantifying parameters such as:

- Detection accuracy of waste types (e.g., bio hazardous vs. general waste)
- Reduction in misclassification of waste
- Efficiency improvements (e.g., faster segregation, reduced human error)

A positivist study may pose hypotheses such as:

- "AI image detection reduces hospital waste sorting errors by 30%."
- "The use of AI leads to faster response times in handling hazardous waste."

Positivism leads to using the quantitative methods like surveys, experiments and statistical analysis, which are good at analyzing the connections between variables and hypothesis testing. Data collected from AI system outputs, hospital records, waste management logs, and efficiency metrics would be analyzed statistically. Surveys or observation records could support comparisons of pre- and post-AI implementation performance.

Research would follow a structured methodology, possibly using experiments or quasi-experiments, with controlled variables to determine the effect of the AI system.

Reasons for not selecting other philosophies

I do not consider that the Interpretivism and pragmatism research philosophies are relevant for that study as they focus on subjective interpretation and mixed methods approaches; and those might not match the applicability and goals of the study.

1. Interpretivism

Interpretivism, on the other hand, gives priority to getting a feel for what social phenomena mean from the position of those who are actually experiencing it, applying such qualitative methods as interviews, participant-observation, and text-analysis.

Reason for Rejection: Interpretivism focuses on understanding human experiences, perceptions, and social constructs through qualitative methods.

Why Not Suitable: AI image detection is a technical application that relies on objective data (image inputs, machine learning models, and accuracy rates), not subjective human interpretation. Interpretivism lacks the empirical basis needed for such analysis.

2. Constructivism

Reason for Rejection: Constructivism emphasizes how knowledge is constructed through social and cultural experiences.

Why Not Suitable: The project centers on the development and application of an AI system to detect hospital waste, requiring measurable performance metrics, not knowledge construction through social contexts.

3. Critical Theory

Reason for Rejection: Critical theory aims to critique and change society, often with a focus on power structures, inequality, or social justice.

Why Not Suitable: While hospital waste management has ethical and environmental implications, the project's main goal is efficiency and accuracy in detection not a socio-political critique or reform.

4. Pragmatism

Reason for Rejection (if not selected): Pragmatism values practical outcomes and combining different methods.

Why Not Chosen: Although suitable in some tech-based research, a more structured, data-driven paradigm (like positivism) may offer clearer frameworks for testing, accuracy evaluation, and reproducibility of AI algorithms, which are crucial in healthcare applications.

3.2. Research approach

A research approach refers to the systematic and structured way that researchers use to conduct research. It is based on the nature of the research problem being addressed and it differs in terms of their underlying logic and methods of inquiry (Hassan, 2024). The three main types of research approaches are:

- Deductive Approach: This approach starts with a theory or a hypothesis, and the researcher tests the hypothesis through the collection and analysis of data. The goal of this approach is to confirm or reject the hypothesis.
- Inductive Approach: This approach starts with the collection and analysis of data. The researcher develops a theory or an explanation based on the patterns and themes that emerge from the data. The goal of this approach is to generate a new theory or to refine an existing one.
- Abductive Approach: This approach is a combination of deductive and inductive approaches. It starts with a problem or a phenomenon that is not fully understood, and the researcher develops a theory or an explanation that can account for the data. The researcher then tests the theory through the collection and analysis of more data. The goal of this approach is to generate a plausible explanation or theory that can be further refined or tested

Selected Approach

As this research involves testing hypotheses derived from current theories, it is suitable for the deductive approach to be used, just as well it aligns with the structured and hypothesis driven character of the study. The deductive process always begins with a theory or a hypothesis, and then the researcher uses appropriate research methods to support the reliability of the hypotheses by empirical evidence. A deductive approach is a wise choice as it provides a basis to develop specific hypotheses from existing theoretical and empirical findings and then verify these assumptions with concrete numbers.

A deductive approach begins with general theories or principles and narrows down to specific observations or applications. In the case of Asiri Hospital, the deductive method involves applying established AI theories and image recognition principles to solve the specific problem of waste management in a healthcare setting.

The deductive approach to applying AI image detection for hospital waste management at Asiri Hospital Private Limited begins with the general principle that artificial intelligence, particularly computer vision and deep learning, is capable of accurately identifying and classifying objects based on visual data. From this theoretical foundation, the hospital deduces that these technologies can be effectively applied to solve the specific problem of improper waste segregation, which poses risks to safety, hygiene, and regulatory compliance. By employing pre trained AI models such as convolutional neural networks (CNNs) and object detection frameworks like YOLO, the system is designed to recognize various categories of hospital waste such as infectious, pharmaceutical, recyclable, and sharps in real time. This application assumes that integrating such models into the hospital's waste disposal process will reduce human error, enhance operational efficiency, and ensure safer handling of hazardous materials. The system is implemented through smart cameras installed at disposal points, and its effectiveness is evaluated through measurable outcomes such as reduced misclassification incidents, improved compliance rates, and more efficient waste management workflows. Thus, the deductive approach enables Asiri Hospital to translate broad AI capabilities into a targeted, evidence-based solution tailored to its specific operational needs.

The deductive method of research offers a structured approach for testing hypotheses and analyzing relationships between variables. In the context of this study, which explores the application of AI image detection in hospital waste management at Asiri Hospital Kandy, the goal is to examine how independent variables such as the use of AI technology affect dependent variables like waste segregation accuracy, operational efficiency, environmental compliance, and staff safety. Since the research adopts a quantitative approach, the deductive method is particularly suitable. It enables the use of statistical analysis to evaluate correlations and draw general conclusions that can be applied to broader healthcare settings. This method provides a clear framework for collecting and interpreting data to confirm or refute the proposed hypotheses related to AI implementation in waste management systems.

Deductive method contributes to the validity of research through its transparent and reproducible procedures, which include clear and explicit disclosures of the theoretical rationale and the underlying hypotheses. Through the rigorous application of deductive methods, they can hold their results firm on the solid ground of the sound theory and they can be easily generalized to larger whole under study. This is especially useful for healthcare research, so implications for practice and policy can be much more substantial. a study will thus start from the point of general theories or hypothesis that would be empirically tested using the data that is quantitative leading to the generation of results that are reliable and valid, which in return will contribute to the individuals' understanding on this particular issue.

Reasons for not selecting other approaches

Asiri Hospital Private Limited did not select other approaches such as the inductive, abductive, and heuristic methods due to their inherent limitations in meeting the precision and reliability required in medical waste management. The inductive approach, which depends on observations to form general rules, requires extensive data collection and may lead to inconsistent results during the early phases of implementation posing safety risks in a hospital setting. The abductive approach, based on inferring the most likely explanation from incomplete data, can lead to assumptions that are not always accurate or verifiable, which is unacceptable when dealing with hazardous and infectious waste. Meanwhile, heuristic or rule-based systems lack the flexibility and adaptability of AI learning models, and may fail when encountering new or unstructured waste types. Given the hospital's need for a systematic, scalable, and error-minimizing solution, these approaches were considered unsuitable compared to the more structured and theory-driven deductive approach, which provides a reliable framework grounded in proven AI technologies.

