Unaccompanied Minor Refugees: Blockchain-Based Age Assessment Monitoring with Gantt Chart Integration

Abstract. Generally, unaccompanied asylum-seekers claim to be minors because chronological age influences how their asylum claim will be processed. In case of serious doubt, an age assessment must be conducted. The age assessment procedure is complex, includes a variety of processes, and involves different phases and actors, from medical doctors to law enforcement officers, and must be followed in a mandatory time sequence, otherwise, the basic rights of the child are violated. This paper proposes a novel procedure of age assessment monitoring with the help of a Gantt chart and the Blockchain decentralized structure. Compared with other solutions, the proposed procedure is versatile, as it can be applied in many cases in the context of a refugee asylum procedure and achieve effective and agile scheduling. Experimental results showed stable performance in large-scale request and processing distributed environments (Blockchain), where the data synchronization speed of the age assessment decision reached four times faster than a traditional procedure, achieving faster data consistency and better protection of unaccompanied children in accordance with the provisions of European and international legislation. Performance evaluation testing validated the procedure's GUI functionality and the implementation technique robustness.

Keywords: Unaccompanied minors, asylum, refugee, age assessment, Gantt chart, Blockchain.

1. Introduction

"In recent years, thousands of children have undertaken a perilous journey to come to Europe and seek international protection. Some traveled with their parents, others with caregivers, with other adults, or alone. Throughout their journey, children may fall into or move between different categories such as accompanied, unaccompanied, separated, internally displaced, asylum-seeking, trafficked, or smuggled" (Hidayat et al., 2022; Dorber & CoE, 2019; Kwarteng, 2018).

“These children must cope with the hardships endured on their journey and the challenges of adapting to an often radically new culture and environment. They also have to navigate intricate procedures that aim to ascertain their status as children and their rights” (Magaji et al., 2018; Sinaga et al., 2023). “Many of these children do not have identity documents that attest to their status as a child and face registration and treatment as adults based on unreliable age assessments” (Cummaudo et al., 2021; Magaji et al., 2018; Sinaga et al., 2023).

“An effective, reliable, and human rights-based mechanism for estimating a person's age is a critical step to ensure that children can benefit from the specific measures designed to protect their rights” (Bőgel et al., 2024; Hanke & Vitiello, 2019). “When they are incorrectly identified as adults, children are trapped in a status that creates a serious risk of rightlessness increasing their vulnerability and affecting their ability to access welfare services and support, education, funding for legal representation, and family reunification. Age determination also influences how their asylum claim will be processed and on the asylum decision itself: it may be the difference between being offered safety or being returned to their country of origin” (Zheni, 2022; Dorber & CoE, 2019).

“As states parties to the United Nations Convention on the Rights of the Child and the European Convention on Human Rights, all Council of Europe member States have a legal obligation to protect and safeguard the rights of all children, everywhere and always” (Zheni, 2022). The 2030 Agenda for Sustainable Development calls on all member states to “*ensure safe, orderly, and regular migration with full respect for human rights and for the humane treatment of migrants, regardless of their migration status, and of refugees and internally displaced persons*” (Franceschetti et al., 2022; Dorber & CoE, 2019).

“In principle, unaccompanied asylum-seekers claiming to be minors must produce evidence of their age. If such evidence is unavailable or serious doubt persists, EU member-states may conduct an age assessment which should be carried out objectively” (Zheni, 2022). “Age assessment can include a variety of processes and phases either undertaken singularly or in combination, such as analysis of documentary evidence, interview, physical appearance, psychological maturity, and medical examination. The assessment must be conducted in a safe, scientific, child and gender-sensitive, and fair manner,

avoiding any risk of violation of the physical integrity of the child, and giving due respect to human dignity)" (Hanke & Vitiello, 2019). The procedure is complex and involves different phases and actors, from medical doctors to law enforcement officers. The procedure is divided into specific stages, which must be followed in a binding time sequence, otherwise, the basic rights of the child are violated (*benefit of the doubt/BoD*, *provision of the best interest of the child/BIC*, *presumption of minority/PoM*).

