Reducing Modern Slavery Using AI and Blockchain

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***Abstract*—The Modern Slavery Act of the UK has failed in reducing modern slavery significantly in UK organizations and their supply chains. One of the critical reasons for the failure is that these organizations utilize human-centered modern slavery due diligence processes, which have significant weaknesses in identifying modern slavery offenses. This paper aims to propose modern slavery due diligence process which leverages the self-sovereign digital identity component, an AI-based modern slavery offense monitoring component, and a modern slavery offense blockchain component designed to help improve the identification of modern slavery offenses which would otherwise remain hidden. This process enables managers to identify and act on more modern slavery offenses due to low-cost continuous monitoring instead of high-cost sample-based monitoring. This proposed solution can significantly reduce modern slavery offenses and generate tangible business benefits**

Keywords—Modern Slavery, Decent Work, Human Rights Due Diligence, AI, Blockchain

I. Introduction

Despite its abolition by law, slavery exists in various parts of the world in multiple forms, including forced labour, child labour, human trafficking, and bonded labour. In its 2017 report, "Global Estimates of Modern Slavery: Forced Labour and Forced Marriage," the International Labour Organization (ILO) estimates that there are more than 40 million slaves worldwide. Goal number 8 among the United Nations Sustainable Development Goals is to "*Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*" and the target 8.7 related to the decent work element of this goal is to "*Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms*". Clearly, this is an aggressive target for the vital goal. However, modern slavery is a complex ecosystem problem with supply-side and demand-side factors and misaligned incentives. Therefore, efforts to eradicate modern slavery need to take an ecosystem approach requiring collaboration across supply chains.

To help achieve the SDG target number 8.7, the Modern Slavery Act 2015 (the "Act") is in force in the UK, since October 29, 2015. It consolidates previous UK legislation tackling slavery, child labour, and human trafficking offenses. Companies subject to the Act have started publishing an annual anti-slavery statement documenting the steps they are taking to ensure that modern slavery offenses are not taking place in either their own operations or their supply chain. As per the guidance issued by the UK government, this statement usually contains information about,

- Organization structure and supply chains to identify the scope of modern slavery compliance efforts
- Organizational policies related to modern slavery in the organization and supply chain
- Due diligence processes to identify actual/potential modern slavery offenses, investigate, act on them, track responses, and communicate impact/actions to relevant stakeholders
- Assessment of modern slavery risks and plans to manage this risk
- Impact of business performance indicators on modern slavery
- Plans/activities related to modern slavery training to relevant stakeholders.

Mantouvalou [15] indicates that modern slavery regulation has not impacted modern slavery practices in supply chains due to various reasons. Appendix E in the guidance document, "Transparency in Supply Chains, etc.: A practical guide," issued by the UK government under section 54(9) of the Modern Slavery Act 2015, says that influential stakeholders with vested interests try to keep modern slavery offenses hidden by pressurizing vulnerable workers and suggests that better due diligence processes can expose these offenses. Along with these challenges, applying rigorous due diligence processes across global supply chains is a large, slow, and costly exercise. We propose a new modern slavery due diligence process leveraging AI and Blockchain technology components to provide organizations with the capability to identify more modern slavery offenses within their own operations and in their supply chains, act on these offenses and track them to closure. This can reduce costs and improve the effectiveness of due diligence processes. We also believe that leveraging this new process can help organizations to derive the business benefits beyond legal compliance described in section 1.7 of the above guidance issued by the UK government. We propose that governments should encourage organizations to adopt this type of due diligence processes to help achieve the SDG target 8.7

II. Review of modern slavery due diligence processes

Due Diligence processes focused on identifying actual or potential modern slavery impacts; acting to address these impacts, and tracking or monitoring the effectiveness of actions are a subset of the Human Rights Due Diligence (HRDD hereon) process defined in "The report of the