Other approaches to applying AI image detection for hospital waste management such as inductive, Abductive, or heuristic methods were not selected by Asiri Hospital Private Limited due to specific limitations in reliability, scalability, and precision required in a high-risk healthcare environment. The inductive approach, which relies on drawing general conclusions from specific observations, was deemed less suitable because it requires extensive trial-and-error and data accumulation before forming accurate models posing a risk of inaccuracies during the early stages of implementation.

Similarly, the Abductive approach, which involves forming the most likely explanation from incomplete data, lacks the certainty and structured logic necessary for a critical process like hazardous waste classification, where errors can lead to severe health and legal consequences. Heuristic or rule-based systems, while simpler to implement, do not offer the adaptability and learning capability of deep learning models and may struggle with the visual variability of waste in real-world hospital settings. Therefore, these alternative methods were set aside in favor of the deductive approach, which allows Asiri Hospital to apply well-established AI theories to design a robust, predictive, and systematic solution tailored to its operational and regulatory requirements.

Deduction and abduction are very useful approaches in many research fields, but they are not applicable to the focal problem. Inductive method is based on the process of generating hypotheses that are deductive from existing theories.

Abductive kind of reasoning is trying to explain the given observations by creating the hypotheses. Abductive reasoning is open-ended, and allows for more creativity and flexibility as compared to the empirical based research. However, this method may not be applicable to this research due to the need of proving empirical evidences and hypothesis testing. The very complex and diverse factors of privacy in healthcare need more organized systems to be used for data collection and analysis, which maybe will not be sufficiently handled by abductive reasoning alone.

3.3. Research strategy

Research strategies are the expansive plans or strategies that analysts use to lead their concentrate effectively. The methods and procedures used to collect, examine, and analyze data in order to answer research questions or achieve research objectives are outlined in these approaches. Different exploration methodologies can be utilized, contingent upon the idea of the review and the examination's goals. Here are some common strategies for research

- **Experiment**

To lay out circumstances and logical results connects, an examination includes changing factors and assessing their outcomes in a controlled climate.

- **Survey**

broad example of individuals is reviewed to study their perspectives, assessments, ways of behaving, or different attributes.

- **Interview/Center Gathering**

Top to bottom bits of knowledge, perspectives, or encounters on a specific issue are gotten through meetings or center gatherings, which utilize direct correspondence with members either exclusively or in a social environment.

- **Observation**

The systematic study of individuals, groups, or occurrences in their natural environments to comprehend their actions, interactions, or occurrences without directly intervening is referred to as observation.

- Contextual investigation

Contextual investigation is a careful examination of a specific individual, gathering, association, or occasion fully intent on offering an exhaustive knowledge and top to bottom examination of the subject.

Selected research strategy

A survey research strategy is highly appropriate for this study on the use of AI-powered image detection in hospital waste management at Asiri Hospital Kandy. This strategy allows for the systematic collection of data from key stakeholders, such as doctors, nurses, waste handling staff, administrative personnel, and technical support teams. The aim is to gather clear insights into the current waste management practices, identify challenges, and evaluate attitudes toward the integration of AI technologies.

The survey will use both structured questionnaires and targeted interviews to collect quantitative and qualitative data. It will examine aspects such as user awareness, acceptance of automated waste segregation, system usability, and perceived benefits of AI-based waste identification. These inputs will help assess the readiness of the hospital environment and its workforce to adopt AI solutions effectively.

One key strength of this method is its ability to gather a wide range of feedback efficiently and cost-effectively from a diverse group of respondents. The nature of the research requires input from multiple departments, and surveys make it possible to reach all relevant stakeholders regardless of their role or availability.

Moreover, surveys ensure consistency and reliability in data collection by using standardized questions, minimizing bias and allowing for accurate comparisons across groups. This is critical in a healthcare setting, where informed and evidence-based decisions are essential for maintaining safety and compliance with waste regulations.

Another advantage is the non-intrusive nature of surveys. Respondents can complete them anonymously and at their convenience, which encourages honest responses especially when addressing operational challenges or system limitations. This ensures that valuable insights can be obtained without disrupting hospital workflows or compromising privacy.

In conclusion, the survey research strategy offers a practical, reliable, and inclusive approach to evaluating the implementation of AI image detection in hospital waste management at Asiri Hospital Kandy. It supports informed decision-making and helps tailor the AI system to meet both institutional goals and staff needs.

Reasons for not selecting other Strategy

The research strategies of experiment, interview, and observation were not selected for the application of AI image detection in hospital waste management at Asiri Hospital Private Limited due to practical and methodological limitations. The experimental strategy, which involves controlled testing of variables, was deemed unsuitable as the hospital environment is dynamic and does not allow for strict control over conditions without disrupting essential medical operations. Moreover, implementing controlled experiments in real-time waste handling could pose safety and ethical concerns.

The interview method, while useful for gaining in-depth insights, was not selected as the primary strategy because it limits the ability to gather large-scale, quantifiable data needed to assess user readiness, system acceptance, and operational impact across different departments. Relying solely on interviews could also introduce personal bias and subjectivity. The observation strategy, though valuable for understanding behavior and workflows, was not chosen as it is time-consuming, may intrude on sensitive medical areas, and does not provide the structured, scalable data required for evaluating a technological solution like AI. Therefore, to ensure a broader, more efficient, and data-driven understanding of stakeholder perspectives and system impact, strategies like survey and case study were prioritized.

Even the three research methods (Experiment, Interview, and Observation) may not paint the picture of a curved diversity among the stakeholders. Because of the multifaceted characteristic of the research subject, requiring the input of different actors, a survey research method is more implementable and pragmatic for collecting quantitative data on a large scale, while confidentiality and response bias are also secured. However, the applied experiments, interviews and the observation research strategies can find out the truth in some research areas. A survey research strategy is a more aligned and conducive tool in terms of gathering quantitative data from different stakeholders who are equally important and ensure ethical standards are met.

3.4. Research Choice

A research study's approach or design is referred to as the research choice.

Types of research Choice

- Mono research is a method of research in which a single method of research is used throughout the entire study. It centers on utilizing one explicit technique, like overviews, trials, or meetings, to gather information and answer research questions. A focused and consistent method for data collection and analysis is provided by this strategy.
- Mixed research joins both subjective and quantitative examination techniques in a solitary report. It includes gathering and examining both mathematical and non-mathematical information to acquire an extensive comprehension of the exploration point. This approach permits specialists to catch a great many points of view, investigate complex peculiarities, and give a more all-encompassing perspective on the exploration subject.
- Multi research includes utilizing various exploration techniques, either inside a solitary examination stage or across various stages, to examine an exploration subject. This approach gives adaptability in information assortment and examination by using different strategies, like studies, meetings, perceptions, or record investigation. It improves the research's overall reliability and validity by allowing for triangulation and validation of findings.

