

Abstract

In this work we present a prototype application based on BCBR to improve the efficiency of the Norwegian Labour Inspection Authority's inspections. BCBR is a framework that combines Case-based reasoning and Bayesian inference to construct checklists which are then displayed in the application UI.

Introduction

- Poor health, safety and environment (HSE) conditions in workplaces is a widespread problem that negatively affects both individuals and the society.
- The Norwegian Labour Inspection Authority (NLIA) conducts HSE inspections using checklists with multiple questions to survey organisations for non-compliance.
- The agency uses 269 different static checklists, which sometimes can be poorly optimized for the inspection targets and also difficult to maintain.

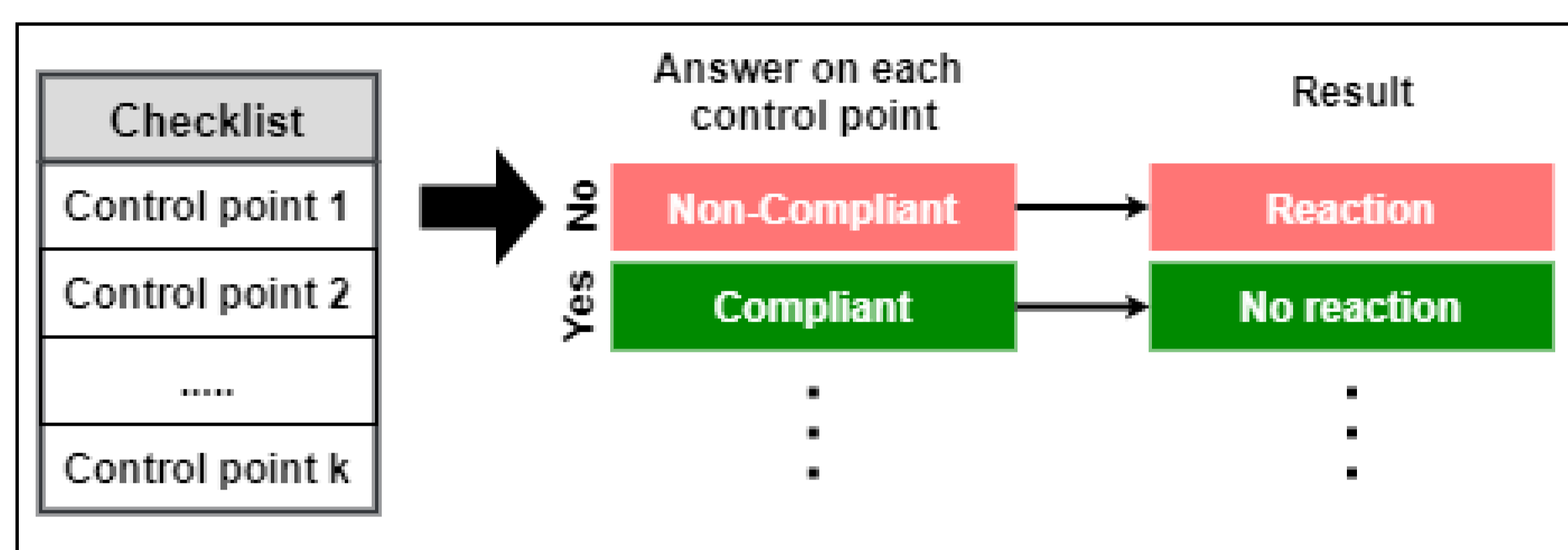


Figure 1: Conceptual view of NLIA's current checklists.

The Checklist Construction Problem

To address the shortcomings above we introduce the Checklist Construction Problem (CCP) [2]:

- Let there be N unique questions with yes/no answers, where the answer to each question has an unknown probability distribution.
- Given the questions, construct a checklist for a given target organisation by selecting K unique questions that maximize the likelihood for obtaining no-answers to every selected question.