In this paper, a novel project management procedure is proposed, for unaccompanied minors (UAM) age assessment monitoring, and is realized using the blockchain decentralized structure as a data-sharing platform and the Gantt chart (Gantt, 1919). The proposed UAM-age assessment procedure uses the Gantt chart model to monitor the entire track execution progress in compliance with the basic rights of the child (UNHCR, 2021; Dorber & CoE, 2019; Basdekidou & Papapanagos, 2023).

Note. A Gantt chart is a popular graphical representation of a project schedule. This bar chart displays the beginning and ending dates of the many components of a project, including planning, dependencies, and resources.

Blockchain technology has been applied so that project data can be shared safely and efficiently among multiple age assessment officials (recording staff, psychologists, pediatricians, supervisors, etc.), facilitating cross-organizational collaboration.

1.1. Research background gap analysis

"Age has important consequences for young asylum seekers. The UN Convention on the Rights of the Child (CRC) applies to individuals under the age of 18. Accordingly, unaccompanied children are defined as individuals under the age of 18, who are separated from both parents and are not being cared for by an adult who, by law or custom, is responsible to do so" (UNHCR, 1997). "Many international and national policies for asylum seekers and refugees grant young people under the age of 18 more protection and support than they do for those above 18 years of age" (EC, 2023; Magaji et al., 2018; Sinaga et al., 2023).

Unaccompanied minors have the right to a legal guardian, they may not be detained unless in their best interest, and they may only be deported to their

country of origin if it is ensured that they will be cared for by an adult upon arrival (EC, 2023; UNHCR, 2021). Age also influences reception arrangements and access to health care and education. If asylum is granted, age determines the possibility of family reunification, which is rarely granted for refugees over the age of 18 (EC, 2023; Bőgel et al., 2024;).

The process of age estimation is a fundamental pillar for legally ensuring the minors' rights and their protection needs (UNICEF, 2022; Thevissen et al., 2010; Andersen, 1971). The procedure is complex and involves different phases and actors, from medical doctors to law enforcement officers (Cummaudo et al., 2021; Rozzi, 2017; Smith and Brownlees, 2011).

1.1.1 Gap analysis - Open cases

The design, implementation, and operation of an age assessment procedure is not a simple and straightforward task with modeling functionality and many intra-constraints involved (Hanke & Vitiello, 2019; Styliadis, 2007; Styliadis et al., 2003).

Age assessment as a smart project management application operating in real-time and requiring real-time queries, evaluation, and action, is a pretty difficult, elaborate, and complex process (Franceschetti et al., 2022). A Blockchain-based Gantt chart system for cross-organizational project management should be used but such a system has not been described so far (Li et al., 2022; Zhang et al., 2021).

1.1.2 Gap analysis – Results weaknesses

"Cross-organizational projects pose difficulties for project managers in managing task scheduling and progress feedback that relies upon language translation" (Bergmanis & Pinnis, 2022) and timely information sharing (Yang R. et al., 2020).

"The independence and heterogeneity among participating organizations may turn data sharing difficult" (Hasanagas et al, 2010a; Hasanagas et al, 2010b). "Besides, traditional data sharing relies on third-party organizations (e.g., cloud, specialized service provider, transcription services, call center services, consulting), and therefore, the privacy and security of data cannot be guaranteed" (Hanke & Vitiello, 2019; Li et al., 2021; Liang et al., 2020).

"In fact, although in general, the sharing of information is of great benefit and provides several advantages for all the entities involved, however, these entities may not trust each other, or even worse, they may compete with each other" (Li et al., 2022). "Consequently, in the context of cross-organizational project management, safety is a crucial factor, which must be guaranteed for the entire life cycle of project management" (Xiao et al, 2021; Yang P. et al. 2020).