Selected research Choice

The mono-quantitative research approach was adopted for the application of AI image detection in hospital waste management at Asiri Hospital Private Limited to focus on collecting and analyzing numerical data that measures the effectiveness, efficiency, and user response to the AI system. This approach relies on structured data collection methods such as surveys with closed-ended questions, system performance metrics, error rate analysis, and usage statistics. By employing quantitative tools, the research aims to evaluate key indicators such as the accuracy of waste classification, reduction in misclassification incidents, staff compliance rates, and the time saved through automation.

The mono-quantitative method is particularly suitable in this context because it provides objective, measurable insights that can guide evidence-based decision-making and system refinement. Additionally, it allows for easy comparison of results before and after implementation, enabling the hospital to assess the direct impact of the AI solution on waste management operations. This focused, data-driven approach ensures clarity, consistency, and statistical validity in evaluating the success of the technology in a complex healthcare setting.

Reason for not selecting other research choices

The mixed research and multi-research methodologies were not selected for the application of AI image detection in hospital waste management at Asiri Hospital Private Limited due to their complexity and the specific focus required for evaluating the AI system's performance. The mixed research methodology, which combines both qualitative and quantitative data, was deemed unnecessary because the study's primary goal was to obtain clear, numerical data on the effectiveness of the AI system, such as classification accuracy, operational efficiency, and compliance rates.

Integrating qualitative insights would have added layers of complexity without significantly enhancing the understanding of the system's technical performance, which is the key area of interest. Additionally, multi-research methodologies, involving multiple research strategies or paradigms, were considered overly broad and resource-intensive for this particular application. This approach would have required more time, effort, and coordination across various methods, which could lead to logistical challenges and complications in data analysis. Instead, a mono-quantitative research approach was selected because it offered a streamlined, focused, and measurable way to evaluate the AI system's impact on waste management, allowing for clear conclusions based on objective, data-driven results. The mixed research and multi-research methodologies might not be appropriate for the study.

3.5. Time Horizon

The time horizon in research refers to the timeframe relevant to the study. It is the period in which the researcher is interested in studying the population. The researcher determines the time horizon depending on the research objectives and the type of investigation. (Alamgeer, 2023)

There are two types of research based on the time horizon

- Cross-Sectional Research: This type of research involves studying samples at a certain point in time. The researcher collects data from samples only once, interested in studying the characteristics of the population at a certain point in time. There is no repetition of gathering data from samples in cross-sectional research. For instance, a researcher might be interested in studying the financial performance of airline companies in a specific year.
- Longitudinal Research: In contrast, longitudinal research involves studying samples over a period of time. The researcher gathers data from samples at different intervals. The purpose of a longitudinal study is to examine changes in attitude, behavior, process, or

phenomenon over a period of time. The scope and time horizon of longitudinal research are not restricted to a certain point. For example, a researcher might be interested in studying the impact of a new teaching method on student performance over several years.

Selected Time horizon

Time Horizon of the Study

A cross-sectional time horizon is suitable for this study on the application of AI image detection in hospital waste management at Asiri Hospital Kandy. This method allows data to be collected at a single point in time, making it possible to assess the current status of AI implementation, waste handling practices, and operational efficiency within the hospital.

Given the evolving nature of healthcare technology and environmental regulations, a cross-sectional approach helps capture a real-time snapshot of how AI is being used to support proper waste classification and disposal. It also allows for the identification of existing gaps, challenges, and success factors in AI adoption within hospital operations.

This approach makes it possible to gather input from various stakeholders such as hospital administrators, waste management staff, IT specialists, and environmental health officers all at once. Collecting data across these groups helps build a broad understanding of the effectiveness, acceptance, and challenges of AI-powered waste solutions, improving the relevance and generalizability of the findings.

Though cross-sectional studies do not track changes over time or establish causality, they are effective for establishing baseline insights. These insights can inform future improvements, guide policy development, and help other hospitals adopt similar AI tools. The method also supports identifying factors such as operational bottlenecks, training needs, or system limitations, enabling evidence-based recommendations.

In summary, the cross-sectional time horizon offers a practical and efficient way to explore how AI image detection is currently impacting waste management at Asiri Hospital, helping drive innovation while maintaining safety and compliance.

Reason for not selecting other time horizons

A longitudinal time span may not be appropriate for the research. Other time horizons, such as longitudinal and retrospective, were not selected for the application of AI image detection in hospital waste management at Asiri Hospital Private Limited due to their complexity, resource requirements, and the specific goals of the research. A longitudinal time horizon, which tracks data over an extended period, was considered unnecessary for the initial evaluation of the AI system, as it would require more time, resources, and continuous data collection that could delay actionable insights.

Moreover, it would not have been practical for assessing the immediate and direct impact of the AI system, which was the main focus of the research. A retrospective time horizon, which analyzes past data to understand trends or patterns, was also unsuitable because it would not provide real-time insights into how the AI system functions within the current waste management processes at the hospital. The cross-sectional time horizon was chosen because it allows for a timely and focused assessment of the AI system's performance at a specific point in time, offering immediate feedback and helping identify areas for improvement in the short term, without the need for long-term data tracking.

A longitudinal study takes a comprehensive approach which involves considerable resources, time, and coordination to gather and process data across multiple time bouts. As a matter of fact, the complexity and scope of the subject of the research may go astray data collection, ends, and use the monitoring. So, this may be a great challenge logistically.

A longitudinal study may not be suitable for providing timely insights for decision-makers in the evolving landscape of hospital waste management using AI image detection. In a fast-paced technological environment, particularly in healthcare settings like Asiri Hospital in Kandy, delays in research outcomes could hinder the timely implementation of innovative waste management solutions. Since long-term studies require extended periods to yield results, there is a risk that by the time findings are available, the technology or regulatory framework may have already evolved, rendering the insights less practical or outdated. Although longitudinal research offers valuable benefits in tracking changes and trends over time, its limitations in delivering prompt data make it less ideal for exploring the immediate applicability and effectiveness of AI-based waste detection systems. Therefore, in the context of this study, a more time-efficient approach is necessary to inform rapid development and integration of AI solutions in waste management at Asiri Hospital.

3.6. Techniques and Procedures

1. Descriptive Analysis

Descriptive analysis is a study that refers to the summarization and displaying the features of variables. The descriptive analysis of the application of AI image detection for hospital waste management at Asiri Hospital Private Limited focuses on providing a detailed overview of the system's implementation, functionality, and impact. The AI image detection system is designed to automatically identify and classify various types of hospital waste, including sharps, infectious materials, pharmaceuticals, and general waste, using advanced computer vision techniques.

The system employs convolutional neural networks (CNNs) and object detection algorithms like YOLO to process images captured by strategically placed cameras at waste disposal points. The analysis highlights how the AI system helps staff segregate waste more accurately and efficiently, reducing human error and minimizing the risk of cross-contamination. Additionally, the system provides real-time feedback, alerting staff when waste is incorrectly disposed of, ensuring better compliance with safety and regulatory standards.