BCBR Framework

To solve the Checklist Construction Problem we propose the BCBR framework [2]:

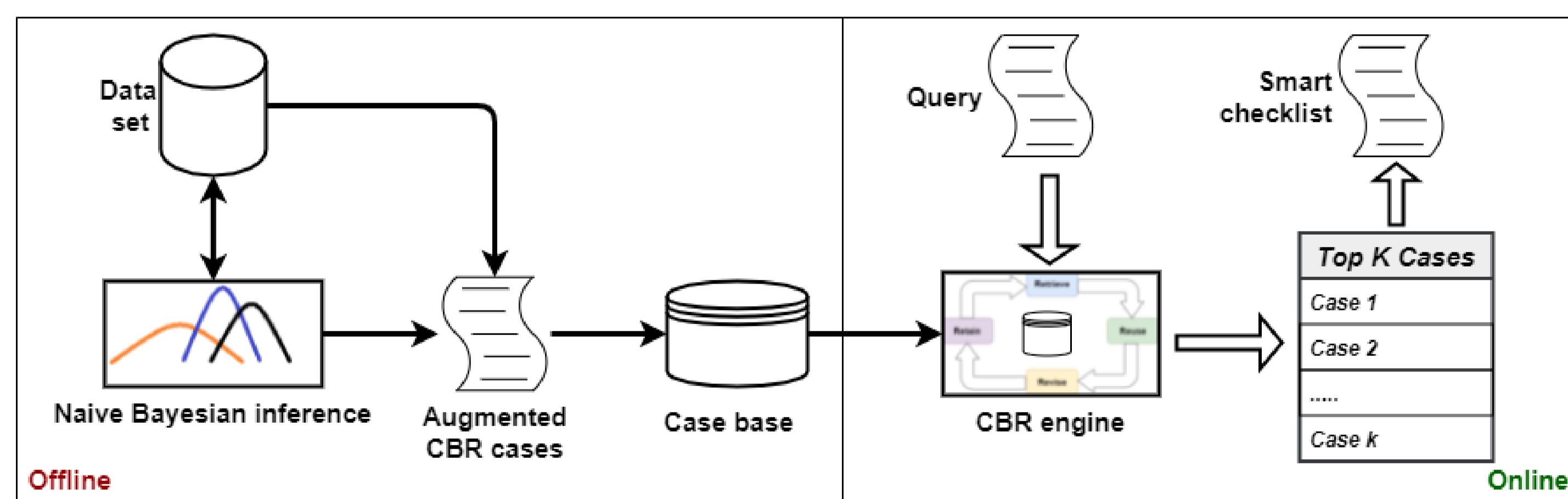


Figure 2: An overview of the BCBR framework. BCBR combines Case-based reasoning (CBR) and Bayesian inference to construct smart checklists with questions that are likely to be found non-compliant at a given target organisation.

1. **The offline part:** Starts with a data set where each instance (row) contains a target organisation and a question from a past inspection.
2. Given the target organisation and question from each instance, Bayesian inference is used to generate empirical probability estimates for non-compliance from the data set.
3. The probability estimates are added as features to each instance of the data set to create a case base of augmented CBR cases.
4. **The online part:** Starts by defining a query that contains target values for the probability estimates as well as the industry code and location of the organisation targeted for the inspection.
5. Given the query, the CBR engine (see [1]) retrieves the K most similar cases from the case base. Each case contains a question for the smart checklist.

6. Each question on the smart checklist is expected to have a high probability for non-compliance when used to survey the target organisation from the query.

Prototype Demonstration

We developed a prototype application based on BCBR that uses a data set we introduced for our earlier work [3]:

- A demonstration video of the prototype can be accessed by scanning the QR code in Figure 3.
- The prototype is also displayed in Figure 4 where the input is an inspection at a building construction company in Oslo.
- Compared to NLIA's existing checklists, the smart checklist covers a broader range of risk factors and contains more questions that are specifically related to the target organisation's industry (building construction).



Figure 3: Prototype demonstration video.

