Program Profile		
Program	Program name	BCIS: An Explainable AI System for Breast Cancer Detection, Classification, Segmentation, and Prognosis Using Medical Imaging.
	Category	A8 (Support for Global Resilience – Primary), A7 (Generative AI Application – Secondary), B3 (Innovation in Technology).

Summary of Program	
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Abstract of Program	Breast cancer remains one of the most pressing non-communicable diseases globally, contributing significantly to female mortality. According to the World Health Organization (WHO), it is the most frequently diagnosed cancer worldwide, with 2.3 million new cases and 685,000 deaths reported in 2020 alone. While early detection through routine mammography screening has helped reduce mortality in high-income countries by over 40% since the 1980s, resource-constrained regions still face major diagnostic and prognostic challenges. This project proposes the development of a Breast Cancer Identifier System (BCIS) that leverages a multidisciplinary combination of artificial intelligence (AI), explainable AI (XAI), and advanced image processing techniques to improve early detection, classification, segmentation, and prognosis of breast cancer. The system aims to analyze diverse imaging modalities, including ultrasound, mammography, and MRI, and to extract meaningful biomarkers and image-based features such as texture, shape, and intensity metrics. Machine learning models, particularly deep learning architectures like ResNet and U-Net, will be used alongside explainable frameworks (e.g., SHAP, LIME) to provide transparency and interpretability in medical decisions. The system will also incorporate prognostic modeling to estimate recurrence risk and support long-term treatment monitoring. A critical outcome of this project is the development of a user-friendly clinical interface that facilitates seamless integration with hospital workflows. The system will undergo rigorous validation using multi-dimensional datasets to ensure robustness, generalizability, and clinical relevance. By bridging the gap between computational intelligence and clinical application, this research seeks to make a tangible impact on women's healthcare. The BCIS platform aspires to contribute to global health resilience by reducing late-stage diagnoses, supporting personalized medicine, and increasing awareness through intelligent, accessible technology.

Details of Program		
Planning		
Objectives	Long-term Goals	• Clinically validated, widely deployed BCIS for early detection, staging, segmentation, and prognosis across mammography, ultrasound, MRI. • Trusted decision support via explainable AI in routine hospital workflow.

		• Reduction in late-stage diagnoses and contribution to SDG 3 in low resource settings.
	Short-term Targets	• Build a working prototype trained on CBIS DDSM, MIAS, INbreast, with ResNet50, MobileNetv2, U Net. • Integrate Grad CAM and SHAP for case level explanations. • Run pilot validation with radiologist feedback, report accuracy, sensitivity, specificity, F1. • Prepare desktop UI for research use and plan cloud or mobile migration.
	Rationale	Global burden is high, screening access is uneven, current tools show low sensitivity and many false positives, clinicians need transparent AI. BCIS addresses this with multi-modality imaging, modern deep learning, and XAI, plus a prognosis module for five-year relapse risk.
Subject (Leader)	Initiator(s)	AFRIN, Sadia
	Champion(s)	Afrin, Sadia
	Major team member(s)	Individual project led solely by Sadia Afrin.
Environment	Nature/Society	BCIS directly addresses a major global health issue by enabling early detection and personalized monitoring of breast cancer. It aims to reduce late-stage diagnoses, improve treatment outcomes, and raise awareness of breast health, especially in underserved communities.
	Industry/Market	The system is designed for integration with medical imaging technologies and can be adopted by hospitals, diagnostic centers, and healthcare software companies. Its use of explainable AI also meets rising market demand for transparent and ethical medical AI tools
	Citizen/Government	BCIS has the potential to support national cancer screening and public health programs by providing a scalable, low-cost, AI-powered diagnostic tool suitable for public hospitals and government-funded healthcare systems.
Resources	Human resources	The project is led independently by a researcher with expertise in AI and medical imaging. Occasional input from radiologists may support clinical validation.