Working Group on the issue of human rights and transnational corporations and other business enterprise," published on July 16, 2018, by the United Nations Working Group on the issue of human rights and transnational corporations and other business enterprises. Gotzmann [8] proposes that best practices for Human Rights Impact Assessment (the component of HRDD identifying adverse human rights impacts) should (1) apply international human rights standards (2) consider the full scope of impacts (3) adopt a human rights-based process (4) ensure accountability (5) address impacts according to the severity. McCorquodale, Smith, Neely, and Brookes [10] found that the primary methods for human rights impact assessment part of HRDD to identify actual/potential human rights impacts were desktop research/studies and internal/external audits and the secondary methods included investigations by internal/external investigators, independent expert reports and grievance mechanisms. They found that if these methods leveraged a dedicated human rights lens, i.e., tools, templates explicitly designed with human rights terminology and framework of thought, they are more likely to help identify adverse human rights impacts, which might otherwise remain hidden. Reusing/extending another lens, i.e., reusing/extending tools, templates designed for workplace health and safety, labour rights, equality, and non-discrimination, indigenous or land rights, etc. was found to be less effective in identifying adverse human rights impacts. They explain that to do a good HRDD, people who play the critical roles in doing it, not only need to be trained to understand the complex concept of human rights, which is made up of multiple individual rights but also need to be trained to operationalize these concepts for the particular organizational or supply chain context in which they are doing HRDD. Unless well trained internal/external experts are available, it is challenging to do HRDD well. Huq, Stevenson, Zorzini [5] describe problems in identifying modern slavery offenses, including corrupt auditors/investigators, misleading documents, mock compliance, the risk to auditors/investigators, compliance only cultures. Stevenson and Cole [7] have analysed the modern slavery statements of UK enterprises to find that the due diligence processes used are resource-intensive and difficult to apply across the supply chain. Some of them use different risk assessment means to target and focus their efforts, some are collaborating with other firms to share the efforts and costs of due diligence processes, while some are encouraging whistleblowing through multiple means. Most organizations are relying on suppliers to monitor modern slavery offenses in lower-level suppliers, requiring them to report compliance in the selection of subcontractors as well as the compliance of the subcontractors with the codes of conduct specified. Cole, Stevenson, Aitken [9] describe that for organizations and supply chains in low-cost, labour-intensive industries like fashion, where social sustainability is a significant concern due to significant reputational risk, blockchain technology can help to increase the transparency of the supply chain to comply with modern slavery regulations. New [13] describes using the example of Waitrose in the UK, how incentive misalignment between organizations and their suppliers might encourage modern slavery in supply chains. This is the case, despite the observation by Gold, Trautrims, Trodd [12] that large commercial organizations can leverage their power over their suppliers to reduce modern slavery practices in the supply chain.

Essentially current best practice for HRDD seems to be to use a human rights lens and leverage well trained internal/external human experts to directly audit/investigate the following processes within the organization and its supply chain, speaking to the relevant people including vulnerable workers and reviewing the data for these processes to identify actual and/or potential modern slavery offenses and handle them according to their severity.

1. On-boarding vulnerable workers (Children, Women, Local migrants, Foreign migrants, Seasonal workers, Contract and agency workers, Marginalised workers, Domestic workers)
2. Day-to-day operational processes including grievance handling processes

However, there are three critical problems with the current best practice. Firstly, human-centered due diligence processes tend to be costlier, slower, and error-prone and hence suitable only for detecting offenses from samples of the above processes, making it is easier for influential stakeholders with vested interests to prevent identification of offenses by pressurizing vulnerable workers. Secondly, influential stakeholders with vested interests in the organization and its supply chain may tamper with the evidence for identified offenses, seek to tamper with the actions and/or the tracking/monitoring of actions. Thirdly unless incentives are aligned at a strategic level, due diligence processes are less likely to be effective at identifying and handling modern slavery offenses.

III. Improving Modern Slavery Due Diligence Process

A. Proposed Modern Slavery Due Diligence Process

We recommend an improved modern slavery due diligence process leveraging three IT solution components, a modern slavery offense records blockchain component, a self-sovereign digital identity component, and an AI-based modern slavery offense monitoring component.

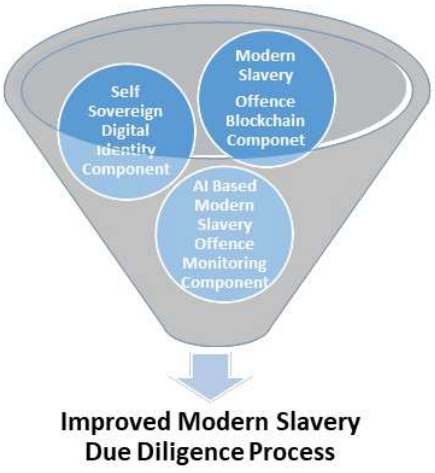

Fig. 1. Improved Modern Slavery Due Diligence Process.

We first describe the three components and then explain how the process leverages them to reduce costs, delays, and errors caused by humans increases actual and potential modern slavery offenses identified and enables transparent, audited actions as well as improves tracking/monitoring of these actions.

Kara [12] emphasizes that technology is used to isolate victims of modern slavery and increase the information asymmetry faced by them. Many victims are not aware that they are working as slaves under the relevant laws and may not be aware of the means of getting out of modern slavery. Kara further describes that the primary benefit of blockchain technology is to create unique, unalterable identities for modern slavery victims who often lack formalized identification documents.

