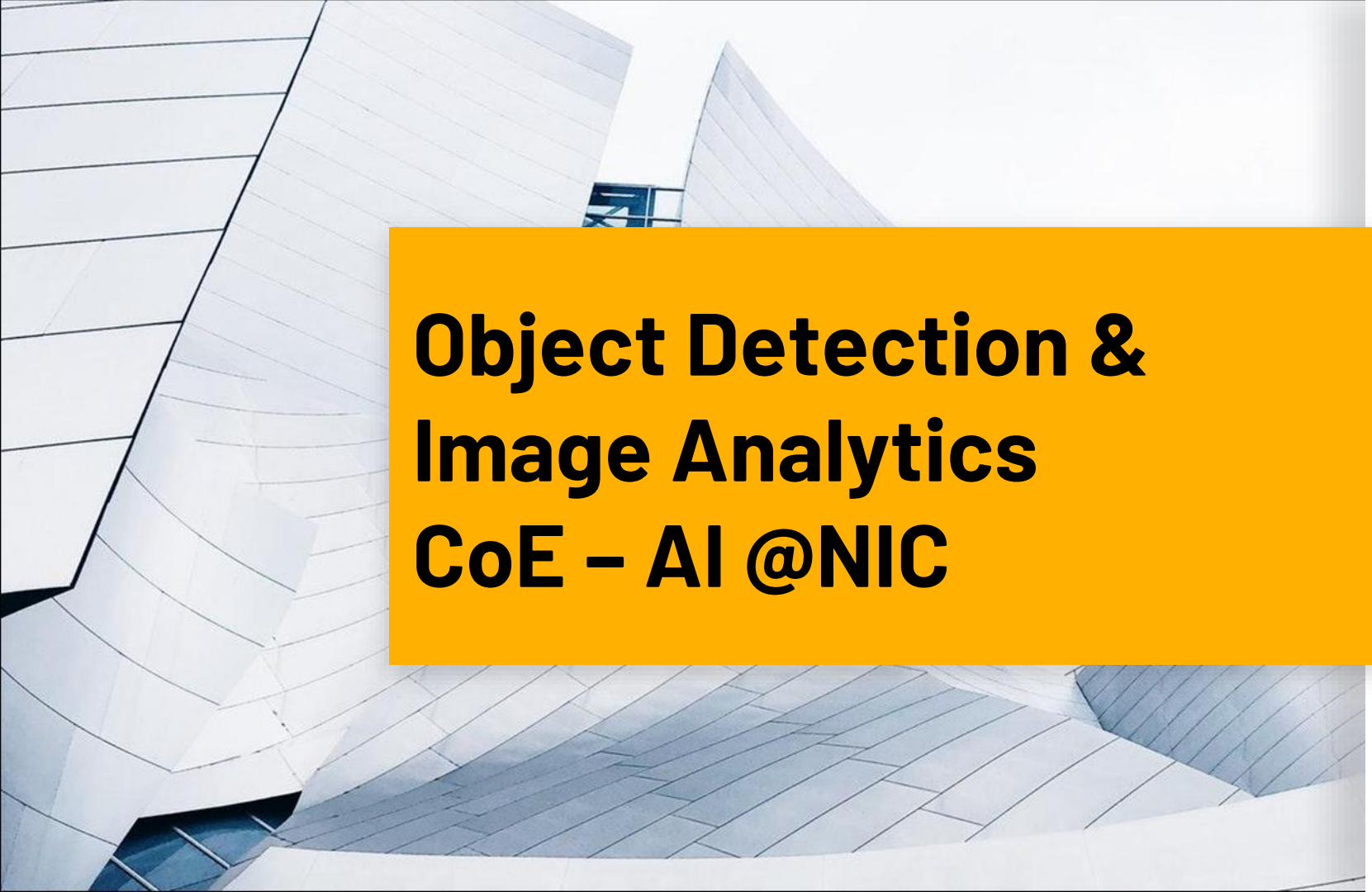


Object Detection & Image Analytics CoE – AI @NIC

1. Swachh Bharat Mission - Urban

Case Study

Toilet Seat & Beneficiary Detection

- **Usecase -**
- **Automatic Detection of Toilet seat & Beneficiary in photos uploaded by citizens in Swachh Bharat Urban and Informing the status to the citizens through MobileApp**
- **The aim is to utilise Artificial Intelligence in reducing workflow cycle.**