1.2. Article's main contributions

The main contributions of this article are as follows:

(a) Blockchain and Gantt charts are the building blocks of the proposed framework. The proposed solution enables the migration of the traditional Gantt chart model from a centralized to a distributed architecture to provide visual expression. Besides, the Blockchain is set about to deal with the secure storage and sharing of data, where *smart contracts* define the various tasks.

(b) The proposed solution aims at dividing the entire age assessment procedure into multiple chronically related blocks (interdependent tasks). The project manager defines the project plan according to European and international legislation and assigns the tasks to different task managers; then, *smart contracts* are used to specify the age assessment operations on the project plan. The proposed solution effectively improves functionality, and flexibility, as well as guarantees versatile project management.

(c) The proposed solution enables the visualization of task schedules as a Gantt chart, besides providing a progress feedback mechanism that assists project managers in monitoring project completion status and making real-time adjustments to the project plan.

(d) Experimental results show that the proposed Blockchain/Gantt integration framework has stable performance and high production efficiency under different consensus mechanisms (Bőgel et al., 2024; Li et al., 2022).

1.3. Article's writing structure

The further article's structure is organized as follows. Section 2 ("Research Questions & Aim") proposed the UAM-age assessment procedure's objectives, purpose, applications, and implications are presented. In Section 3 ("Materials & Method") some preliminary concepts are introduced, including

the structure of the Gantt chart, the system architecture, data structure, smart contract design, and workflow. In Section 4 ("Results & Validation") the operation steps, the stability under different consensus mechanisms through comparative experiments, and the proposed framework's validation (usability testing) are covered. Finally, in Section 5 ("Conclusions") research results, findings, contribution and novelty, potential applications, and suggestions for further study are briefly presented.

2. Research Questions & Aim

The main aim of the proposed UAM-age assessment procedure, with Blockchain and Gantt chart functionality, is to protect children's rights from illegal behaviors during the decentralized process.

Digital *collections* can archive children's data in safe, stable, and efficient Distributed Ledger Technology (DLT) Blockchain structures and exchange them in DLT networks without a central authority, but in age assessment projects the law enforcement officer (*regulator*) must monitor the transaction process and its data content and be interrupted in the event of data anomalies to realize in-transaction regulatory, post-transaction proof saving, and traceability.

Note. A distributed ledger technology (DLT) system enables businesses to exchange codes and data without requiring a single, centralized authority.

2.1. Research Questions

The research questions are described as follows:
(i) Describe the phases and the tasks per phase of the age assessment procedure; (ii) establish the chronological order of the tasks; (iii) define the task-dependency relations (Finish-to-Start, Start-to-Start, Finish-to-Finish, Start-to-Finish); (iv) design a Gantt chart and a Blockchain decentralized structure; and (v) assign *smart contracts* to various tasks and actors involved.

2.2 Research Objectives

After describing the general research questions, this article's specific research objectives are defined as follows (Dorber & CoE, 2019; Cummaudo et al., 2021; Hidayat et al., 2022; Kwarteng, 2018):

• Always a guardian or representative must be appointed (*presumption of minority*).

• An age assessment should only be conducted if it is in the best interests of the child (*provision of the best interest of the child*).

• The person/child must be informed that they should have the same access to rights and should be treated as a child throughout the procedure (*presumption of minority*).

• The person/child has the right to be heard, to express their views, and have their views considered at all stages of the age assessment procedure (*benefit of the doubt*).

• Age assessment should not take place without a child's informed consent. During the age assessment, the person/child needs information about their rights, their right to consent or refuse to consent, and the consequences (EU-GDPR regulation).

• After a decision has been made, the person/child must be informed about the consequences of the decision, and any available appeals or reviews.

• Empower the person/child to act if their rights are violated and inform them of the effective remedies available and how to access them.

