Analysis and Comparison of Asset Declaration Systems

Besnik Dragusha[1][0000−0002−7509−2179], Azir Aliu[1][0000−0002−1575−170X], and Kadri Sylejmani[2][0000−0002−4428−1161]

[1] South East European University, Ilindenska No. 335, 1200 Tetovo, North Macedonia
[2] University of Prishtina, St. George Bush No. 31, 10000 Prishtina, Kosovo
bd29734@seeu.edu.mk
azir.aliu@seeu.edu.mk
kadri.sylejmani@uni-pr.edu

Abstract. Senior officials report their assets to the relevant national anti-corruption institution (ACI) each year. For an ACI, is a complex problem, how to detect the abnormal (unusual) growth of the assets of senior public officials. The digitalization of the systems of asset declarations can help the ACIs to identify the public officials that have abnormal growth of assets by using machine learning methods on the data of the asset declarations. Most asset declaration systems are designed for gathering and managing data of asset declarations. The main aims of those systems are to compare and verify the data of asset declarations of senior officials against their supposed real state of properties. This paper presents an analysis of features, methodology, and workflows for the systems of asset declaration in five countries, such as Albania, France, Kosovo, North Macedonia, and Ukraine. In addition, the paper presents a comparative analysis of the electronic systems to see if they are using any algorithmic methods for automated analysis of the assets declared data to detect suspicious declarants. Our analysis shows the similarities in the workflow processes of ACIs for components such as attributes, submission, and verification of declarations. Also, the paper presents the differences between SDRP, EACIDS, E-DECLARATION, SIMIDAI, and ADEL electronic systems regarding online declaration, process automation, cross-validation, and full control. By implementing an automated risk analysis module based on the 'Red Flags' algorithm, SIMIDAI appears as the optimized system for declaring assets.

Keywords: Asset Declaration System · E-declaration · Indicators · Data Analysis.

1 Introduction

The Asset Declaration (AD) process entails the methodology of data disclosure on functions, properties, incomes, loans, cash, businesses, etc., of Senior Public Officials (SPO) and their family members to the relevant state institution or special agency each year. The AD process, in addition to asset data gathering

of senior public officials, also includes their comparison, submission, verification, and full audit to detect unjustified enrichment and conflict of interest. The assets and interest declaration systems have two main functions, such as prevention of corruption, and fighting against it [1]. The AD process is an important mechanism for identifying the legality of public officials' assets [2], and it may be an important tool for fighting and preventing corruption of politicians and SPOs [3]. For an ACI, it is important to have a mechanism to find and identify the officials who have abnormal growth of assets or unjustified enrichment over the years. The digitalization of AD systems could help in the automation of asset analysis [4], more specifically the application of advanced Machine Learning (ML) algorithms for prediction-making of suspicious declarants.

Nowadays, the process of transformation of systems of public services from paper-based to electronic ones is a global trend in e-government strategies of various countries. ICT-driven anti-corruption initiatives must be implemented in the public sectors [5], and service automation to decision-making must be followed with software processes since it helps in reducing corruption [6], and therefore helps in eliminating the discretion of officials and reducing bureaucracy [7]. The transformation of AD systems by data digitalization is important for fighting against corruption. In addition to the digitalization of the process of declaration of assets, in trend is also the publication of declarations in 'open data' form and process automation, because an automated system will transform the place by providing more efficient and transparent services [8]. Also, online declarations, automatic submissions, cross-check verification by connection with government external databases, and data declaration analysis by using advanced algorithms are crucial for an ACI to be more effective in the fight against corruption [4]. Western Balkan countries, such as Albania, Montenegro, North Macedonia, Slovenia, and Serbia, like some others in the world, such as Canada, France, Estonia, Indonesia, Japan, Lithuania, Georgia, Romania, Hungary, USA, Ukraine, Uganda, UK, etc., have digitalized their asset declaration process, and they are using an electronic system for gathering and managing asset data [9–11]. Lithuania [12] digitalized its AD system in 2004, while Kosovo ACA [13] has stored AD data in digital format since 2011, but it is using the manual method for data gathering and verification.

In this paper, we analyzed and compared five AD systems from different countries to identify their benefits and make a comparison of their features. The main aims of this research are: (1) the description of an asset declaration system workflow and identification of the most important attributes, (2) the identification of indicators used to classify public officials as suspected declarants, and (3) the identification of gaps in existing asset declaration systems.

The rest of the article is structured as in the following: Section II provides a brief background on AD systems; while Section III consists of the literature review on asset declaration frameworks and systems; Section IV encompasses the methodologies and workflow processes of five existing AD systems; Section V presents an analysis of AD systems and discussions about them; and finally, the paper ends in Section VI with a short conclusion and future work.