SBM Urban Machine Learning – Accuracy - 88%

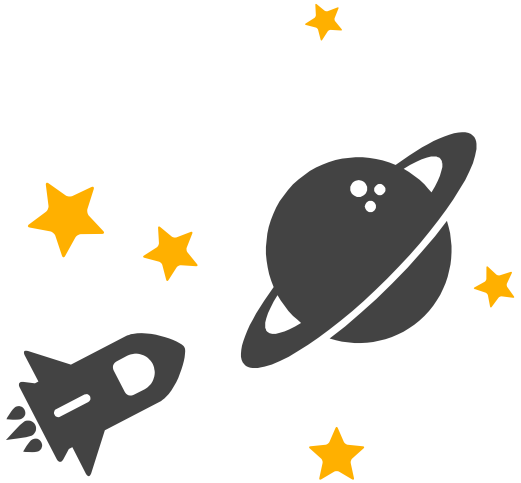
APPLICATION_ID	Toilet Seat Found -Detection by Machine Learning	APPLICATION_ID	Toilet Seat Not Found - Detection by Machine Learning
AR18A0000920		OR1500028925	
AS17T0013676		SK18S0000008	

Toilet Seat Detection in Toilet Photos uploaded in Swachh Bharat Urban Mission Portal by Mobile App

APPLICATION_ID	Beneficiary Found -Detection by Machine Learning	APPLICATION_ID	Beneficiary Not Found - Detection by Machine Learning
AR18A0000920		HR16E0031714	
MH17U0268710		KA1500138169	

Beneficiary Detection in Toilet Photos uploaded in Swachh Bharat Urban Mission Portal by Mobile App

Deep Learning



- Model used : YOLO V3
- Framework: Darknet
- Inferencing : Using TensorRT with DS3.0

YOLO3 - Neural Network

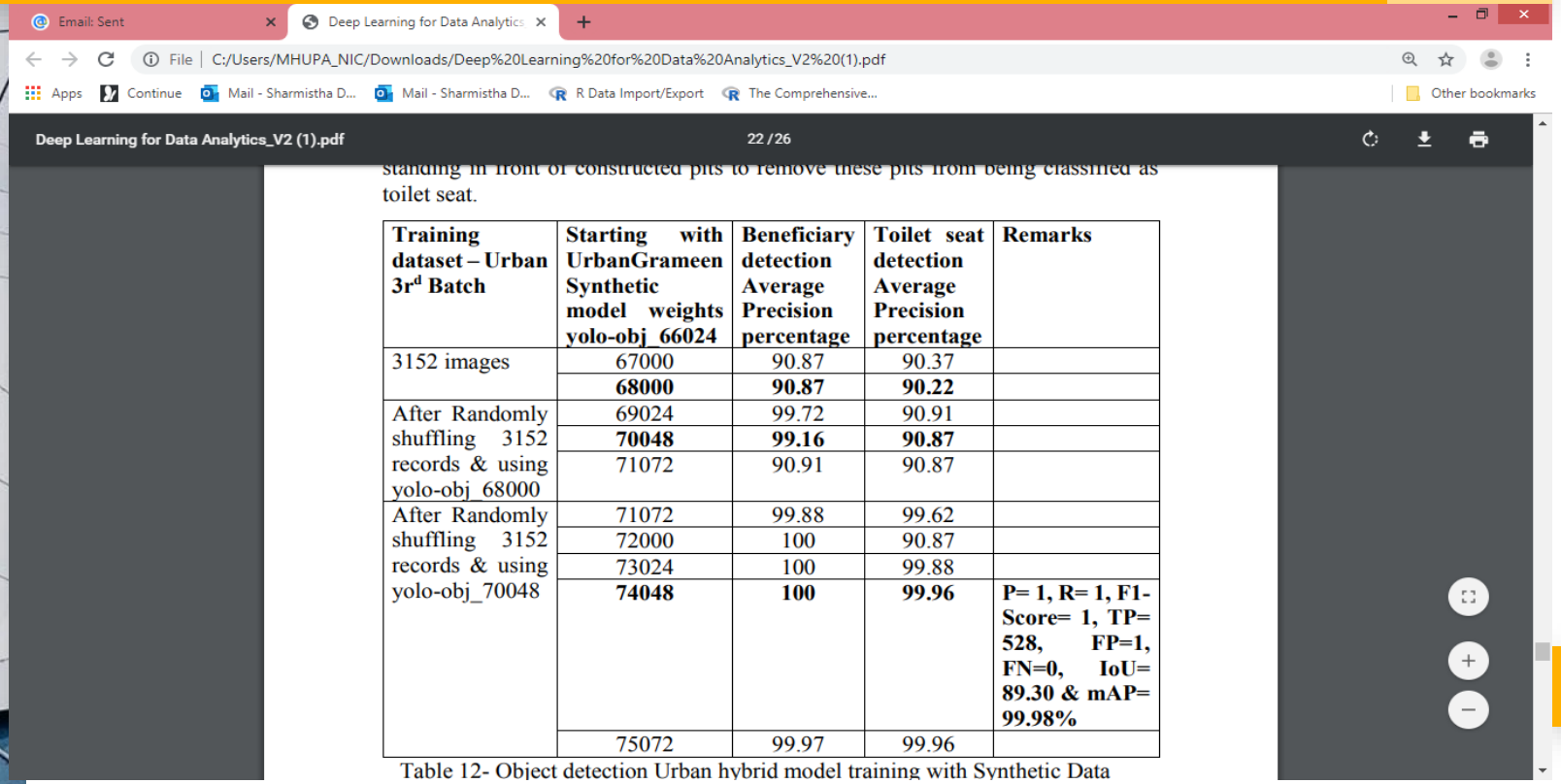
- You only look once (YOLO) is a state-of-the-art, real-time object detection system. **YOLO V3 applies a single neural network to the full image. It divides the image into regions and predicts bounding boxes and probabilities for each region.**
- **Darknet is an open source neural network framework** written in C and CUDA. It is fast, easy to install, and supports CPU and GPU Computation. It prints out the objects it detected, its confidence, and how long it took to find them.