2.3 Purpose, Applications, and Implications

The purpose of the conducted research is to develop a Web-enabled framework (Gantt chart, Blockchain) for a smart UAM-age assessment procedure.

Potential applications could be associated with chronological age assessment for asylum or international protection claims, etc. Also, prospective applications are referred to in project management (the proposed procedure has to be documented as a real-time archive method).

The proposed procedure includes open data from unaccompanied persons who claim to be children and provides tools for researchers to gather, explore, analyze, annotate, reflect on, and reimagine asylum and international protection policies.

The proposed Gantt chart and Blockchain framework investigate the social-political impacts of digital technologies that monitor and govern children's rights. So, social implications are considered for the increasing use of digital technologies to monitor and manage human rights under the GDPR (Hanke & Vitiello, 2019).

3. Materials & Method

The proposed UAM-age assessment procedure has been described by a number of tasks allocated in two phases (A) and (B) as follows (Dorber & CoE, 2019; UNHCR, 1997; UNHCR, 2021; Bőgel et al., 2024):

BIA form - Guidance to practitioners on assessing whether it is necessary to undertake an age assessment and when is it in the best interests of the child. The best interest of the child principle must be integrated into the age assessment policy and implemented during age assessment procedures.

(A) The pre-age assessment control phase.

Age assessment should not be conducted to estimate the age of someone who is without documentation but is clearly a child. There must be a substantiated doubt as to whether the person is a child or an adult. It is important that the person's safety and protection needs are met before initiating an age assessment.

A1. Necessary conditions - The usual grounds for an age assessment are: when there are doubts a person claims to be a child; when the claimed age is not supported by documents; when there are doubts a person claims to be an adult; and when age must be determined to ascertain criminal responsibility.

A2. Securing key safeguards: Children should never be detained while age assessment results are pending. Care and special protection must be provided to children displaying signs that they may have been victims of violence, sexual exploitation, abuse, or trafficking in human beings.

A3. Detection of any heightened risks and/or vulnerabilities.

A4. Search for additional evidence.

(B) The age assessment application phase.

BIC/BoD checklist - The benefit of the doubt principle must be applied through age assessment procedures which must treat the person as a child at all times.

B0. The child must be informed about age assessment procedures and their rights during them. It is always necessary to obtain informed consent before the age assessment is initiated.

B1. Assessment of macroscopic characteristics of physical development

B2. Psychosocial assessment.

B3. Medical examinations (optional task).

B4. Examination results evaluation.

B5. Decision issuing. After a decision has been made, the child must be informed about the consequences of the decision, and any available appeals or reviews. The child must be encouraged to act if his/her rights are violated and must be informed of the effective remedies available and how to access them.

3.1. The Gantt chart

Subsequently, to protect the rights of the child (GDPR, BoD, BIC, and PoM) the inter-tasks correlations are defined as follows (Figures 1 and 2):

Dependency Finish-to-Start (FS):

B0 → B1 → B2 → [B3] → B4 → B5

(A) → (B) A4 → (B) (A) → BIC/BoD checklist A3 → B5

A1→A2 A1→A3 A1→A4

Dependency Finish-to-Finish (FF):

A3 ← A2 BIC/BoD checklist ← (B)

Dependency Start-to-Start (SS):

B0 → (B) B0 → BIC/BoD checklist

Dependency Start-to-Finish (SF):