2 Background

The UNCAC[1] calls on member countries to put in place a structure and framework for the declaration of assets by SPOs in order to improve good governance and the fight against corruption. [9]. A research paper report by the World Bank [10] has presented the number of countries (161 countries) that have a declaration (disclosure) system from 176 countries in the sample. The AD systems are used for declaring the assets of SPOs, data analysis, comparison, verification, etc. Depending on the IT infrastructure of ACIs, the asset declarations are conducted by gathering data using one of three possible methods [14], namely, manuals (hard copy), electronic (online), and mixed (both manual and electronic) forms. Each ACI uses a specific declaration platform [13] to gather data on the asset declaration of the SPOs, such as the domain of the person's ID, public and private functions, immovable and movable properties, cash, liabilities, income, family income, business, etc. Each of these attributes may have some declaration entity per person within the type (e.g., the immovable properties contain: houses, apartments, land, forests, etc., the movable properties include: cars, buses, planes, etc., the incomes contain: wages and all other incomes).
The main processes of an AD system are declaration, preliminary check, submission, data validation, verification, and investigation. Verification is essential for detecting unjustified enrichment, interest activities, unusual growth assets, etc. [15]. The ACIs select approximately 10% to 30% of the current year's declarants at random or in a predefined institutional order, to fully verify and control declared assets. This approach excludes about 70%-90% of SPOs from the verification process. Another approach is the risk management [4] strategy that prioritizes the declarants based on their position or institutions that are considered high-risk based on local laws. The process of the verification of assets could find abnormal enrichment, detect conflict of interest, etc. But, when the domain of verification is small, or the declarants are wrongly selected, many potential suspected persons might be excluded from the verification process.
According to the literature reviewed and our best knowledge, existing AD systems do not use advanced ML algorithms for the automatic detection of abnormal growth of assets or unjustified enrichment of senior public officials.

3 Literature Review

There are some papers and reports in the literature that describe the processes of asset declarations in different countries. Our literature review suggests that AD systems should be digitized to support data collection and the methodology for managing asset declarations and conflicts of interest. T. Hoppe, et al. [13], presented and described the process of asset declaration, data processing, full audit, and investigation in the regional (Western Balkan) countries. These regional countries use a similar methodology of asset declaration process, which is realized in four phases: (1) gathering data – which describes the period, forms, and

[1] *UNCAC: United National Convention Against Corruption https://uncaccoalition.org*

attributes of asset declaration; (2) preliminary check – which means the process of checking declaration data; (3) creating a list of declarants for verification and full control; and (4) full control or full verification of asset declarations and investigation for all SPO's list from the third phase. In an analysis study document, authors A. Habershon and H. Mulukutla [16] presented the main functions of the electronic system for asset declaration of the Corruption Eradication Commission (CEC) in Indonesia. These functions of the e-system are managing AD's data of Indonesian public officials, reorganizing its verifying procedure, automatic submission compliance, automatic formal (preliminary) check, and automatically flagging declarations for audit. Authors D. Kotlyar and L. Pop [4] presented an analysis of the asset declaration system by focusing on the technical concept of automated risk analysis. This guide recommended the automated risk analysis for asset declaration systems based on countries' corruption indicators to produce the 'Red Flags' for the suspicious declarants by using the True/False algorithmic approach. The automated risk analysis methodology could be applied in asset declaration systems by containing four elements, such as risk indicators, the weight of risk indicators, the method of analysis, and the formula of total risk value, as defined by Equation (1).

$$R = \sum_{i=1}^{N} AR_i \times W_i \tag{1}$$

where: R- risk value of declaration; N – total number of risk analysis rules; i – the rule of risk analysis; AR – risk analysis rule answer (True, or False); W - the weight of each risk analysis rule [4].

B. Cela [17] introduced Ukraine's electronic AD system, which is making significant progress in the fight against corruption. The system contains software to automatically check the uploaded electronic declaration and it is a 'Red Flag' for any inconsistency or false information. While the authors T. Hoppe and V. Kalniņš [18] presented the NACP electronic AD system workflow process, which is connected to 10 external databases to verify declaration data. The OECD [12], described assets and conflict of interest declaration protocols, scopes and subjects, forms of declaration, and evaluation systems in the countries: Lithuania, Romania, Spain, and Ukraine. The authors H. Ear-Dupuy and O. Serrat [5] presented the importance of using ICT in fighting corruption. They presented the benefits of using the latest ICT advancements in fighting corruption in Asian countries and how it has transformed governance and institutions in Asia by using the ICT to promise e-government, open data, growth transparency, online services, reporting of issues, online declaration, etc. Whereas authors L. Amin and J.Marín [19], analyzed asset declarations methodologies and presented some recommendations to OPG (Open Government Partnership) members. These recommendations reviewing the asset declarations framework, developing digital systems for online declaration of SPOs, and the implementation of a plan to monitor and verify assets. The plan describes the importance of comprehensive regulation of assets such as immovable and movable property, incomes, liabilities, and sources of wealth.

All these articles presented the methodology for declaration of assets in different countries, which applied electronic declaration, automatic submission, cross-validation of data, and the high-risk analysis based on the 'red flag' method. None of our examined papers presented an advanced algorithmic method for classifying and predicting suspect declarants, which is the main purpose of ACIs. In the future, we will attempt to optimize the AD system of the Kosovo ACA by developing an intelligent system, which will apply the advanced Machine Learning (ML) algorithms to automatically identify SPO with abnormal enrichment.