	Financial resources	Funding is needed to support computational infrastructure, potential dataset access fees, and software licensing if required. If extended to a team, basic support for researcher time and collaborative workshops would also be necessary.
	Technological resources	A GPU-enabled system is essential. Tools include Python (TensorFlow, PyTorch), OpenCV, and XAI libraries (e.g., SHAP, Grad-CAM). Public datasets like CBIS-DDSM, MIAS, and INbreast will be used.
Mechanism	Strategy (Weight/Sequence)	The project allows flexibility in selecting machine learning models (e.g., SVM, Random Forest) or advanced deep learning architectures (e.g., ResNet50, U-Net, MobileNetv2) depending on performance. Feature selection methods, types of imaging modalities (MRI, mammography, ultrasound), and XAI techniques (SHAP, Grad-CAM) are also among the strategic choices.
	Organization	The accuracy and clinical usefulness of the system will largely depend on selecting the right models and biomarkers. Equally important is the choice of explainability tools, which ensure clinicians can trust and interpret the results. Image quality and dataset diversity also significantly impact system robustness.

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<tr><td></td><td>Culture</td><td>The project begins with image collection and preprocessing, followed by feature extraction and model training. Once baseline models are established, XAI methods will be integrated for interpretability. The system will then undergo validation through expert feedback and performance testing on unseen data.</td></tr>
<tr><td colspan="3">Doing</td></tr>
<tr><td colspan="2">Launch date</td><td>Expected: December, 2025</td></tr>
<tr><td colspan="2">Responsible organization</td><td>World University of Bangladesh</td></tr>
<tr><td colspan="2">Program content and process</td><td>BCIS is designed as an end-to-end AI platform for breast cancer detection, classification, segmentation, and prognosis using multi-modality imaging (mammography, ultrasound, MRI). The implementation follows four phases.
Phase 1 – Preprocessing: Image data undergoes noise reduction, normalization, breast and tumor localization, and color space adjustments when needed. Segmentation models are applied to generate precise 2D/3D breast masks.
Phase 2 – Biomarker Development & Prediction: Statistical, textural, geometric, and intensity-based features are extracted to quantify tumor characteristics. Supervised learning models (Decision Tree, SVM, CNN) and clustering methods are used for classification and anomaly detection.
Phase 3 – Diagnosis and Staging: Tumor regions are classified into benign, malignant, or aggressive subtypes using CNNs and multinomial classification. Results are mapped to clinical staging and enable physicians to design targeted treatment strategies.
Phase 4 – Prognostics & Monitoring: Temporal analysis of imaging data is used to track post-treatment tumor regions and detect relapse probability. Regression models estimate survival likelihood over five years.

Throughout development, explainable AI (Grad-CAM, SHAP) is integrated for visual interpretability. The system is modular, allowing iterative validation with radiologists and extension to cloud or mobile platforms. The final delivery will be a desktop prototype with a simple GUI and comprehensive performance metrics (accuracy, sensitivity, specificity, F1-score).</td></tr>
<tr><td colspan="2">Key highlights of the content/process</td><td>Content Highlights
Multi-modality integration (mammogram, MRI, ultrasound)
Prognostic module for relapse monitoring
Explainable AI visualization for clinical trust
Process Highlights
Four-phase structured pipeline (preprocess → classify → stage → prognose)
Iterative testing and radiologist feedback loops
Modular architecture enabling future cloud/mobile deployment</td></tr>
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Differences from traditional approaches	• **Automation:** Replaces subjective manual radiology review with consistent, automated AI predictions. • **Transparency:** Integrates explainable AI, giving clinicians case-specific visual insights into model decisions. • **Scope:** Goes beyond detection—offers staging, segmentation, and prognosis in a single system. • **Data-Driven:** Learns from large, annotated datasets, improving generalization and early detection accuracy. • **Personalized Care:** Provides continuous post-treatment monitoring, which traditional CAD systems rarely include.