B5 ← BIA form B4 ← B0

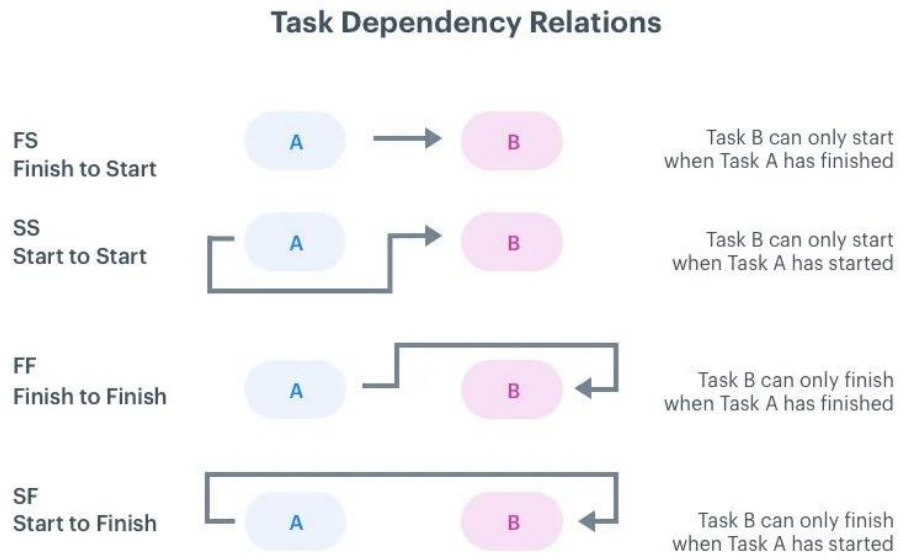

Figure 1. The task dependency relations.

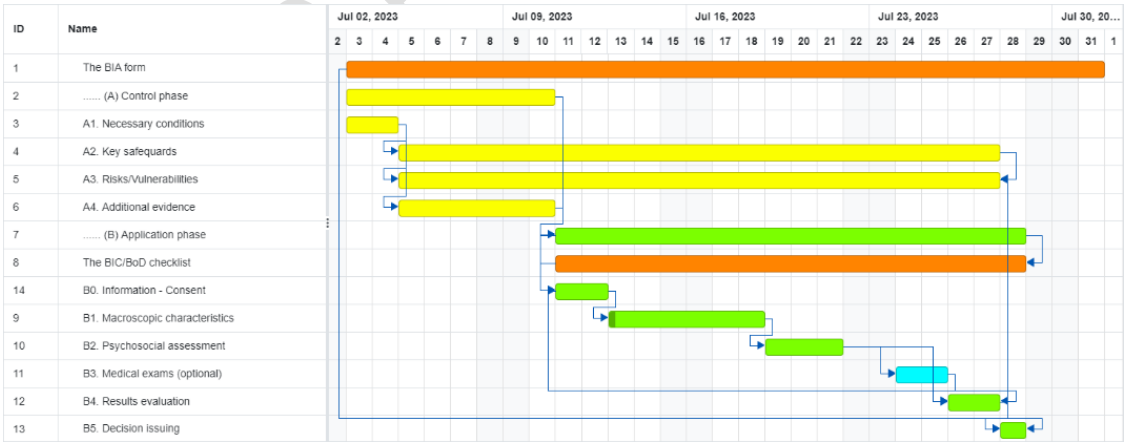

Figure 2. UAM-age assessment: The phases, tasks, and dependencies.

3.2. The Blockchain

Blockchain. A distributed network composed of nodes representing different spots (organizations) for global data synchronization and storage. The nodes in the consortium are mutually trusted. More precisely, they realize identity verification through digital certificates to ensure the security and integrity of data in the system. The *smart contract* running on it regulates the various steps in project management and stores the project data in the ledger for permanent storage.

Private Blockchain/Gantt architecture - Definitions

The Blockchain/Gantt architecture, as an implementation framework of the proposed UAM-age assessment procedure, is displayed in Fig. 3. The decentralized private Blockchain structure is supported by four (4) servers located in the reception and identification center, the psychological clinic, the pediatric clinic, and the internal control unit (Fig. 3).

Spot-1: The reception and identification center.

Spot-2: The pediatric clinic (assessment of macroscopic characteristics of physical development & the optional medical examinations).

Spot-3: The psychosocial clinic (psychosocial assessment).

Spot-4: The internal control unit.

Members: The persons claim to be (unaccompanied) minors (i.e. age<18 y.o.)