4 Methodology

Our methodology is defined to analyze and compare the processes of AD systems, to understand the methods, technologies, algorithms, and indicators that are used to detect and fight corruption. First, we reviewed the literature on asset declaration systems and anti-corruption institutions. Secondly, we selected five ACIs, three from the Western Balkans and two from outside the region, to analyze and compare their AD systems. They are HIDAACI[2] of Albania, ACA[3] of Kosovo, HATPL[4] of France, SCPC[5] of North Macedonia, and NACP[6] of Ukraine. After data collection, we chose to use the qualitative method to analyze the workflow processes of AD systems. The quantitative method was also used to analyze and compare the features of the five selected AD systems. Additionally, we used the online survey method to obtain input for AD systems from the professional staff of the ACIs.
According to the aims of this paper for the comparison of the AD systems, we have analyzed their workflow and main features to answer these questions: (1) What are the main steps of the workflow AD process; and (2) What are the main features of an advanced electronic asset declaration system?

4.1 Data Gathering

The data collection approach was based on the research and selection of papers, articles, reports, guides, and annual reports on AD processes and systems. During the research, 113 papers were gathered on AD processes and/or AD systems over the last decade. As well, we used the survey, e-mail, and phone calls to the five selected ACIs to collect data on their AD systems. The preparation of this questionnaire was preceded by a study visit of mine to HIDAACI (in Albania), where I saw and discussed with the inspectorate's staff the main features and technical functionalities of their electronic AD system. We have chosen to review the most cited papers and articles that are related to AD systems and processes.

[2] *HIDAACI: High Inspectorate of Declaration and Audit of Assets and Conflict of Interest - https://www.ildkpki.al/*
[3] *ACA: Anti-Corruption Agency - https://www.akk-ks.org/*
[4] *HATPL: High Authority for Transparency in Public Life - https://www.hatvp.fr/*
[5] *SCPC: State Commission for Prevention of Corruption - https://dksk.mk/*
[6] *NACP: National Agency for Corruption Prevention - https://nazk.gov.ua/*

We then selected the AD systems of Albania, Kosovo, North Macedonia, France, and Ukraine for analysis and comparison. We developed this analysis and compared the region and out-of-the-region ACIs to identify the advanced features of AD systems and their gaps in the automation of processes.

4.2 Workflow Processes of Asset Declaration Systems

The workflow of AD systems presents all the steps that must be completed in the asset declaration process from the data collation (first phase) to the verification and case processed in the competent prosecutions (as the final phase). Further to this, we describe the five electronic AD systems, which are SDRP, EACIDS, E-DECLARATION, SIMIDAI, and ADEL. In general, all of these systems (all of these anti-corruption institutions) use some similar steps that might be considered the core of the process workflow. We designed a workflow for the asset declaration of the Kosovo ACA (see Fig. 1) to describe the main steps of these systems.

SDRP. The main corruption prevention body in Kosovo is an independent and specialized agency called Anti-Corruption Agency (ACA) [20]. The ACA has been using a digital system, SDRP, since 2011. The System of Declaration and Registration of Properties (SDRP) is developed for the registration and management data of the asset declaration of SPOs. The SDRP platform is developed in Microsoft C# language, ASP.Net, and SQL Server, and it is designed to be used as an internal web application for the ACA staff. The main features of the SDRP are: storing the data of all declarations in digital format, searching into database for different years and declarations, generating some reports, and protecting private information during the process of published registers of asset declarations (that will be published to the ACA website[7] in PDF). Also, SDRP supports the feature of automatically generating the random list of the current year declarations for full control. The opening of data about public officials increases transparency [21] and can empower citizens to participate in the process of fighting corruption [22]. Therefore, the publication of asset declarations is important in the cooperation between ACIs and citizens to detect the non-declared properties, interests, and other assets of the SPOs. In this regard, the ACA has published on its website all declarations of assets since 2011. According to ACA's annual work report for 2021 [23], the ACA is developing a new asset declaration system that will be extended with online declaration and case management modules, and the interconnection to six governmental databases. But until now, Kosovo uses the paper form for the declaration of assets, which are manually submitted to ACA staff, and they are digitalized being entered word by word into the SDRP database [13].
The diagram in Fig. 1 presents the main steps of the AD processes, which we have designed based on the ACA business workflow. At the beginning of each year, ACA publishes the list of all SPOs who are obligated to declare the assets within

[7] *ACA website: https://www.akk-ks.org/en/deklarimi_i_pasuris/171/deklarimet/171*