Progress as of today	Proposal stage, detailed concept finalized, background study completed, and preliminary dataset sourcing plan outlined.
Problems in implementation	• Limited access to annotated medical imaging datasets (mammography, MRI, ultrasound) • Computational limitations for training deep learning models • Lack of clinical validation and collaboration with medical professionals • Designing a user-friendly interface for clinical use
Approaches to solve the problems	From the mammographic point of view, this project will follow the four phases methodology described below: • **Apply preprocessing for enhancing and localizing breast cancer:** The first phase consists of the employment of advanced image processing techniques for preprocessing the image data acquired from affiliated hospital. The preprocessing may include: (a) Noise reduction for enhancing the quality of image. (b) Constricting the 2D or 3D models for segmentation of breast and tumor of breast. (c) Color space customization if needed. • **Prediction of breast cancer using biomarker:** The second phase consists of the development of biomarkers for the precise identification of the cancer from the analysis of 2D/3D digital images, particularly in mammogram and MRI images through the following steps: a) Different breast cancer features (i.e., statistical features, Texture features, geometric features, and Intensity based features) for quantifying the existence of breast cancer. b) Different supervised machine learning techniques (Decision Tree, Rules Based, Classification, Naïve Bayes, SVM, CNN/ Deep Learning) to detect the tumor segmentation. c) Different clustering techniques will apply by extracting features to detect the abnormalities cell. • **Diagnosis of types/stage of breast cancer:** This phase consists of the diagnosis of patient based on the acquired data to detect more normal or aggressive breast cancer types by a) Obtaining characteristics of the tumor regions segmented in the previous step will be calculated by feature extractors to map to the classification and deep learning model e.g., Convolutional Neural Network CNN.

	b) Classifying tumor types based on multinomial classification methods based on decision Tree, support vector machines (SVM) or deep models CNN. As soon as the cancer type is known, we proceed to the next phase, where a personalized treatment is proposed, and the same visual biomarkers are used to provide continuous monitoring of the affected tissue after the treatment, to detect if the cancer is still present. • **Development of prognostics model for analysis of the development of cancer:** In this phase, the prognostics features will be used for the continuous extraction of information from digital images of patient follow-up. To do this, a) The evolution of the temporal analysis of cancer regions from the data provided by these biomarkers, considering images of different modalities (especially ultrasound and MRI) will be quantified. b) The regression model will be used for measuring the probability of survival of breast cancer. c) The detection of local recurrence (relapse probability) by the perceived quantitative changes in breast cancer regions after applying different treatment.
Completion date, if completed	N/A — Proposal under review, expected implementation upon approval.
Seeing	
Impacts on students	• **Skill Development:** Students will gain hands-on experience in AI, deep learning, and medical image processing key skills for modern healthcare technology roles.**Research Inspiration:** The project will • encourage undergraduate and postgraduate students to explore interdisciplinary research at the intersection of computing and medical science.
Impacts on professors	• **Academic Visibility:** Faculty leading the project may receive recognition through publications and conference presentations in AI and healthcare domains. • **Curriculum Enrichment:** Elements from the project can be integrated into courses like Machine Learning, Medical Informatics, or Computer Vision, enriching academic content.
Impacts on university administration	The university leadership, including the Vice-Chancellor and senior administrators, are supportive of the BCIS initiative as it strengthens WUB's research profile and global visibility. They view it as aligned with the institution's mission to promote innovation and interdisciplinary research. The administration values its potential to bring international recognition through publications, conference participation, and possible WURI ranking contributions. Overall, they are satisfied with the program's direction and have shown interest in providing institutional support once it moves beyond the proposal stage.
Responses from industry/market	• **Clinical Interest:** Hospitals and diagnostic centers may show interest in BCIS as a cost-effective screening and decision-support system. • **Pilot Collaborations**: Potential for institutional partnerships or clinical pilots with radiology departments for real-world testing.