SBM Urban Deep Learning Case Study

- **Training dataset :**
- The model is initially fit on a **training dataset** that is a set of examples used to fit the parameters. The training dataset consist of pairs of an input vector (images) and the corresponding output labels.
- **During training 90% of annotated dataset was used as training set**
- **Validation Dataset :**
- A validation dataset is a dataset of examples used to tune the hyperparameters of a classifier and detector. **Since there is only 2 classes, a small training dataset was sufficient to give good trained model hence results also.**
- **During training used 10% of annotated dataset as validation set. Precision ,Recall , Accuracy** are calculated on validation set only.
- **Testing Dataset :**
- A test dataset is a dataset that is independent of the training dataset, but that follows the same probability distribution as the training dataset. If a model fits to the training dataset, it also fits the test dataset well.

SBM Urban Deep Learning – Accuracy - 99%

AI Model Weight Taken & Metrics Scores



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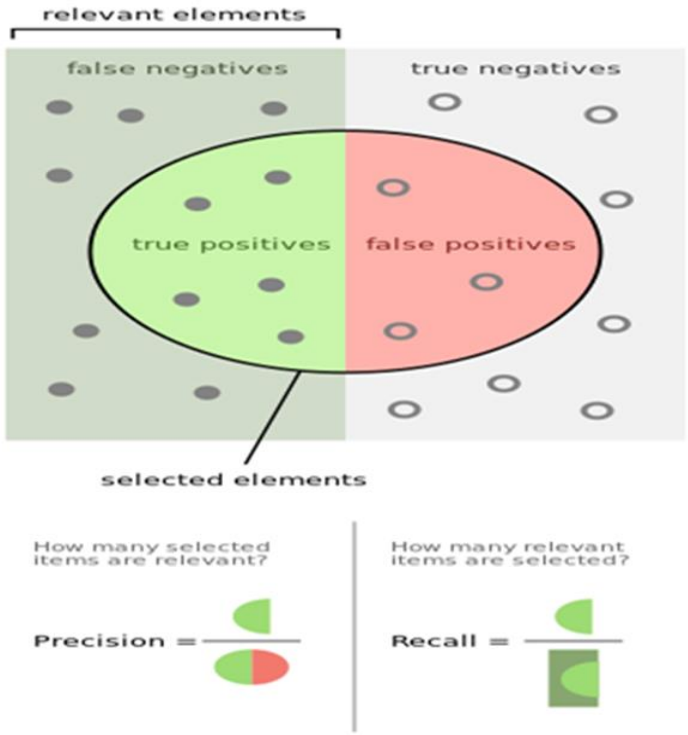
Deep Learning for Data Analytics_V2 (1).pdf 22 / 26

standing in front of constructed pits to remove these pits from being classified as toilet seat.