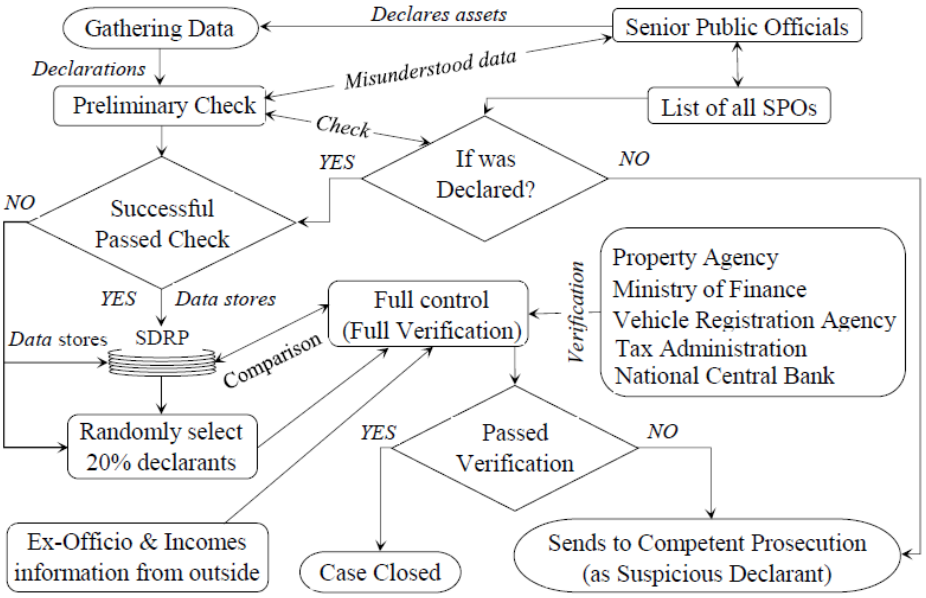

Fig. 1. Workflow diagram for the system of asset declaration of the Kosovo ACA

the deadline set by the applicable law on the declaration assets. After gathering the declaration data, ACA initiates a process called 'Preliminary Check', which means verifying each declaration for misunderstood and incorrect data types. Also, in this step, ACA checks and validates the declarations with the list of SPOs. Where all officials that did not declare assets send their cases to competent prosecutions, while all declarations are put in the SDRP database to digitize them. The full control process is considered the most important step of this workflow, which includes the validation and verification of each asset declaration data of all SPOs from the full control list. The full control list contains at least 20% of all declarants in the current year, which were selected randomly by the short method. Sometimes ACA extends the full verification list by adding other declarants where it has any information on the false declarations or faster-growing assets. Finally, ACA closes the cases for all declarants that justify their assets, whereas, for all others that cannot justify their assets, it sends the cases on suspicious declarants to competent prosecutions.

EACIDS. The Electronic Assets and Conflict of Interest Declaration System (EACIDS) is a web-based platform for the online declaration of assets of the SPOs in Albania, which was launched for use this year. This e-declaration system is administered by HIDAACI institution. The EACIDS[8] has developed two main modules: online declaration of assets and case management. Until this

[8] *EACIDS platform: https://deklarimi.ildkpki.al/Account/Login?ReturnUrl=%2F*

year, HIDAACI used the manual method for storing and gathering data of asset declarations, but starting last January, it changed to an electronic form. This electronic AD system is designed to connect with some other government databases for data exchange, but until now, such connections have not happened. The EACIDS system has integrated a module for asset data verification and uses a 'Red Flag' method for flagging the officials who had changed any properties from the last previous declaration. According to HIDAACI's annual work report for 2020 [24], they had carried out full control on 762 declarants out of a total of 3769. Albania, like Kosovo and North Macedonia, applied four types of asset declaration, such as upon taking the office, periodic or annual, after leaving the office, and upon request declaration [13].

E-DECLARATION. The e-system for AD in North Macedonia is administered by SCPC. The SCPC is the main institution of anti-corruption in N. Macedonia. It is mandated with the gathering, monitoring, and managing of data of asset declarations. The AD process submission is obligatory for high-level public officials, senior servants, notaries, and anyone else who SCPC requests as an official in a case if the person is involved [25]. In 2016, the SCPC implemented software for the electronic filing of asset declarations of SPOs. This software of E-Declaration is known as *Register of Declaration*[9] and it is used for online declaration, submission, recording, and monitoring of assets declaration of public officials in N. Macedonia. The most significant asset declaration fields that should be disclosed by public officials are detailed immovable properties, movable properties, securities (bonds), claims and debts, and other properties in his/her possession or ownership of his/her family members [26]. The SCPC receives and publishes the declarations online while the verification process is done manually for the comparison of each next declaration with the previous one [27].

SIMIDAI. The electronic system for managing data of the assets and conflict of interest declarations was launched in Ukraine in 2016. By using this system, Ukraine enables electronic submission, management, and monitoring of the asset declarations of SPOs [9]. SIMIDAI is a web-based application, which is designed for a fully-electronic online declaration through the *'E-declaration Register'*[10] module. This platform is administered by NACP institution. This institution [28] is an executive agency with important guarantees for independence with competencies for managing the asset declaration, verification, control of conflict of interest and gifts of public officials. The main functions of SIMIDAI are registration, submission, storing, publications, and electronic verification of the declarations. During the registration process for each senior official, SIMIDAI provides online services by using the digital signature for login and submission of any document in the system. The submission process can be applied by the declarants after filling in all sections of the declaration by touching the submit