The descriptive analysis also examines the operational integration of the system within the hospital's existing waste management processes, the initial training and adaptation period for staff, and the system's overall contribution to improving waste management efficiency, reducing hospital waste volume, and ensuring adherence to environmental sustainability goals.

2. Questionnaire Surveys

Those questionnaire surveys widely employed to gather the quantitative date from a huge sample of the respondents have become a hand. The questionnaire surveys for the application of AI image detection in hospital waste management at Asiri Hospital Private Limited aim to gather structured feedback from key stakeholders, including hospital staff, waste management personnel, and administrative teams.

The surveys are designed to assess the effectiveness, usability, and impact of the AI system on daily waste handling processes. Key areas of focus include the accuracy of waste classification, user satisfaction, perceived ease of use, and the system's influence on reducing waste mismanagement incidents. The questionnaire includes both Likert-scale questions to quantify responses on a scale (e.g., from "strongly agree" to "strongly disagree") and open-ended questions to capture detailed feedback on potential challenges, suggestions for improvement, and insights on the system’s integration into existing workflows.

By gathering this feedback, the survey provides valuable insights into how well the AI system is being received by staff, the system's alignment with hospital waste management goals, and any barriers or areas for improvement in its implementation. The findings from the survey will help refine the AI system, ensuring it meets both operational and regulatory requirements while fostering greater staff compliance and engagement.

In this research we may use to administer questionnaire surveys to healthcare professionals, patients, policymakers, and other audience groups to obtain data about their attitudes, perceptions, and experiences.

3. Descriptive Statistics

The use of descriptive statistics in the application of AI image detection for hospital waste management at Asiri Hospital Private Limited plays a critical role in summarizing and interpreting the quantitative data collected during the system’s implementation. These statistics help provide a clear overview of the AI system's performance by presenting data such as the number of waste items correctly classified, percentage of classification accuracy, frequency of misclassification incidents, and staff compliance rates.

Measures such as mean, median, mode, percentages, and standard deviation are used to analyze key variables, offering insights into the central tendencies and variability of the system’s outcomes. For instance, the average time taken to classify waste before and after AI implementation can be compared to assess efficiency improvements. Similarly, the percentage of staff who found the system user-friendly can indicate user acceptance levels. By converting raw data into meaningful metrics, descriptive statistics allow stakeholders to easily understand the impact of AI on waste segregation processes and support evidence-based decisions for further optimization and scaling of the system within the hospital.

4. Inferential Analysis

The inferential analysis in the application of AI image detection for hospital waste management at Asiri Hospital Private Limited is used to draw conclusions and make predictions about the broader impact of the system based on sample data collected during its implementation. By applying statistical techniques such as hypothesis testing, confidence intervals, and correlation analysis, the study evaluates whether observed improvements such as increased waste classification accuracy, reduced disposal errors, or higher staff compliance are statistically significant and not due to random chance.

For example, inferential analysis may be used to determine whether the AI system significantly reduces the rate of hazardous waste misclassification compared to traditional manual sorting methods. It can also explore the relationship between user training levels and system usage efficiency, or the correlation between staff feedback scores and actual system performance metrics. This analysis supports generalizing findings from a sample group of hospital staff to the larger hospital population, enabling data-driven decisions about future investments, staff training programs, or broader deployment of the AI system across other departments or facilities. Ultimately, inferential analysis provides the evidence needed to validate the AI system's effectiveness and justify its continued use and potential expansion.

Techniques like hypothesis testing, analysis of variance (ANOVA) and chi square tests are some of the useful statistical methods that can be utilized to evaluate the significance of findings from the study and to reach conclusions to test the aim of the study.

5. Correlation and Regression Analyses

The correlation and regression analyses applied in the study of AI image detection for hospital waste management at Asiri Hospital Private Limited are essential for understanding the relationships between key variables and predicting outcomes based on those relationships. Correlation analysis is used to examine the strength and direction of associations between variables such as staff training levels and waste classification accuracy, or system usage frequency and reduction in misclassification rates.

A positive correlation, for instance, may indicate that better-trained staff are more likely to use the AI system effectively, leading to improved waste segregation. Meanwhile, regression analysis allows the study to predict dependent outcomes such as classification accuracy or time saved in waste sorting based on independent variables like user experience, system usage hours, or department workload.

By constructing regression models, researchers can quantify the extent to which various factors influence the success of the AI system and identify which variables have the greatest impact. These analyses provide deeper insights beyond basic descriptive statistics, supporting strategic decision-making and helping Asiri Hospital optimize system deployment, training efforts, and resource allocation to maximize the benefits of AI-assisted waste management.

Correlation and regression analyses are essential for examining the linear relationship between variables and predicting the value of one variable based on another. In this study, such analytical techniques can be used to assess the strength, direction, and nature of the relationship between the implementation of AI image detection systems and various factors related to hospital waste management. These factors may include operational efficiency, accuracy in waste categorization, staff responsiveness, and environmental compliance. By applying correlation analysis, the study can determine how closely the adoption of AI correlates with improvements in waste handling practices, while regression analysis can help predict the potential outcomes of broader AI integration at Asiri Hospital in Kandy.

3.7. Data analysis

Data analysis is a vital process that involves examining, modifying, and presenting data to extract meaningful information and reach important conclusions. It is typically categorized into two main types: descriptive analysis and inferential analysis. Descriptive analysis aims to present and summarize the main features of a dataset using statistical measures such as mean, median, mode, and standard deviation, as well as visual aids like histograms or bar charts. It focuses on describing the data without making any assumptions or predictions about a larger population. (Rawat, 2021)

On the other hand, inferential analysis extends beyond the data collected and attempts to infer or test hypotheses about a larger population based on a sample (Hassan, 2024). It employs statistical methods to estimate or infer characteristics of the population. Inferential analysis includes two subcategories: correlation and regression. Correlation analysis is a statistical method used to determine the relationship between two variables, which is assessed by the correlation coefficient. Regression analysis, on the other hand, aims to model the relationship between a dependent variable and one or more independent variables. It helps predict or estimate the value of the dependent variable based on the values of the independent variables, making it useful for forecasting and trend analysis as it demonstrates how the independent variables impact the dependent variable

3.7.1. Type of Data

- Primary Data: Surveys, interviews, and direct observations of waste sorting processes, Smart Cameras in Waste Bins, Hospital Staff Observations, Waste Management Staff Reports , Staff Questionnaires and Interviews with Waste Management Team
- Secondary Data: Hospital waste reports, AI implementation case studies, and regulatory guidelines , Previous compliance reports, Previous studies on AI in waste management

3.8. Variable Analysis

Independent Variable

AI-powered Image Detection

AI-powered image detection serves as the independent variable, meaning it is the primary factor that influences the outcomes of hospital waste management. The AI system processes images of waste and classifies them into different categories, impacting overall waste segregation efficiency, compliance, and environmental safety.

AI-powered image detection refers to the use of artificial intelligence (AI) algorithms, such as machine learning models, to identify, classify, and sort various types of hospital waste based on images captured through cameras or sensors installed in waste disposal areas. This technology relies on deep learning models, trained on large datasets of labeled images, to recognize waste items and differentiate between hazardous and non-hazardous waste.