The project manager & the task managers: Officials, pediatricians, child psychologists, medical doctors, and law enforcement officers.

CA node: In the UAM-age assessment decentralized network, an *identity certificate* is required for communication. So, the CA node acts as a trusted entity and holds the public keys of all users, while the algorithm for generating public and private key pairs for user registration is executed locally. Hence, task managers need to be registered by the administrator at the CA node to generate a unique digital certificate (public and private keys) for data transmission.

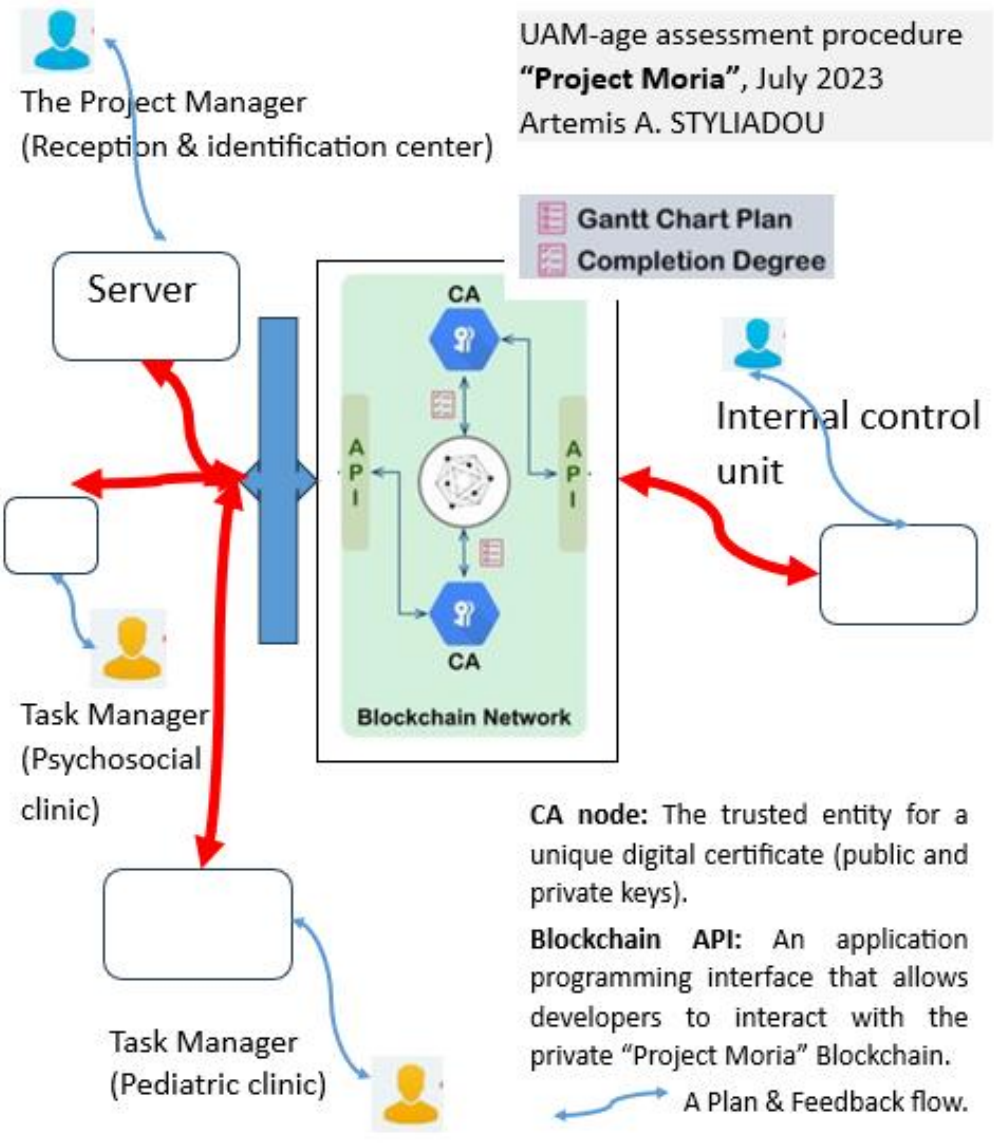

Figure 3. UAM-age assessment: The Blockchain/Gantt architecture.