[9] *E-Declaration of SCPC: https://register.dksk.mk/Account/Login?ReturnUrl=%2f*
[10] *SIMIDAI platform: https://nazk.gov.ua/en/assets-declaration/*

button, where the declarant is notified by e-mail with the attachment declaration submitted [29]. The scope of AD form includes [28] assets, income, expenses and financial liabilities, cash, immovable properties, intellectual property rights, place(s) of work, etc. Through a public API in format JSON, HTML, and PDF, the asset declarations are automatically published on the NACP website after submission of declarations in the system. The most important feature of SIMIDAI is the electronic verification module [29], which was launched in January 2019 and is an upgraded system for automated verification. This is a separate module, which includes checking form fields within the statement for inconsistent data, comparing the actual statement with the previous one, by marking them with the "Red Flags", and comparing the asset declaration data with external databases. Additionally, in the 'red flag' method (persons with high corruption risk), NACP selects the SPOs with senior status and responsibility that are subject to full verification. SIMIDAI with an automated verification module can produce the 'red flags' according to inconsistencies within one declaration or/and compared with the previous declaration of the same senior public official [30].

ADEL. The e-system ADEL[11] is an online platform for declaring the assets and conflicts of interest of SPOs in France. This system is used for data collection of assets and conflict of interest declarations of French public officials, and it is administered by HATPL. The main functions of ADEL [22] are the registration of SPOs and their asset declarations, data security by using asymmetric encryption, file submission and access authorization, information verification, and publication of the declarations to the HATPL website in an open data format XML or CSV. The number of French SPOs who must declare their assets is about 17000 officials as of the 1st of January 2022. For managing data declarations submitted online, the Hight Authority has developed and implemented a new module called *'Ulysse'*. This module calculates the deadline for the submission of declarations. Additionally, *Ulysse* developed media monitoring software – ARTEMIS [29], which collects information from open sources about asset declarations based on criteria defined by the system admin. Based on our literature review, the ADEL system for asset declaration of SPOs does not implement any feature to automatically verify or analyze assets, but it can share its data with other French institutions that have the mission to fight corruption, too.

4.3 A Comparison Analysis Between Asset Declaration Systems

To compare the AD systems based on their features and functions that are enabled, we created an online questionnaire by used *Google Forms*. We sent it to HIDAACI (Albania), NACP (Ukraine), HATPL (France), SCPC (North Macedonia), and ACA (Kosovo), but we received responses only from Kosovo and Albania. The results of this survey for ACA and HIDAACI, are presented in Table 1. While Kosovo ACA uses the manual method, Albanian HIDAACI this year has launched its system for online declaration. In addition to auto-submission

[11] *ADEL platform for online declaration: https://declarations.hatvp.fr/#/*

Table 1. A Comparison between Kosovo and Albania Asset Declaration Systems.

Features/Systems	ACA (SDRP)	HIDAACI (EACIDS)
Number of declarations	5.001∼7.500	3.001∼4.000
Method of declarations	Hard Copy	Electronic
Is an auto-submitted declaration implemented?	NO	YES
Do you use a method for data analysis?	YES, manual analysis	YES, manual analysis
Type of verification	Preliminary check, and full verification	Preliminary check, and full verification
Method of the preliminary check	Manually	Manually (Automatically from the next year)
Methods for data analysis	Analyze the data of the declaration; compare it to external government databases, and compare it with previous declarations.	Analyze the data of the declaration; compare it to external government databases, and compare it with the previous declaration.
What attributes of AD are checked and verified?	Immovable and movable properties, all incomes, businesses, all functions, debits, and credits.	Immovable and movable properties, cash, all incomes, businesses, all functions, debits and credits, and all types of assets (properties, incomes, debits, credits, and profits) of each family member.
The preliminary check included	Identify incorrectly, misunderstood, and incomplete data, and blank brackets.	Identify incorrectly, misunderstood, and incomplete data, and blank brackets.
The number of officials that are part of full verification?	21∼30% of all declarants	21∼30% of all declarants
The number of suspicious declarants after the full control is completed	10∼100 declarants	101∼200 declarants
Are you using any formula to analyze the data of AD?	NO	YES, automatically by using the Red Flags method.
How many previous declarations do you compare?	Last two years (manually)	Automatically the last two declarations (using the Red Flags method).
How many external interconnections does your AD system have?	None	None (In the next year will start with methods)
The important indicators for analyzing asset declarations are	Faster growth assets; False declaration; Non-declaration; Hide properties or assets; Faster growth of the cash or blank values.	Growth assets from the last declaration; Non-declaration; Hide any assets from declared; Declare the high value of cash; Faster enrichment; etc.

and comparing changes on declarations by using a 'Red Flag' method, the new electronic system EACIDS of Albania does not have any advanced features implemented that would make a big difference from the SDRP of Kosovo. The last row of Table 1 presents the features of indicators that are: faster growth assets, false declaration, hidden properties or assets, faster growth of cash, faster enrichment, non-declaration, and growth assets from the last declaration.