The independent variable, AI-powered image detection, is the primary factor being manipulated in this study to assess its impact on hospital waste management. The efficiency and accuracy of the AI model in identifying waste directly influence the outcomes related to waste sorting, cost savings, regulatory compliance, and environmental sustainability.

Dependent Variables

1. **Waste Sorting Accuracy**

The accuracy with which the AI system correctly identifies and classifies different types of hospital waste, including medical and non-medical waste, hazardous and non-hazardous waste. Accuracy can be measured by the percentage of correctly classified waste items compared to the total waste sorted by the AI system.

The better the AI image detection model performs, the higher the waste sorting accuracy will be. Efficient AI systems can reduce human error and misclassification, leading to improved accuracy in waste management.

2. **Cost Efficiency**

The reduction in costs associated with waste management due to the automation provided by the AI system. This includes savings from fewer personnel required for manual sorting, reduced waste treatment costs, and avoidance of fines for improper waste disposal. This can be measured by comparing the operational costs before and after implementing the AI-powered system. Cost reductions are measured in terms of labor costs, waste disposal costs, and fines for non-compliance.

A well-performing AI system can reduce the need for manual labor and improve the accuracy of waste disposal, leading to overall cost savings for the hospital.

3. **Compliance**

The extent to which the hospital's waste management system adheres to environmental and regulatory standards set by health authorities and environmental agencies. Compliance can be assessed by reviewing the number of violations or non-compliance incidents before and after implementing the AI system. This may include audits or inspections.

AI systems help ensure that waste is properly classified and disposed of according to regulations, reducing the risk of non-compliance. Improved waste classification accuracy can directly lead to better regulatory adherence.

4. **Sustainability**

The impact of the AI system on improving the environmental sustainability of the hospital's waste management practices. This includes reducing the hospital's environmental footprint by promoting proper waste segregation, recycling, and minimizing hazardous waste mishandling.

Sustainability can be measured by tracking the volume of waste diverted from landfills (recycled), the reduction in hazardous waste mishandling, and the overall carbon footprint associated with waste disposal. The application of AI for better waste classification supports more effective recycling and proper disposal, which contributes to the hospital's sustainability goals and reduces its environmental impact.

Impact of AI Image Detection on Dependent Variables

Dependent Variable	Effect of AI Image Detection	Example in Asiri Hospital
Waste Segregation Efficiency	AI ensures correct disposal of biomedical, general, and recyclable waste.	The system identifies a plastic syringe in the general waste bin and alerts staff.
AI Detection Accuracy	More training data improves AI's ability to classify waste correctly.	AI correctly classifies 95% of waste images collected from different hospital departments.
Error Rate	Reduces the risk of misclassification of hospital waste.	AI mistakenly classifies a used mask as recyclable, prompting a need for retraining.
Compliance with Regulations	AI detects non-compliant waste disposal and provides real-time alerts.	AI flags improper disposal of hazardous waste in a general waste bin and informs hospital management.
Operational Costs	AI minimizes labor-intensive waste segregation, reducing costs.	The hospital reduces the need for manual sorting staff, saving resource

Table 1 - Impact of AI Image Detection on Dependent Variables

3.9. Data Collection Method

The primary data collection method for the application of AI image detection in hospital waste management at Asiri Hospital Private Limited is the use of structured questionnaire surveys. This method was chosen to gather quantifiable, consistent, and large-scale feedback from key stakeholders, including medical staff, waste management personnel, and administrative staff. The questionnaires are designed with closed-ended questions using Likert scales and multiple-choice formats to assess variables such as user satisfaction, system usability, accuracy of waste classification, and impact on workflow efficiency.

This method supports the research's mono-quantitative approach by enabling statistical analysis and comparison across different departments and user groups. Additionally, the structured format ensures that data collection is efficient and minimally disruptive to hospital operations. It also allows for easy aggregation and interpretation of results, helping researchers draw meaningful conclusions about the system's performance and acceptance. The chosen method aligns with the overall research objective of evaluating the operational effectiveness of the AI system through measurable, objective feedback from those directly interacting with the technology.

The data collection tool of Questioners will be used, which is a well-known, easy, and very effective survey method of gathering information from a big variety of respondents. The survey should be expected to collect the quantitative information of healthcare professionals who work at Asiri hospital in Kandy, Sri Lanka and who are going in charge of Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited. For the survey, we will use the Likert scale which is a popular scale used in the studies for measuring the level of agreement or disagreement of the participants concerning their research goals. The Likert scale has a variety of response choices namely, "Strongly Agree", "Agree", "Neutral", "Disagree" and "Strongly Disagree". The respondents should choose the response that closely matches their opinions on different elements of the use of Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited

A questionnaire is going to be designed very carefully to make absolutely sure that it is easy to understand, relevant, and comprehensive. It will consist of elements that are carefully nurtured to meet the research goals and sub-goals. The survey may also collect demographic questions to get the information on the participants' roles, how many years of experience they have, and their department affiliation.

This information help contextualize for data analysis and interpretation. With online survey format and the Likert scale rating system, the study intends to get needed data in a timely and convenient fashion, commonly with only a limited number of questions, and receive rich quantitative data needed for analysis. This way of analysis will bolster analytical work and make closer to each effect of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

Justification for not selecting other data collection methods

Other data collection methods such as focus groups, direct observation, and document analysis were not selected for the study on the application of AI image detection for hospital waste management at Asiri Hospital Private Limited due to their limitations in effectively supporting the research objectives. Focus groups, while useful for gathering diverse opinions, were avoided due to the potential for biased discussions, dominance of certain participants, and difficulty in quantifying results, which is essential in this study’s quantitative-focused approach. Direct observation, though valuable for capturing real-time behavior, was considered impractical in a hospital setting where waste handling involves health and safety risks, and continuous observation could disrupt clinical workflows. Additionally, observation lacks the depth of structured feedback necessary to assess user satisfaction and system usability. Document analysis, such as reviewing existing hospital waste records or policy documents, was not prioritized as it does not provide real-time or user-specific insights related to the AI system's performance. Instead, questionnaire surveys were selected as the primary data collection method because they allow for standardized, scalable, and quantifiable feedback across a broad sample of staff, aligning well with the research's mono-quantitative design and the need for data-driven evaluation.

The method of data collection that was considered for the research on the influence Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited within the Sri Lankan health sector was not selected without paying attention to different aspects including the nature of the research objectives, the characteristics of the study population as well as the ethical issues involved. There are alternative data collection techniques, however, several reasons justify underlying the use of a survey technique via Google Forms as the most suitable method to conduct the research.

Qualitative data collection methods like interviews or focus groups were not a suitable choice for these research due to the large and consist of a lot of the members' data information. The high degree of intricacy and diversity of the topic to be investigated enables a survey method to gather information quickly from a wide range of individuals at the Asiri Hospital in Kandy, Sri Lanka. This approach in the research will result in capturing different angles and views that will provide the researcher with a broad and profound understanding of the topic under investigation. In this regard, information-collection strategies that can be quantified like the observational studies or experimental models were rejected due to practical factors and ethical considerations. The observational studies demand allocation of a huge resource consisting of time and workforce to observe and record data in real time condition, which may not be possible because of the nature of the healthcare setting.