Responses from citizen/government	**Public Health Alignment:** The system aligns with national and global health goals (SDG 3 – Good Health and Well-being), especially in low-resource settings where early screening tools are limited.
Measurable output (revenues)	Since BCIS is in the proposal and prototype development stage, no direct revenue has been generated yet. Expected future revenues may come from: • Research grants and institutional funding for AI-healthcare innovation • Licensing the BCIS software to hospitals and diagnostic centers • Collaboration fees from clinical pilot studies • Potential commercialization as a SaaS platform for breast cancer screening (Estimated revenue projections can be developed post-validation, based on pilot deployment results and adoption interest.)
Measurable input (expenses)	Approximate initial investment requirements: • **Computational Infrastructure:** USD 10,000–12,000 for GPU servers or cloud compute credits • **Dataset Access and Storage:** USD 3,000 for licensing or curation of mammography/MRI datasets • **Researcher and Assistant Time:** USD 8,000–10,000 equivalent for development and validation efforts • **Workshops and Clinical Collaboration:** USD 2,000 for radiologist consultations and review sessions Total estimated expenses for the first year: **USD 25,000–27,000** (including infrastructure, labor, and validation costs).
Cost-benefit analysis for effectiveness	**Costs:** • **Research and Development:** Significant time and effort will be required to develop, train, and validate deep learning and XAI-based diagnostic models tailored for breast cancer detection and prognosis. • **Computational Resources:** Deep learning requires high-performance GPUs and substantial storage capacity, which may incur costs if local or cloud-based computational infrastructure is needed. • **Training and Integration:** Additional investment may be required to train students, researchers, and healthcare professionals on how to use the system effectively and integrate it into clinical or research workflows. **Benefits:** • **Improved Diagnostic Accuracy:** The system is expected to enhance detection and classification performance, reducing false positives and enabling more accurate, early-stage diagnosis. • **Educational Advancement:** BCIS promotes interdisciplinary learning and research in AI, healthcare, and computer vision, adding valuable content to both undergraduate and postgraduate education. **Long-Term Clinical Value:** With early detection and personalized prognosis, the system may reduce the cost of treatment over time by enabling timely intervention and reducing late-stage cancer burdens.

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<tr><th colspan="2">Future Planning</th></tr>
<tr><td>Where does the project go from here?</td><td>AI Model Expansion:
Dataset Enrichment: Extend the training datasets by incorporating multi-institutional and multi-modal imaging sources, including new mammography, MRI, and ultrasound scans.
Feature Refinement: Identify and test additional quantitative imaging biomarkers that may improve model precision in early-stage cancer detection and subtype classification.
Multi-Task Learning: Implement advanced deep learning architectures (e.g., transformer-based or hybrid models) to perform simultaneous classification, segmentation, and prognosis prediction.
Explainability and Clinical Readiness:
Enhanced XAI Integration: Expand the use of explainable AI tools to offer clearer visual feedback and trust-building explanations for every prediction.
User Feedback Loop: Deploy the system in pilot settings to gather feedback from radiologists and oncologists, iteratively improving model usability and reliability.
Scalability and Deployment:
Web or Mobile Interface: Transition the system from a desktop prototype to a cloud-based or mobile application for broader clinical accessibility.