In particular, blockchain-based self-sovereign identity described in Mühle, Grüner, Gayvoronskaya, Meinel [2], can help to improve employee on-boarding processes in organizations and their supply chains to capture employment consent as well as enable such employees to on-board to salary accounts with banks. This enables systematic tracking and management of vulnerable workers across their careers within and across organizations and provides a direct mechanism for reducing their information asymmetry

The Self Sovereign Digital Identity Component functions as described below

- Employee creates decentralized identity (DID hereon) on a blockchain (preferably public blockchain) using a modern slavery compliant digital identity application on his smartphone personal device and uses it to prove that he is in control of the DID.

- Employee acquires digital attestation certificates about his/her attributes from appropriate attesting parties (e.g., Government) and stores them on his smartphone along with the attributes

- The employee uses DID and digital attestation certificates to prove his/her attributes to the employer and Bank using his/her personal smartphone device as part of on-boarding to the employer's Human Resources (HR hereon) system and/or bank system. This process also ensures that the employee provides explicit consent to the employment contract. For agency workers, the digital identity of the agency and the organization can be used to digitally sign and on-board the contract to the HR system. As each individual agency worker is added, the digital identity of the employee can be used to add a tripartite endorsement to the agency contract. In both these cases, the process of validating the contract signatures from respective parties can include relevant government organizations to reduce the possibility of non-compliant employment/agency contracts. Since this does not impact the privacy of the employment contract, beyond the current situation, we believe that this is practically implementable and can help to save later audit efforts by government authorities as well as potential upstream suppliers as part of their respective modern slavery compliance.

- Employee uses DID to provide Global Data Protection Regulation (GDPR hereon) consent to employers HR system for gathering and processing of video feed of the workplace to identify modern slavery offenses

- Employee uses DID to provide Open Banking consent while on-boarding to the bank system enabling the Bank to provide salary payment to an AI-based Modern Slavery Offenses Monitoring Component describe below to check compliance with living wages regulation using the number of hours worked (see Table II below).

TABLE I. TECHNOLOGY SOLUTIONS FOR IDENTIFYING MODERN SLAVERY OFFENSES

Modern Slavery Offense Areas	***Potential Technology Solution***
Employment is freely chosen	Using digital identity for on-boarding/access to the HR system captures employment and GDPR consent from employee and prevents the on-boarding of children using image analytics. The process of on-boarding/access to the HR system can cover agency workers too by two-stage on-boarding, firstly of the agency contract to the HR system and then one endorsement for each agency worker on-boarded to the agency contract. In these cases, the on-boarding process can include an online review by the relevant government body to ensure that employment contracts are compliant.
Child labour shall not be used	
Living wages are paid	Using digital identity for on-boarding/access to salary account in Bank captures open banking consent and enables monitoring compliance to living wage regulations

The AI-Based Modern Slavery Offenses Monitoring Component functions as described in below table

TABLE II. TECHNOLOGY SOLUTIONS FOR IDENTIFYING MODERN SLAVERY OFFENSES

Modern Slavery Offense Areas	***Potential Technology Solution***
Working conditions are safe and hygenic	Video analysis of Closed-Circuit Television (CCTV here on) footage of workplace
Working hours are not excessive	Report from image analysis (CCTV footage of the entry-exit area)
Regular employment is provided	
No harsh or inhumane treatment is provided	Activity analysis of CCTV footage of workplace
Freedom of association and right to collective bargaining are respected	It may not be possible to monitor until more audio-video training data is collected and used for training the relevant AI algorithms
No discrimination is practiced	

The below table describes the AI elements used in the AI-based Modern Slavery Offenses Monitoring Component

TABLE III. AI ALGORITHMS NEEDED

References in Table I and II	*Names/Types of algorithms needed*
Image analytics	CNN-VGG-16 and CNN-VGG-19 by Simonyan, Zisserman [6], Alexnet by Krizhevsky, Sutskever, Hinton [1], Inception by Szegedy, Vanhoucke, Ioffe, Shlens [4]
Video analytics	Object and Motion Detection across image sequence – see Yazdi, Bouwmans [15]
Activity analytics	RNN based model of Object/Parts by De, Arnab, Golodetz, Sapienza, and Torr [3].