3.9.1. Data Collection and Analyze Tools

Application of AI image detection in hospital waste management at Asiri Hospital Private Limited, Google Forms was used as the primary platform for administering the structured questionnaire. This digital tool was selected for its ease of use, accessibility, and ability to efficiently collect and organize responses from a large number of participants across different hospital departments. Google Forms enabled the researchers to create a clean, user-friendly interface with various question types such as Likert scales, multiple-choice, and short-answer fields, aligning perfectly with the study’s mono-quantitative research design. It also facilitated quick distribution via email and internal communication channels, minimizing disruption to hospital workflows.

Real-time data collection and automatic response aggregation helped streamline the analysis process, allowing researchers to download data in formats compatible with statistical tools like Excel or SPSS. Moreover, the anonymity feature of Google Forms encouraged honest and unbiased feedback from participants, enhancing the reliability of the results. Overall, the use of Google Forms supported efficient, secure, and scalable data collection for evaluating the effectiveness and user acceptance of the AI waste detection system.

Google Forms can easily bring about the required data by using the Likert scale question, where participants are required to rank their response in a Likert scale or numeric scale form. To begin with, Google Forms, which is equipped with a user-friendly and intuitive interface, allows to create and disseminate surveys to a broad audience, including the hospital staff (medical professionals), patients, administrators and policy-makers in Asiri Hospital in Sri Lanka Using online survey tools allows researchers to make their surveys available across different devices and operating systems which helps participants respond to the survey at their own convenience (consequently participants will be able to increase the response rates which leads to a better representativeness of sampled population).

Not only does Google forms present an array of customization features whereby researchers can craft questions with Likert scale options such as agree, agree fairly, disagree and strongly disagree, but the forms also come with predefined emerging categories, classifications and structured choices for the analysts to choose. This flexibility enables researchers to capture detailed feedback along with the attitudes, perceptions, and preferences of hospital staff and stakeholders regarding the use of AI-based image detection in waste management systems. Additionally, tools like Google Forms offer built-in features for real-time visualization and analysis of survey data, simplifying the interpretation of responses and helping to identify key trends and patterns across different respondent groups. In summary, Google Forms serves as a versatile and efficient platform for collecting quantitative data, especially through Likert scale surveys, allowing researchers to understand how AI technologies are currently perceived and applied in the waste handling processes at Asiri Hospital Kandy.

3.10. Sampling framework

3.10.1 Population

We have decided to use the population of 120 individuals from the research place which is the Sri Lankan health care industry and in this case of study they are the Asiri Hospitals located at Kandy. On this side, these groups include medical professionals, patients, administrators, and policymakers, who all play an important role in Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private. Rather than the general people, selecting individuals from the research subject will result in the population which is specifically representative of the given context of the study. Thus, the study findings will be more relevant, authentic, and applicable to Sri Lankan health care industry. For one, the sampling population is made up of individuals who are diverse and representative of different standpoints, extent of experiences, and roles in healthcare. The population heterogeneity will result in research outcomes rich and inclusive, as showed by the varied points of view and concerns related to Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

3.10.2. Sample Size

The research samples of 132 persons selected from Asiri Hospital in Kandy, Sri Lanka, is collected through stratified random sampling which ensures the representativeness and generalizability of the study results. The random sampling technique consists of the possibility of everyone in the population having the same likelihood of being involved in the sample, avoiding bias and increasing the probability of reaching a sample that resembles the characteristics of the general population. The sample size of 132 is determined using Morgan's table, which takes into account the population size of 200 individuals. According to Morgan's table, for a population size of 200, an adequate sample number for a 5% margin of error and a 95% confidence level is 132 people. This sample size ensures that the study has sufficient statistical power to detect meaningful differences and draw reliable conclusions about the influence of Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited. The implementation of stratified random sampling in Asiri hospital can take place through the adoption of a systematic approach to select one or several samples from the hospital population. First of all a list of eligible staff members within the hospital which consists of the healthcare professionals, patients, administrators and the policy makers is generated.

Subsequently, the following sampling techniques can be utilized, simple random sampling or stratified random sampling, in order to randomly select the randomly selected participants from this list of individuals, to ensure that all individuals have equal opportunity to become a part of the sample. The research implements a random sampling strategy to see that the selected sample size is representative of the community in question which is made up of individuals in different labor roles as well as occupational health professionals in the healthcare branches in Kandy, Sri Lanka. This method not only improves the study's reliability but also makes its findings more generalizable, allowing researchers to draw correct conclusions and recommend informed policies on the use of Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

Department	**Position**	**Population**	**Sample Size**
Medical	Doctors	60	40
	Medical Equipment operators	20	13
	Nurse	40	27
	Patients	40	27
Administration	Hospital Administrators	20	13
IT department	IT specialist,	15	10
	Analysis	7	5
Other	policymakers	25	16
Total		***200***	***132***

Table 2 - Sample Size

Operationalization

Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

Variable	**Indicators**	**Literature Review**	**Measurement (Likert Scale)**
Waste classification accuracy (percentage of correctly identified waste items). .	Waste classification accuracy	Chowdhury, M.E.H., Rahman, T., Islam, M.R. and Khandakar, A., 2020.	**(1-5 Liker Scale)** 1 – Strongly disagree 2- Disagree 3 – Moderate 4 – Agree 5 – Strongly agree
	staff compliance rate	**Pittet et al. (2000)**,	
	Consistency Across Shifts or Departments	Alsubaie et al. (2013)	
Reduction in waste misclassification incidents.	Total Volume of Waste Reduced	Smith, 2020	**(1-5 Liker Scale)** 1 – Strongly disagree 2- Disagree 3 – Moderate 4 – Agree 5 – Strongly agree
	Reduction in Misclassified Waste	Jones et al., 2019	
	Waste Sent to Landfill	Global Waste Index, 2021	

	Percentage of Recycled Materials	European Environment Agency, 2020	
	Cost Savings from Waste Management	Carter and Thomas, 2018	
Time taken for waste sorting and disposal	Average Time per Waste Item for Sorting	Brown and Green, 2021	**(1-5 Liker Scale)** 1 – Strongly disagree 2- Disagree 3 – Moderate 4 – Agree 5 – Strongly agree
	Total Time to Sort Waste per Shift	Smith et al., 2020	
Staff compliance rate with waste disposal protocols.	Percentage of Correctly Segregated Waste Items	Johnson, R. and Lee, S. (2019).	**(1-5 Liker Scale)** 1 – Strongly disagree 2- Disagree 3 – Moderate 4 – Agree 5 – Strongly agree
	Compliance Rate by Department/Unit	Nguyen, H. and Turner, G. (2020).	
	Number of Waste Sorting Errors Per Shift	Davis, F., Rogers, A. and Taylor, M. (2021).	