Training dataset – Urban 3rd Batch	Starting with UrbanGrameen Synthetic model weights yolo-obj_66024	Beneficiary detection Average Precision percentage	Toilet seat detection Average Precision percentage	Remarks
3152 images	67000	90.87	90.37	
	68000	**90.87**	**90.22**	
After Randomly shuffling 3152 records & using yolo-obj_68000	69024	99.72	90.91	
	70048	**99.16**	**90.87**	
	71072	90.91	90.87	
After Randomly shuffling 3152 records & using yolo-obj_70048	71072	99.88	99.62	
	72000	100	90.87	
	73024	100	99.88	
	74048	**100**	**99.96**	**P= 1, R= 1, F1-Score= 1, TP= 528, FP=1, FN=0, IoU= 89.30 & mAP= 99.98%**
	75072	99.97	99.96	

Table 12- Object detection Urban hybrid model training with Synthetic Data

SBM Urban Deep Learning



- Recall : 100% for both classes in validation set.
- Inference Time on 2000 images using DS3.0 : 52 second (around 39 fps)
- Test set accuracy is around 99% using the trained Neural Network Model.

Random Sample Check of Results given by AI

Application ID	Beneficiary Detected	Toilet Detected	Check Beneficia	Check Toilet
UP1500535659.jpeg	B	T	B	T
UP18D0014683.jpeg	B	T	B	T
KA1500018478.jpeg	B		B	
UP1500535036.jpeg	B	T	B	T
UP18Z0238831.jpeg	B	T	B	T
TN18O0095890.jpeg	B		B	
UP17G0141200.jpeg	B	T	B	T
UP17N0154430.jpeg	B	T	B	T
UP18Z0158741.jpeg	B	T	B	T
UP18Z0088769.jpeg	B	T	B	T
UP16U0858567.jpeg	B	T	B	T
KA18L0026549.jpeg	B		B	
UP17S0167057.jpeg	B	T	B	T
KA1500114064.jpeg	B	T	B	T
UP17U0149680.jpeg	B	T	B	T
TN18L0013956.jpeg	B	T	B	T
KA16Z0028015.jpeg	B	T	B	T
KA1500011094.jpeg	B	T	B	T
MP1500358710.jpeg	B		B	
TN18B0045310.jpeg	B	T	B	T
MH16S0222601.jpeg	B	T	B	T
TN18O0069339.jpeg	B	T	B	T
TN18N0063848.jpeg	B		B	
BR17E0146685.jpeg	B	T	B	T
KA1500140512.jpeg	B	T	B	T
KA1500050493.jpeg	B	T	B	T
MP18Z0025135.jpeg	B		B	

Results Sample from AI model Building

- Enter Image Path: /workspace/swachbharat/darknet/build/darknet/x64/data/obj/UP1500586470.jpeg: Predicted in 27.474000 milli-seconds.

  Beneficiary: 99% (left_x: 115 top_y: 158 width: 40 height: 26)

- Enter Image Path: /workspace/swachbharat/darknet/build/darknet/x64/data/obj/TN19A0017203.jpeg: Predicted in 26.891000 milli-seconds.

  ToiletSeat: 99% (left_x: 137 top_y: 384 width: 106 height: 61)

  Beneficiary: 100% (left_x: 177 top_y: 81 width: 35 height: 41)

- Enter Image Path: /workspace/swachbharat/darknet/build/darknet/x64/data/obj/NL16Z0015526.jpeg: Predicted in 26.884000 milli-seconds.

- Enter Image Path: /workspace/swachbharat/darknet/build/darknet/x64/data/obj/MH16J0234766.jpeg: Predicted in 26.543000 milli-seconds.