5 Analysis and Discussion

Nowadays, the trend of AD systems in different countries around the world is to transform the declaration process from manual to electronic form. Countries that have digitalized AD systems have been focused on the online declaration, open data, and connecting the system to government external databases. Although some countries have implemented an electronic system for the asset declaration of SPOs, the process of verification remains manual. Several others (Romania, Ukraine, Georgia, Armenia, Moldova, etc.) have implemented the automatic analysis of declarations and data cross-checks with the Civil Registry [15, 30]. Let us consider the comparison features between SDRP, EACIDS, E-Declaration, SIMIDAI, and ADEL systems. Table 2, presents the main features of these five AD systems, wherein the columns present the names of AD systems, while the rows represent the value for each specific system feature. For each feature that is implemented on the selected AD system, it is written with YES, and vice versa it is NO. All AD systems support digital storing data, but they did not have implemented automatic full verification. Only the SDRP system does not support features of online declaration, automatically submission, and automatically publish declarations on its website. The check-verification feature is not supported by SDRP and E-declaration systems, while SIMIDAI and ADEL can perform verification of declarations on external databases. The SIMIDAI is the only system that uses a specific method of risk analysis of asset declarations, while this system and SDRP automatically generate the list of declarations for full control of the asset declarations.

Table 2. A comparison of the AD systems based on the functional features.

Features/Systems	SDRP	EACIDS	E-Declaration	SIMIDAI	ADEL
Online declaration	NO	YES	YES	YES	YES
Store data in digital format	YES	YES	YES	YES	YES
Automatically submit	NO	YES	YES	YES	YES
Automatic check verification	NO	YES	NO	YES	YES
Automatic full verification	NO	NO	NO	NO	NO
Verification of declaration with external databases	NO	NO	NO	YES	YES
Uses a method of risk analysis	NO	NO	NO	YES	NO
Create an automatic list of full control	YES	NO	NO	YES	NO
Automatically publish declarations	NO	YES	YES	YES	YES

According to the number of features that are system supported, the SIMIDAI is ranked a more advanced AD system with eight features applied from all nines, while the SDRP is lower as it has applied only two features. Based on the results of Table 2, we have calculated the average value of features for each AD system that is acceptable or not. These percentage values of features are visualized with a char in Fig. 2, which shows that the SIMIDAI has performed with 88.89% of acceptable features and 11.11% unacceptable. The ADEL is ranked second after the SIMIDAI with 66.67% acceptable and 33.33%, unacceptable features. The third-ranked system is EACIDS performed with an acceptable value of 55.56% and 44.44% unacceptable. The penultimate ranking on the list is the E-Declaration system, with 44.44% acceptable, and 55.56% of unacceptable features. The SDRP system is the last in the ranking list of advanced systems with only 22.22% acceptable features while 77.78% are unacceptable.

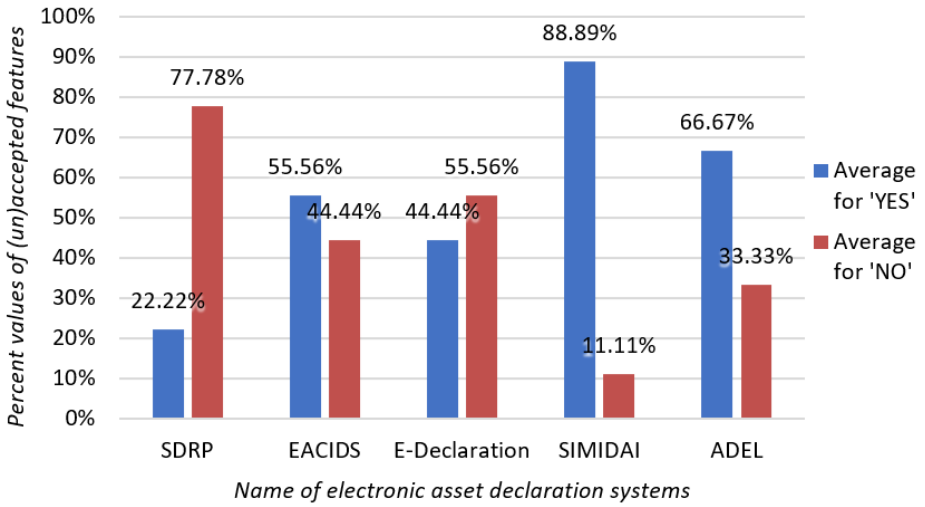

Fig. 2. Percentage of features accepted/unaccepted by the asset declaration systems

6 Conclusion and Future Work

The systems of asset declarations that are analyzed in this research paper did not implement an advanced algorithm that can do data analysis of asset declarations for automatic detection of suspicious declarants to prevent and fight against corruption. Even though some states have finished the process of digitalization of the AD system, the application of advanced ML algorithms for automation processes of verification and prediction-making has not yet occurred. The third aim of this research was to identify the gaps in AD these systems, and we found the gaps where advanced algorithms for data analysis and decision-making, such