Table 3 - Operationalization

3.11.Reliability validity and Generalizability

Especially in research it is very vital to make sure the findings are as well reliable, valid and generalizable for the study to maintain its' a strong and credible nature. The reliability refers to whether an outcome of the experiment or a piece of data could be reproduced and this should be the same across the conditions, for example, different moments or environments, or even people from different communities (Nikolopoulou, 2023). It is significant to make sure that the way the data is collected, for instance, through questionnaires, causes the same group of respondents to answer consistently under the similar environment. Employing approaches like pilot testing enable improved trustworthiness.

The concept of validity refers to the accuracy and appropriateness of the measurement tools in fully capturing the intended constructs or factors (Hassan, 2024). In this research, it is essential to evaluate whether the survey questions are scientifically aligned with all key aspects under investigation specifically the implementation of AI image detection in hospital waste management, staff awareness, operational efficiency, environmental impact, and safety compliance. Content validity can be ensured by involving a panel of subject matter experts who review the questionnaire to assess whether the questions are structured properly and reflect the core research objectives. Additionally, factor analysis may be applied to verify construct validity, confirming that the survey items effectively represent the theoretical framework and measure the intended dimensions related to AI adoption in waste management at Asiri Hospital Kandy.

By generalizability, it is meant the extent to which the results of your research can be utilised or extended spatially, beyond the sampling area of the study population (Nikolopoulou, 2023). In your, you target the ASIRI hospital situated in Kandy, Sri Lanka to execute on your research. In order to increase the generalization capacity of your results, you can carry out sampling types that secure the representativeness of the phase of healthcare professionals for those settings. Moreover, a methodological explanation of your research procedure, sampling arrangements, as well as your competitors will help to evaluate the suitability of the results by other researchers.

In order to have good reliability, validity, and generalizability in this research take strict considerations in design, data collection and reporting process carefully, and openly during all stages of the study. Through exposing of the various facets, it will reinforce your work's reliability and offer you the possibility to make valuable contributions in the healthcare analytics and management.

3.12. Roll of the researcher

In an attempt to evaluate the impact of Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited the researcher is central to the success of the undertaking. The integrity, impartiality and ethics of the study are dependent on the researcher. The researcher is the principal creator and the effective implementer of the research process and, at the same time, an efficient overseer of all stages, from idea inception to knowledge sharing.

The researcher as an objective inquirer, who is sincere, unbiased and depends on conducting the research with honesty and safeguarding of rigor. Researchers should always be impartial in research work that they do they should remain objective without being influenced by other people's ideas or their own prejudices. The principles of objectivity and impartiality are observed, which are the basic conditions for the reliability of the research outcomes in the assurance of which the study results are free from undue influence or distortion. The researcher resembles a microscopic and a strategist who is very cautious while putting together the plan to sample effectively and collect data as accurately as possible. Adopting random sampling methods, administering different instruments such as the Google Forms are conducting the survey, the researcher has aiming to capture a broad perspective of the diversified perspectives and experience of the stakeholders at the asiri Hospital in Kandy. This inclusive approach not only adds up to the validity of the research findings, but also contributes to a more deep comprehension of the complex intricacies revolving around the Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

The researcher plays the role of the ethical speciality and confidentiality deviser as well as the data gatherer. Ensuring informed consent is given, study participant privacy is protected and appropriate guidelines are adhered to, the researcher protects participants' rights and dignity. Furthermore, the author exemplifies the attitude to transparency and accountability by clearly saying how he reached certain conclusions in the study to all stakeholders including the health professionals, patients, administrators, and policymakers. To put it simply, the mission of the researcher in the above study is multifaceted, involving the role of an unbiased investigator, an attentive planner, an ethical custodian, and a transparent communicative. These roles must be executed with honesty and dedication to ensure that the research outcomes are legitimate and competitive and that they also efficiently contribute to the discourse on the significant issues of Application of AI Image Detection for Hospital Waste Management in Asiri Hospital Private Limited.

3.13. Ethical considerations

The implementation of AI image detection for hospital waste management at Asiri Hospital Kandy requires a thorough evaluation of several ethical considerations to ensure the technology is used responsibly. One of the foremost concerns is maintaining data privacy and confidentiality, particularly when handling images or videos that might inadvertently capture patient-related visuals or other sensitive information. Compliance with privacy regulations is essential to avoid ethical breaches. Furthermore, obtaining informed consent from all staff involved in the waste handling process is crucial. These individuals should be fully aware of the AI system's functionality, purpose, and the manner in which it monitors and classifies waste, ensuring transparency and ethical integrity throughout the system's deployment.

Additionally, it is important to address potential biases in the AI system by ensuring that training data is diverse and representative of various waste categories to prevent unfair misclassification. The hospital must also ensure accountability in cases of AI errors in waste sorting, ensuring that human oversight is in place to correct any misclassifications and that responsibility is clearly defined. Ethical concerns related to employment must be addressed, ensuring that AI does not replace jobs but instead supports staff by improving efficiency and providing opportunities for skill development.
Furthermore, the environmental impact of the AI system itself should be considered, ensuring that it operates in an energy-efficient manner and does not contribute to electronic waste. Transparency and explain ability are key, as the decision-making process of the AI system should be understandable to staff, allowing them to intervene when necessary. Lastly, continuous monitoring and evaluation of the system's performance are necessary to ensure that the AI system remains ethically sound and aligned with hospital policies and legal requirements. By addressing these ethical considerations, Asiri Hospital can implement AI technology in a responsible and effective manner, promoting efficiency while safeguarding privacy, fairness, and environmental sustainability.

SECTION 4 – PARCTICABILITY & IDENTIFICATION OF CONSTRAINS

4.1. Practicability

The practicability of applying AI image detection for hospital waste management at Asiri Hospital Private Limited is highly promising, yet requires careful planning and resource allocation. The hospital must ensure that the necessary infrastructure, including high-quality cameras, sensors, and computational resources, is in place to support the AI system's operation. The integration of AI technology into existing waste management processes must be seamless, with minimal disruption to daily operations.

Training staff to effectively use and maintain the AI system is crucial, as is providing ongoing support to troubleshoot any technical challenges that may arise. Moreover, the system must be scalable to accommodate the volume of waste generated in a hospital environment, with the ability to process and classify various types of waste accurately and in real time. The AI solution must also be adaptable to different hospital settings and waste management protocols, ensuring it works across diverse departments with varying waste types.

Cost considerations are another important aspect, as implementing AI image detection requires an initial investment in technology and ongoing maintenance, which must be balanced with potential savings from improved waste sorting and disposal efficiency. Additionally, the system must comply with relevant health and safety regulations, ensuring that it does not compromise the safety of staff or patients. Overall, while the adoption of AI in hospital waste management is highly feasible, its successful implementation depends on strategic planning, proper resource allocation, and addressing potential operational and financial challenges.