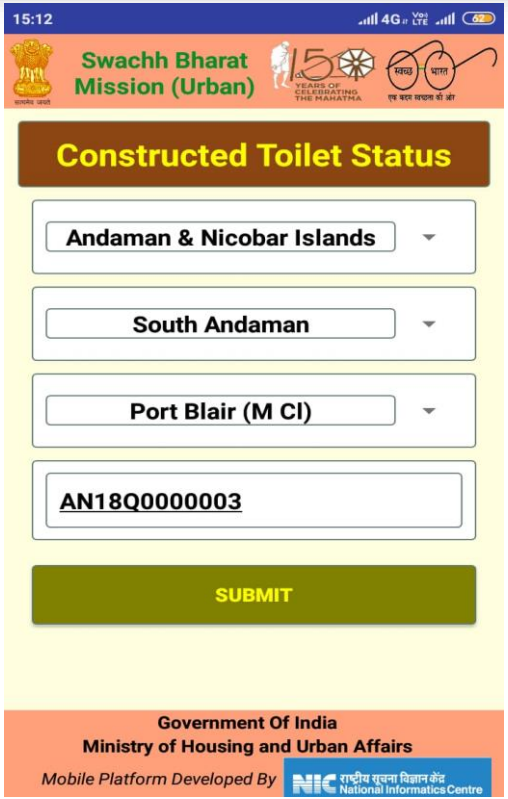
  ToiletSeat: 100% (left_x: 113 top_y: 245 width: 138 height: 76)

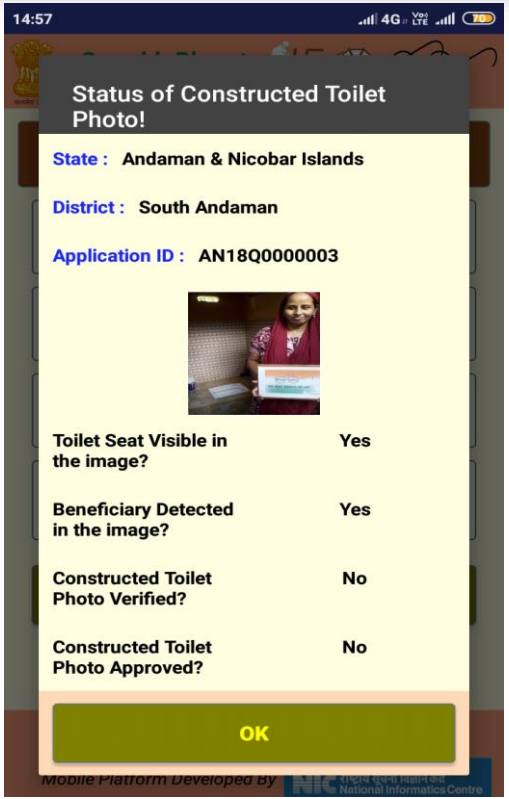
- Enter Image Path: /workspace/swachbharat/darknet/build/darknet/x64/data/obj/UP18Z0220293.jpeg: Predicted in 26.911000 milli-seconds.

  ToiletSeat: 90% (left_x: 42 top_y: 141 width: 31 height: 19)

  Beneficiary: 98% (left_x: 55 top_y: 28 width: 14 height: 19)