as ML techniques to predict and detect potential suspicious SPOs are not applied, and the second gap is that the systems are not enabled to fully verify the assets (as seen in Table 1 and Table 2). According to the work process of Kosovo ACA, we designed a workflow for anti-corruption institutions (see Fig. 1) and described the main steps of AD process from the declaration step to the full verification. The first aim of this paper has been achieved with the design of the ACA workflow model, and the identification of the most important attributes of asset declaration, which are immovable properties, movable properties, incomes, cash, debs, credits, etc. Also, the description of workflow presented the main steps of asset declaration processes, which are declaration, submission, preliminary check, publication, selected declarants for asset verification, and full control or full verification. With this workflow description, we have answered the question about the identification of the main steps of the asset declaration process. Fulfilling our second goal is done through a survey, where we identified some indicators for the classification of declarants as suspicious officials, and these were faster growth of assets, false declaration, hidden properties or assets, faster growth of cash, faster enrichment, non-declaration, and growth of assets from the last declaration. In the section on analysis and discussion, we have answered the second question by comparing the electronic systems of asset declaration, where we see that SIMIDAI has implemented the 'red flag' algorithm, the risk analysis methodology for data analysis of asset declarations, and the automatically check validation. These features have made a difference from others, and could be considered the properties of an advanced AD system. With comparison and analysis of the AD systems, based on the features of the AD processes, we raised the issue that the systems, which have implemented the online declarations have also applied the methodology of automatically submitted declarations. At the end of this paper, with the results of Fig. 2, we conclude that the SIMIDAI system is more advanced than the others, but it is not enough to make an intelligent system to automatically detect suspicious declarants.
In future work, we plan to approach a new solution to design an advanced Machine Learning (ML) algorithm for data analysis of the asset declarations in detecting suspicious public officials and decision-making!

References

1. Abu-Morad, M.A., Noor, F.M., Ayub, Z.A.: The shortcomings of the income and asset declaration system in Jordan illicit enrichment law. Journal of Global Business and Social Entrepreneurship (GBSE) **2**(1), 98–110 (2016).
2. Agyeman, E.D.: Fighting Corruption in the Public Sector of Ghana - The Role of Assets Declaration. The Institute of Economic Affairs (IEA) **44**, 56 (2016). Stanford Libraries. https://searchworks.stanford.edu/view/12809577. L.Accessed 5 May 2022.
3. Nuchprayool, B.: Legal Reform of Asset Declaration System: A Strategy to Prevent and Combat Corruption in Thailand. In: The 42nd International Academic Conference, p.p 251–258. IISES, Rome: Italy (2018). https://doi.org/10.20472/IAC.2018.042.035.

4. Kotlyar, D., Pop, L.: Automated Risk Analysis of Asset and Interest Declarations of Public Officials: A Technical Guide. In: Knowledge Solutions. StAR (Stolen Asset Recovery Initiative), World Bank, Washington, DC, pp. 1-–40 (2021). https://openknowledge.worldbank.org/handle/10986/36336.
5. Ear-Dupuy, H., Serrat, O.: Fighting Corruption with ICT: Strengthening Civil Society's Role. In: Knowledge Solutions. Springer, Singapore, **6850** pp. 797-–811 (2017). https://doi.org/10.1007/978-981-10-0983-9_86.
6. Davies, T., Fumega, S.: Mixed incentives: Adopting ICT innovations for transparency, accountability, and anti-corruption. U4 Issue, Google Scholar, (4), 1–19 (2014), Chr. Michelsen Institution (CMI),Bergen.
7. Mutungi, F., Baguma, R., Janowski, T.: Towards Digital Anti-Corruption Typology for Public Service Delivery. In: Proceedings of the 20th Annual International Conference on Digital Government Research,**Vol. 11** (No. 1) p.p 484-–494. Association for Computing Machinery (ACM). Dubai, United Arab Emirates (2019). https://doi.org/10.1145/3325112.3325266.
8. Zhang, W., Zhang, Y., Wang, B.: E-government Application in Combating Corruption: China's Case. In: 2011 International Conference on Information Management, Innovation Management and Industrial Engineering,**Vol. 2**, p.p 246–250. IEEE. Shenzhen, China (2011). https://doi.org/10.1109/ICIII.2011.207.
9. Ngumbi, E., Owiny, P.: From Paper to Practice: Enhancing Public Accountability in Africa through Reform of Wealth Declaration Systems. SSRN Electronic Journal , 1–19 (2020), https://doi.org/10.2139/ssrn.3579514.
10. Rossi, I.M., Pop, L., Berger, T.: Getting the Full Picture on Public Officials: A How-to Guide for Effective Financial Disclosure. World Bank, Washington, DC (2017), https://doi.org/10.1596/978-1-4648-0953-8.
11. Halai, A., Halai, V., Hrechaniuk, R., Datsko, K.: Digital Anti-Corruption Tools and Their Implementation in Various Legal Systems Around the World. In: IV International Scientific Congress "Society of Ambient Intelligence – 2021" (ISCSAI 2021), EDP Sciences, **100** (p. 03005), (2021). https://doi.org/10.1051/shsconf/202110003005.
12. OECD Book-Report.: Asset Declarations for Public Officials: A Tool to Prevent Corruption. In: The Organisation for Economic Co-operation and Development. OECD iLibrary, 152 pages (2011). https://doi.org/10.1787/9789264095281-en.
13. Hoppe LL.M., T., Papa, H., Dzindo, M., Orešković, D., Preteni, H., Georgiev, V., Ratkovic, V., and Kepnik-Hinić, Z.: Income and Asset Declarations in Practice. ReSPA (Regional School for Public Administration) - Network for Ethics and Integrity, Danilovgrad, Montenegro. 222 pages (2003).
14. Burdescu, R., Reid, G. J., Gilman, S., Trapnell, S.: Income and Asset Declarations: Tools and Trade-Offs. Institute: Stolen Asset Recovery (StAR) Initiative. World Bank, Washington, DC, No. 55004, pp. 1–179 (2009).
15. Myers, B., Bajpai, R.: Enhancing Government Effectiveness and Transparency: The Fight Against Corruption. International Bank for Reconstruction and Development, World Bank, Washington, DC, 386 pages (2020), http://hdl.handle.net/10986/34533.
16. Habershon, A., Mulukutla, H.: Income and Asset Declaration Systems in Indonesia: Country analysis. In: Income and Asset Disclosure. eLibrary: UNODC (United Nations Office on Drugs and Crime), Bangkok, Thailand, 97—114 (2019). https://doi.org/10.1596/9780821397961_CH05.
17. Cela, B.: Electronic Asset Declarations for Public Officials – two years after its launch. A panacea against corruption?. UNDP, Ukraine, 25