Health Policy Integration: Explore collaboration with public health programs to evaluate the system's role in national breast cancer screening initiatives, especially in under-resourced areas.</td></tr>
<tr><th colspan="2">Addendum</th></tr>
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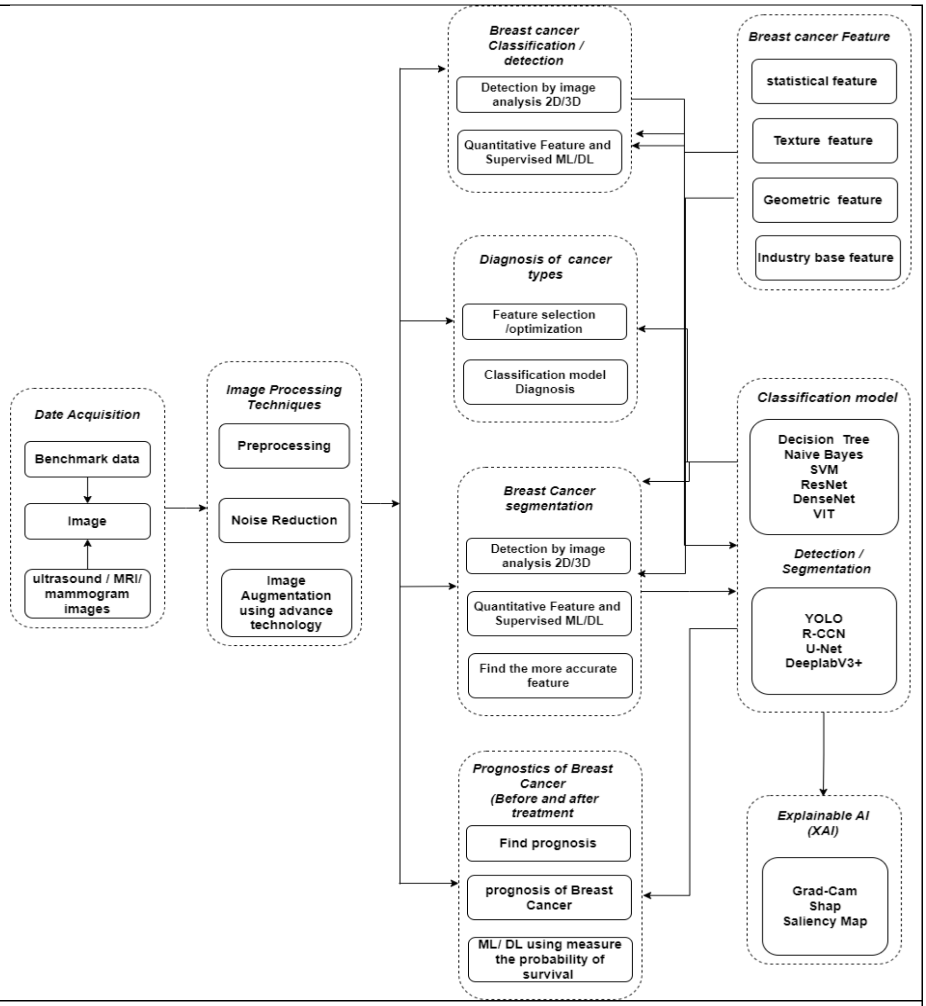
<td>Exhibits, pictures, diagrams, etc.</td>
<td>
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<td>Reports, mimeos, monographs, books, etc.</td>
<td>
BCIS Project Proposal Document: Full program description including background, objectives, methodology, and expected outcomes.
Literature Review Compilation: Summarizing 20 peer-reviewed articles ([1]–[20]) covering quantitative imaging, deep learning, segmentation, and XAI methods for breast cancer.
Background Study Report: Internal document with regional incidence statistics, dataset availability, and computational resource assessment.
Methodology Flow Diagram: Visual representation of the four-phase development pipeline (preprocessing → classification → staging → prognosis).
Preliminary Dataset Sourcing Plan: Identifies public datasets (CBIS-DDSM, MIAS, INbreast) and their usage strategy for training and validation.
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<td>Others which may help explain the program (including website links)</td>
<td>
University Website: https://www.wub.edu.bd
Program Champion Profile: [Faculty Directory – Department of CSE, WUB] (if available online)
Global Reference: WHO Breast Cancer Fact Sheet (https://www.who.int/news-room/fact-sheets/detail/breast-cancer)
Public Datasets Used:
CBIS-DDSM
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	○ MIAS Database ○ INbreast These links and references provide supporting validation, show the scientific grounding of the work, and help reviewers see that the program is aligned with recognized global needs and available datasets.