Image Analytics in eGovernance – A Practical Example





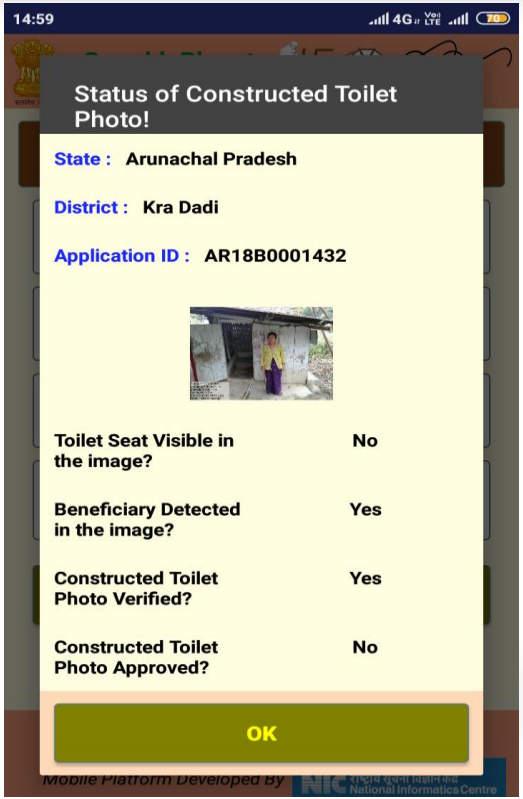
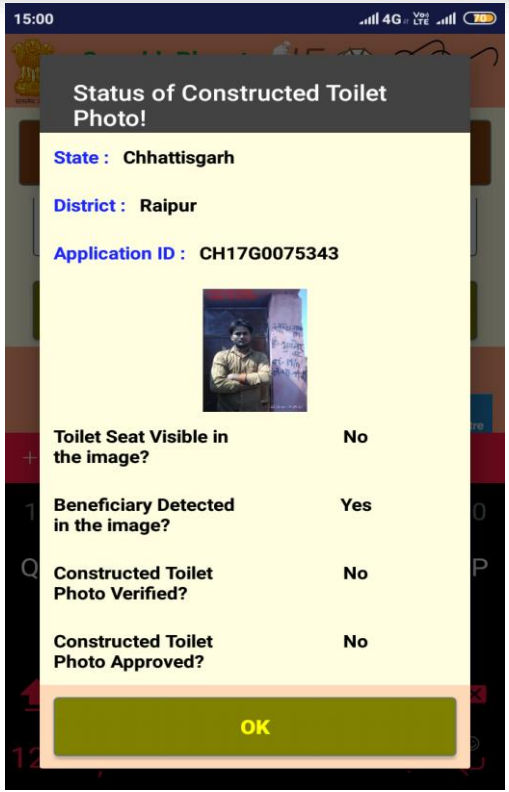
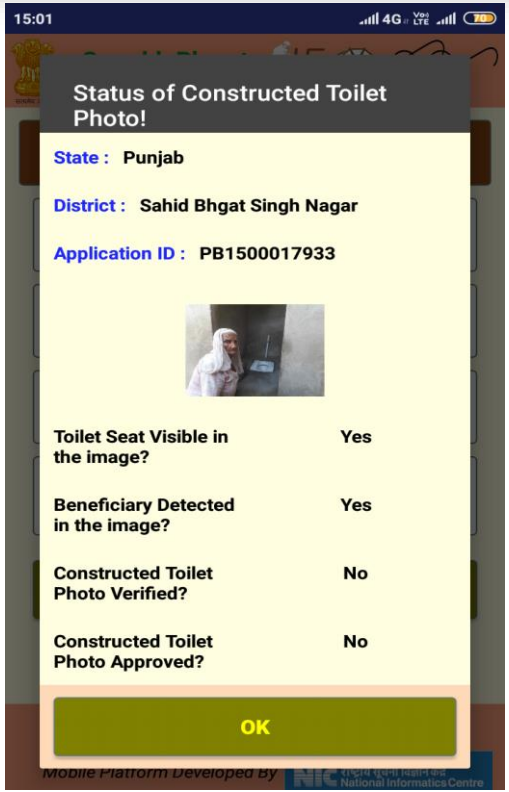
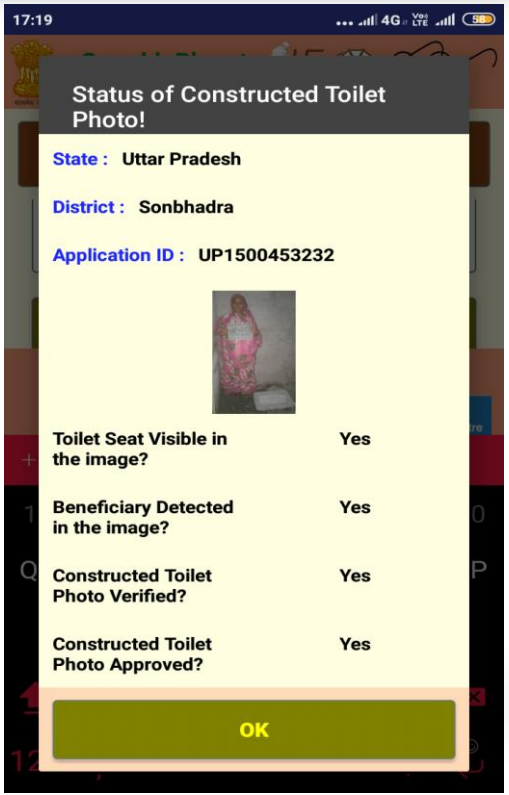


Image Analytics in eGovernance – A Practical Example







Impact

- It will help Beneficiaries upload correct Constructed toilet photos so that it does not get rejected, consequently reducing the approval cycle & time.
- It will help management analyse the effectiveness of Implementation of the scheme.
- This model can be used for Toilet seat detection in houses constructed under PMAY.

SwachhAI – AI Enabled Mobile App launched by MOS(I/C), MOHUA on 13th August 2019