The modern slavery offense blockchain component functions as described below

- The modern slavery offense Blockchain component is a public permissioned blockchain (distributed ledger) with nodes for all the members of the ecosystem, including the organization, it's suppliers, the regulator, non-government bodies monitoring offenses and helps to record each offense.
- Whenever the AI-Based Modern Slavery Offenses Monitoring Component instance connected to the node for the organization or any of its suppliers detects a modern slavery offense, it proposes it to the remaining nodes along with the evidence. The large-sized audio-video evidence snippet is stored off-chain, and only a hash of this evidence is proposed on-chain. The respective nodes review the on-chain, and off-chain evidence proposed manually or using automated means and provide their approval/rejection depending on validity. Only if there is a consensus among the nodes that it is a valid actual/potential modern slavery offense, it is written to the public permissioned blockchain. Once it is written to the public permissioned blockchain, the record is immutable.
- The modern slavery offense blockchain component may facilitate the handling of the modern slavery offense event among the various stakeholders in a transparent, auditable manner. This will include deciding, recording the actions across the ecosystem, and tracking the actions across the ecosystem to closure.

B. Use cases of Modern Slavery Due Diligence Processes

The vulnerable worker creates his/her identity and attributes and gets relevant attestations from an appropriate trusted party using the self-sovereign digital identity component. The vulnerable worker uses his/her self-sovereign digital identity and its attributes to open a bank account in the bank system and provide Open Banking consent to monitoring of living wages. The vulnerable worker uses his/her self-sovereign digital identity and its attributes to on-board to the HR system, provide GDPR consent to gathering and processing of video feed of the workplace to monitor modern slavery compliance

The process of on-boarding children to the HR system of organization/supplier uses a self-sovereign digital identity component to identify and prevent non-compliance with minimum age regulations. The process of accessing salary paid into the Bank account using open banking technology identifies non-compliance with living wage regulations. The AI-Based Modern Slavery Offenses Monitoring Component can learn to identify the following types of modern slavery offenses

- Working conditions are not safe and hygienic.
- Working hours are excessive
- Regular employment is not provided
- Harsh or inhumane treatment is provided.

Overtime by human supported training data curation, the AI-Based Modern Slavery Offenses Monitoring Component can also learn to identify the following types of modern slavery offenses

- Freedom of association and right to collective bargaining are respected
- No discrimination is practiced

The modern slavery offense blockchain component can record modern slavery offense evidence in a tamper-proof manner after appropriate parties have validated it. The modern slavery offense Blockchain component can trigger collaboration among the various stakeholders for each modern slavery offense event in a transparent, auditable manner to act on the offense and track/monitor these actions

The above, due diligence process is dependent on (1) a self-sovereign digital identity provider who can provide a modern slavery compliant digital identity application for smartphone personal devices as described above (2) A trusted party to attest self-sovereign identity (3) Bank which can on-board using self-sovereign identity and support customer consent-based open banking interface to the AI-Based Modern Slavery Offenses Monitoring Component (4) organization/supplier HR systems which can on-board employee using self-sovereign digital identity and record GDPR consent (5) AI-Based Modern Slavery Offenses Monitoring Component which can identify modern slavery offenses (6) modern slavery offense Blockchain component which ensures tamper-proof evidence management and transparent, audited collaboration to handle modern slavery offenses.

IV. MANAGERIAL IMPLICATIONS

A. Practicality and Scalability of the solution

Self-sovereign digital identity components, AI components to identify modern slavery offenses and Blockchain technologies for creating tamper-proof records are available commercially from multiple technology providers. Many of these are available for scalable deployment on cloud, can support multi-lingual interfaces for multi-country deployments. So, there are no technology challenges to realize the solutions described in a practical and scalable manner. We have described some ways and means of meeting the applicable regulation in this paper. However, there are two critical dependencies on the GDPR consent provided by the employee to the employer HR system and the

open banking consent provided by the employee to the Bank to enable the AI-Based Modern Slavery Offenses Monitoring Component, which need some discussion. Under current GDPR regulation and Open Banking regulations, providing both these consents is not normally mandatory for the employee since it violates his/her privacy. Employers will need to mandate that the employee provide these consents to enable employers to provide on-chain proof of their compliance with modern slavery regulations to the regulator. If necessary, we recommend that there should be an appropriate modification in the relevant regulations to facilitate this. Other than this slight challenge, we are confident that such solutions will be efficient and scalable from the regulatory point of view.

B. Implications for Setup of New Process

This solution requires organizations and suppliers to modify their employee on-boarding processes to use self-sovereign digital identities for all employees. If their chosen provider of self-sovereign digital identities is compliant with the standards and guidelines of the Digital Identity Foundation, such digital identities will be interoperable and support the solution. There is a need for business and technology alignment with attesting organization, Bank, and HR system provider. This solution generates multiple benefits listed in this paper as well as creates a basis for a lot more benefits due to the other possible uses of self-sovereign digital identities. This solution requires organizations and suppliers to install and maintain audio and video surveillance equipment in their workplace (shop floor, mines, etc.) and connect the audio-video feed from it to the AI-based modern slavery offense monitoring component. Most of the time, the equipment will already exist, and the only effort and cost needed are to connect and process the audio-video feed.