Smart contracts. “Due to its ability to create *smart contracts*, Blockchain is perfectly suitable for project management, which phases include project creation, project allocation, project execution, and project acceptance. As known, the entire project cycle requires information sharing and oversight from multiple parties.

The project manager defines the project plan and assigns such chunks to different organizations in task schedules; then, it uses *smart contracts* to specify the read and write operations on the project plan.

In this context, the ability to access electronic data securely and efficiently enhances the ability to perform quality assurance-type projects. The applicability of Blockchain in project management has been investigated by many researchers” (Bőgel et al., 2024; Yang R. et al., 2020; Li et al., 2021).

4. Results & Validation

This Section discusses an UAM-age assessment implementation experiment (a case study under the name “Project Moria”) in a multiorganizational environment located at the refugee camp “Moria” on the island of Lesvos, Greece.

4.1. Case study

The implementation experiment assumes that the project manager, responsible for monitoring the UAM-age assessment procedure, is User-0 and belongs to organization Org1. The project “Moria” is divided into fourteen (14) tasks assigned as *smart contracts* to 14 different task managers (Fig. 2).

The task managers, responsible for supervising the *smart contracts* (tasks), are recognized as “Users” by the established Blockchain; where User-2, User-3, User-4, User-6, User-7, User-12, User-13, and User-14 belong to organization Spot-1; User-5, User-9, and User-11 belong to organization Spot-2; User-10 belongs to organization Spot-3; and User-1, User-14 belong to organization Spot-4 (Table 1).

Table 1. The task set (*smart contracts*) of the "Project Moria"

Task Id	Manager	Organization	Start date	End date
1	User-1	Spot-4	July 03, 2023	July 31, 2023
2	User-2	Spot-1	July 03, 2023	July 10, 2023
3	User-3	Spot-1	July 03, 2023	July 04, 2023
4	User-4	Spot-1	July 05, 2023	July 27, 2023
5	User-5	Spot-2	July 05, 2023	July 27, 2023
6	User-6	Spot-1	July 05, 2023	July 10, 2023
7	User-7	Spot-1	July 11, 2023	July 28, 2023
8	User-8	Spot-4	July 11, 2023	July 28, 2023
9	User-9	Spot-2	July 13, 2023	July 18, 2023
10	User-10	Spot-3	July 19, 2023	July 21, 2023
11	User-11	Spot-2	July 24, 2023	July 25, 2023
12	User-12	Spot-1	July 26, 2023	July 27, 2023
13	User-13	Spot-1	July 28, 2023	July 28, 2023
14	User-14	Spot-1	July 11, 2023	July 12, 2023

Each task manager is registered in the system through its terminal. User-0 logs into the Blockchain/Gantt framework, creates the "Project Moria" (initialization), and assigns task scheduling (*smart contracts*) to task managers according to Table 1.

The Gantt chart represented by "Project Moria" is shown in Fig. 2, where the yellow bars represent the tasks (*smart contracts*) in the Control phase and the green bars represent the tasks in the Application phase. The completion status of task implementation can be seen in the graph, so Blockchain/Gantt framework ensures that all members participating in the project can obtain the latest status information (Fig. 4).

Project Manager User-0 can always monitor the project's overall implementation to achieve the goal of the UAM-age assessment procedure, saving resource costs, and improving execution efficiency.