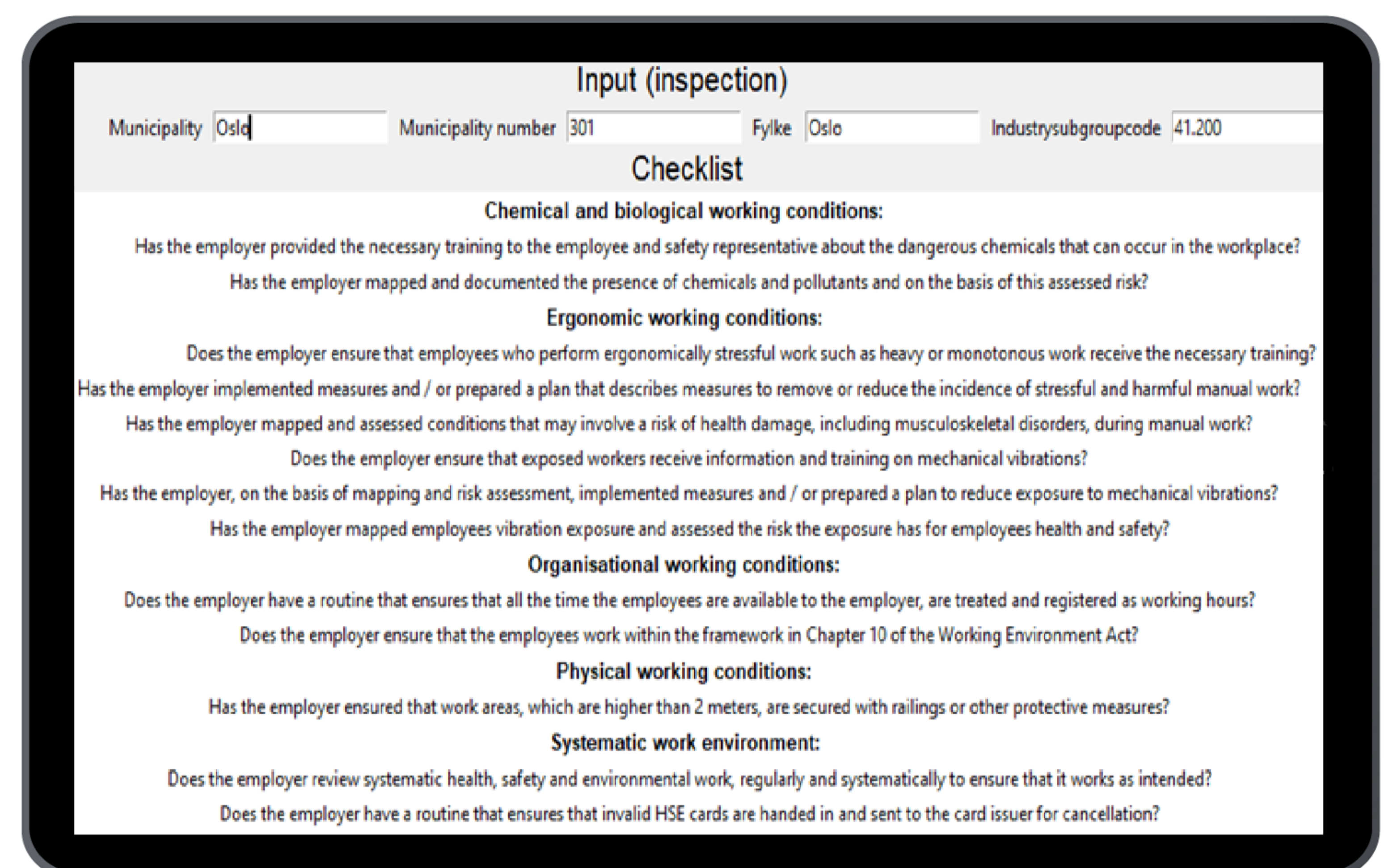


Figure 4: A smart checklist generated for a building construction company in Oslo.

Validation Results

BCBR is compared against three baselines in terms of average accuracy (**Acc**), precision (**Prec**) and recall (**Rec**) for their respective checklists:

- The results shown in Table 1 suggest that BCBR outperforms LR, NBI and NLIA's currently used checklists.
- The number of violations found per inspection is expected to increase by 95% on average.
- We expect that the smart checklists will significantly improve the overall labour inspection efficiency for NLIA, which in turn will improve the working environment of the inspected organisations.

Table 1: Validation results of constructed vs. NLIA's original checklists. The results are given for the original checklists (Org. CL), Logistic regression (LR), Naive Bayesian inference (NBI) and BCBR.

Method	Acc	Prec	Rec
Org. CL	0.337	0.181	0.622
LR	0.484	0.267	0.694
NBI	0.486	0.270	0.698
BCBR	0.574	0.343	0.718

References

- [1] K. Bach, B. M. Mathisen, and A. Jaiswal. Demonstrating the mycbr rest api. In *ICCBR Workshops*, pages 144–155, 2019.
- [2] E. Flogard, O. J. Mengshoel, and K. Bach. Bayesian feature construction for case-based reasoning: Generating good checklists. In *International Conference on Case-Based Reasoning*, pages 94–109, 2021.
- [3] E. Flogard, O. J. Mengshoel, and K. Bach. Labour inspection checklist content. *IEEE Dataport*, 2021.