This solution needs to be integrated into the GDPR compliance processes and solutions to ensure obtaining/managing consent as well as support other services to the employees, related to the data captured by this solution about them. Eventually, it will be possible to leverage trusted computing technology, to prevent unauthorized analysis of the audio-video feed, beyond the GDPR consent provided by the vulnerable employee.

This solution needs to be integrated into the Open Banking consent framework of the Bank to enable the monitoring of the living wage

C. Implications from Operating the New Process

Once the above setup processes have been completed and the solution is fully operational, it automates the identification of modern slavery offenses on a continuous basis, thereby reducing the human effort and cost needed for this and overtime increasing the offenses identified. Initially, the solution will need more human support to review the offenses identified by it and use human judgment to decide whether it is indeed an offense. Based on the actions of this human, the training data set of the solution will be varied periodically, and the solution will improve over time and needless human support as the accuracy of identification increases. Nevertheless, it is desirable to retain humans in the loop all the time later too.

Over time, this solution will learn and increase the chances of identifying more modern slavery offenses. It will also reduce manual modern slavery compliance efforts (including internal/third-party expert efforts for training, audit, investigation) focused on offense identification. This solution helps to create a tamper-proof record of modern slavery offenses which are directly visible to the relevant stakeholders, thereby reducing the efforts incurred in handling modern slavery offenses. Overall, this is expected to reduce the modern slavery compliance costs, modern slavery offenses, and help achieve wider business benefits.

While the above solution may help to identify and reduce modern slavery offenses in one part of the ecosystem, modern slavery being an ecosystem problem, modern slavery offenses may occur again in different form in different part of the ecosystem due to misaligned incentives. This solution can be extended to support modern slavery experts from organizations participating in the ecosystem to collaborate and align stakeholder incentives to reliably reduce modern slavery offenses and prevent recurrence across the ecosystem. We shall describe how this can be done in a later paper.

D. Implications for Accelerating the United Nations Sustainable Development Goals

Since all the technology components are commercially available as of March 2020, integrating them to realize end-to-end solutions can be done in multiple ways. Understanding them using cloud-based standardized components, facilitated by regulation can support accelerated adoption and help to fulfil the target of immediate and effective measures towards eliminating modern slavery. In particular, the adoption of self-sovereign digital identity, based employee on-boarding processes along with the related integrations to the respective HR systems of organizations and their suppliers, can accelerate the elimination of child labour.

V. CONCLUSION

The target 8.7 focused on the decent work element of goal 8 among the sustainable development goals has driven country-specific modern slavery regulations like the UK Modern Slavery Act. Most organizations to whom these regulations are applicable are complying with these regulations in minimal and manual manners, despite the possibility of deriving significant business value from increasing the length and breadth of compliance efforts. We reviewed the challenges that organizations face in ensuring modern slavery compliance within their own operations as well as the operations of their suppliers and proposed improved modern slavery due diligence process that helps to identify and handle different types of modern slavery offenses. It not only meets the challenges faced but also reduces the cost of modern slavery compliance efforts due to automation and error reduction as well as increases the scale and scope of monitoring of modern slavery compliance from sample-based audits to 24X7 monitoring. Most importantly, we discussed the practicality and scalability of the proposed solution.

We believe that realizing the proposed modern slavery compliance solution as part of the overall modern slavery compliance process and activities using cloud-based standardized components facilitated by regulation can help the acceleration of the fulfilment of the target of immediate and effective measures towards eliminating modern slavery

as well as help eliminate child slavery by 2025. This will maximise the decent work focused target 8.7 of SDG 8.

VI Future Research Agenda

Modern slavery is a complex ecosystem problem. There are ambiguity and interpretation challenges. In this paper, we have described a framework and toolkit to identify and act on modern slavery offenses addressing some of these challenges. Firstly, some challenges like identifying violations of freedom of association, right to collective bargaining, and no discrimination need to be addressed by future work. Secondly, research shows that modern slavery is a sticky, re-occurring phenomenon. If you remove it in one part of the ecosystem, it can reappear in a slightly different form in a different part of the ecosystem. So future research agenda also includes applying this framework and toolkit to reliably reduce modern slavery from the entire ecosystem by identifying and reducing misalignment of incentives across the ecosystem and stakeholders to prevent re-occurrence.

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