The clearly practical approach of the study is enabled by the use of Google Forms as the tool for data collection because it offers an accessible and user-friendly option for survey administration. Google Forms will help to get the surveys created and disseminated to the participants within Asiri Hospital Kandy was chosen for this study due to its accessibility and relevance as a leading healthcare facility in Sri Lanka. Using a survey strategy via Google Forms offers a user-friendly interface and cross-platform compatibility, allowing participants such as hospital staff and waste management personnel to respond at their convenience. This flexibility helps improve response rates and ensures a more representative sample. The platform enables quick and cost-effective collection of qualitative and quantitative data, which is ideal given the typical resource and logistical constraints associated with research. By employing structured questionnaires using Likert scale responses, researchers can capture detailed insights into staff perceptions, experiences, and attitudes regarding the use of AI image detection for waste management. This approach simplifies the data collection process, minimizing the burden on both participants and the research team.

While the questionnaire approach using Google Forms is more manageable than the other options in terms of data management and analysis, it still takes a good time to analyse the gathered information. This platform has in-built tools for real-time visualization and analysis of survey results enabling researchers to measure both response rates and track any patterns and trends and create actionable insights. This unified method of data handling and processing, on the other hand, increases data analysis efficiency and accuracy of the research process, thus allowing the researchers to extract valuable conclusions and suggestions from the data. The use of survey approach proves cooperation and communication to be the most crucial factor for researchers, participants and stakeholders involved in the whole research process. The platform provides for sharing links for surveys in a smooth fashion, joint work on survey design and implementation, as well as providing the research findings to the appropriate audience. This collaborative facet helps to realistically shape the research by promoting transparency, accountability, and commitment from all parties, which then improves the research results' relevance and applicability in providing the basis for health practices and policies in Sri Lanka.

The Google Forms approach adopted for survey purposes exhibits tremendous practicality in various aspects including the administration of surveys, the efficiency of data collection, data management, analysis, and collaboration among stakeholders. By using these tangible advantages, the researchers can comprehensively examine how Application of AI Image Detection for Hospital Waste Management affect in Asiri Hospital Private Limited.

4.2. Identification of constraints

The implementation of AI image detection for hospital waste management at Asiri Hospital Private Limited faces several key constraints that must be addressed to ensure success. First, infrastructure limitations including the availability and placement of high-resolution cameras, reliable network connectivity, and sufficient edge-computing capacity can impact the system’s ability to capture and process images in real time. Second, data constraints such as the need for large, diverse, and accurately labeled training datasets may delay model development and reduce classification accuracy if insufficient or biased data are available.

Third, budgetary constraints encompass both the upfront investment in hardware, software, and staff training, as well as ongoing maintenance and update costs, which must be balanced against expected efficiency gains. Fourth, integration constraints the challenge of seamlessly embedding the AI solution into existing waste management workflows, IT systems, and regulatory reporting processes can create operational friction and require tailored software interfaces. Fifth, regulatory and compliance constraints demand that the system comply with healthcare privacy regulations and environmental waste-disposal standards, potentially limiting camera placement or data retention practices.

Sixth, human factors constraints, including staff resistance to new technology, learning curves, and the need for continuous training and support, may hinder user adoption and consistent use. Finally, technical constraints such as varying lighting conditions in disposal areas, occlusion of waste items, and the potential for algorithmic errors pose ongoing challenges that require robust model retraining and human-in-the-loop oversight to mitigate. Addressing these constraints through careful planning, stakeholder engagement, and iterative refinement will be critical to the effective deployment of AI-driven waste management at Asiri Hospital.

GANT CHART

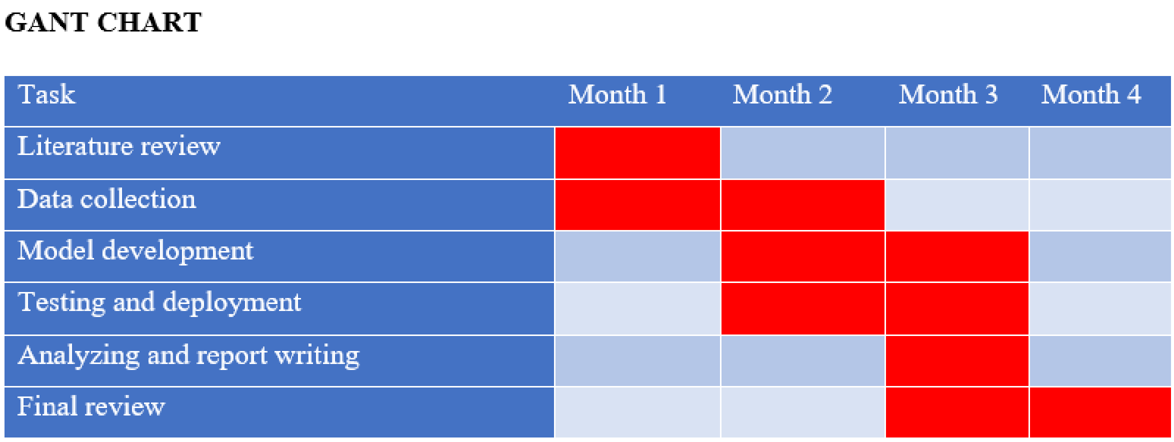

Figure 3 gant chart

CONCLUSION

The implementation of AI image detection for hospital waste management at Asiri Hospital Private Limited represents a significant advancement in ensuring safe, efficient, and compliant disposal of medical waste. With the increasing amount of medical waste generated worldwide, the use of AI can help healthcare systems to streamline their waste management processes, reduce costs, and improve sustainability. By leveraging deep learning–based computer vision to accurately classify waste in real time, the system reduces human error, enhances staff adherence to segregation protocols, and optimizes operational workflows.

AI technologies such as image detection can significantly enhance hospital waste management processes by improving the accuracy of waste classification, optimizing segregation, and minimizing the risk of hazardous disposal errors. At Asiri Hospital in Kandy, the implementation of AI image detection systems presents an opportunity to streamline waste handling, boost recycling efforts, and reduce environmental impact. Nevertheless, challenges such as data privacy, system integration, and the need for staff training must be carefully addressed. Additionally, the success of AI deployment depends on the hospital's readiness in terms of infrastructure and its ability to manage change among personnel. Despite these barriers, the potential advantages such as increased operational efficiency and improved compliance with healthcare waste regulations make the adoption of AI-driven waste management solutions both relevant and necessary. With thoughtful planning, ongoing training, and continual system optimization, these challenges can be effectively managed.

By implementing the recommendations discussed in this study, healthcare systems can overcome the challenges and risks associated with AI implementation and leverage the full potential of AI to improve waste management practices, reduce costs, and increase sustainability. As such, AI represents an exciting opportunity for the healthcare industry to transform the way we manage clinical waste and move towards a more sustainable future.

Ethically grounded and pragmatically designed, the AI solution not only supports Asiri Hospital's environmental sustainability goals and regulatory obligations but also lays the groundwork for scalable, data-driven waste management practices that can be extended to other healthcare facilities. Ultimately, this initiative underscores the transformative potential of AI in fostering safer, greener, and more cost-effective hospital operations.

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