August 2018. https://www.undp.org/ukraine/blog/electronic-asset-declarations-public-officials-—two-years-after-its-launch-panacea-against-corruption.
18. Hoppe, T., Kalniņš, V.:The Business Process of Verifying E-Asset Declarations at the National Agency on Corruption Prevention. EUACI, Ukraine.http://tilman-hoppe.de/Report_business_process_for_verifying_declarations_ENG.pdf, 232 pages (2017).
19. Amin, L. and Marín, J.M.: Recommendations on Asset and Interest Declarations for OGP Action Plans. Transparency International. ISBN: 978-3-96076-145-7, https://www.opengovpartnership.org/wp-content/uploads/2020/07/Recommendations-on-Asset-and-Interest-Declaration-for-OGP-Action-Plans.pdf.
20. Zhao, H., Ahn, M.J., Manoharan, A.P.: E-government, corruption reduction and culture: A study based on panel data of 57 countries. In: Proceedings of the 18th Annual International Conference on Digital Government Research, ACM, Staten Island, NY, USA, **9**, p.p 310–318 (2017). https://doi.org/10.1145/3085228.3085292.
21. Darusalam, Janssen, M., Ubacht. J.: Towards Generalized Process Patterns for Detecting Corruption within the Government Using Open Data. In: Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age, ACM, Delft, Netherlands, **86**, p.p 1-6 (2018). https://doi.org/10.1145/3209281.3209282.
22. Wu, S., Hou U, L., Bhowmick, S.S., Gatterbauer, W.: Conflict of Interest Declaration and Detection System in Heterogeneous Networks. In: Proceedings of the 2017 ACM on Conference on Information and Knowledge Management, ACM, Singapore, **4**, p.p 2383–2386 (2017). https://doi.org/10.1145/3132847.3133134.
23. ACA, Annual Work Report for period 1 January - 31 December 2021, 49 pages https://akk-ks.org/assets/cms/uploads/files/Publikimet/. Anti-Corruption Agency, Prishtina, Kosovo. Last accessed 27 May 2022.
24. High Inspectorate of Declaration and Audit of Assets and C.I., Annual Report for 2020, 30 pages https://www.ildkpki.al/gloolsys/2021/07/RAPORT-VJETOR-PER-VITIN-2020.pdf. HIDAACI, Tirana, Albania. Last accessed 30 May 2022.
25. OECD.: Competitiveness in South East Europe 2021: A Policy Outlook. In: Competitiveness and Private Sector Development. OECD Publishing, Paris, France, 1871 pages (2021). https://doi.org/10.1787/dcbc2ea9-en.
26. UNODC.: Country Review Report of North Macedonia. UNODC, https://www.unodc.org/documents/treaties/UNCAC/CountryVisitFinalReports/, 393 pages (2019).
27. Daneva, A.P., Bitrakov, K.: The "New" State Commission for Prevention of Corruption and its Potentional for Effective Prevention of Corruption. Macedonian Journal for Criminal Law & Criminology, OSCE, ISBN: 978-608-4788-53-9, 1–17 (2019), Research Gate. https://doi.org/343.137.5:[343.91-053.2/.6:323.28
28. Emerson, M., Kovziridze, T., Hriptievschi, N., Kalitenko, O., Prohnitchi, E.: Anti-Corruption Policies in Georgia, Moldova and Ukraine. Pobrane, http://www.3dcftas.eu/, p.p 1–33 (2017).
29. Kotlyar, D., Pop, L.: E-filing Asset Declarations- Benifits and Challenges. StAR - World Bank, Washington, DC. Retrieved from https://policycommons.net/artifacts/1275978/e-filing-asset-declarations/1863496/. CID: 20.500.12592/8h808h, 24 pages (2019).
30. Network for Integrity. Developing digital tools to promote transparency in public life, 31 pages, (December 2020), https://networkforintegrity.org/developing-digital-tools-promote-transparency-public-life/. N.f.I. Last accessed 12 May 2022.