Task Id: 7
Start date: July 11, 2023
End date: July 28, 2023
Task (*smart contract*) name: (B) Application phase
Task manager: User-7
Task status: Processing
Progress: 63%

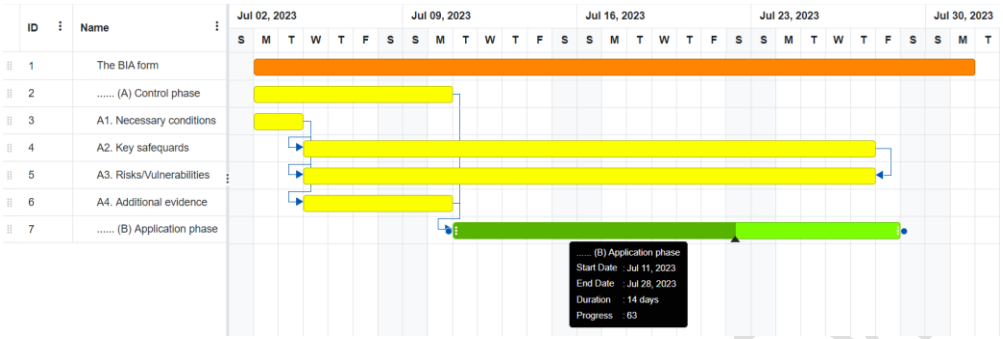

Figure 4. Status information for task Id: 7.

4.2. Validation (Usability Testing)

For a comparative usability testing study of the proposed Blockchain/Gantt UAM-age assessment procedure versus the traditional centralized approach (local processing in Spot-1, Spot-2, Spot-3, and Spot-4), the execution time is four (4) times faster according to Dun Li (Li et al., 2022) with stable performance and faster data consistency (Li et al., 2022; Zhaofeng et al., 2018; Zhu et al., 2021; Styliadou & Williamson, 2018).

The proposed system mitigates the difficulties arising from human resource management and information transfer in multi-organizational project cooperation scenarios. In this proposed research, the Blockchain eliminates the heterogeneity between different partners, enabling them to maintain and manage the same project jointly (Basdekidou & Styliadou 2017a; Basdekidou & Styliadou 2017b; Basdekidou & Styliadou 2017c).

In detail, with the support of the fourteen (14) *smart contracts*, the project manager can communicate the Gantt chart schedule to the task managers across the organization through the Blockchain/Gantt framework (UAM-age assessment procedure). Therefore, the participants can achieve real-time feedback on the project progress, and the project manager can make timely adjustments to the project schedule (Basdekidou, 2021; Basdekidou, 2019; Basdekidou, 2018a; Basdekidou, 2018b; Basdekidou, 2017).

Experimental results show that the proposed system can deal with large-scale data request scenarios while maintaining stable performance under different consensus mechanisms (Basdekidou & Papapanagos, 2023; Li et al., 2022; Zhu et al., 2021; Styliadou, 2018a; Styliadou, 2018b; Styliadou, 2018c).

From the comparative analysis of the Blockchain/Gantt vs. traditional centralized implementation techniques, the Blockchain/Gantt is faster (time), easier (user-friendliness), and in addition -as more important- more flexible (design process modification ability and redesign functionality) (Table 2).

Table 2. Usability testing ("Project Moria" with 500 unaccompanied minors) Blockchain/Gantt vs. traditional centralized implementation approach

Evaluation parameters	UAM-age assessment - Traditional centralized implementation technique	UAM-age assessment – Blockchain/Gantt implementation technique
Real-time monitoring of unaccompanied minors' protection	No	Yes!
Children's rights violation control (GDPR rights, benefit of the doubt principle, provision of the best interest of the child, presumption of minority)	No	Yes!
Smart contracts – UAM age assessment tasks monitoring	No	Yes
Execution time	Four (4) months	One (1) month
Performance – Data consistency		Stable performance and Faster data consistency
Expenditure (With a wage €12 per hour)	>30.720€ At least 4 officers working for 4 months (20 days/month and 8 h/day)	<7.680€ At most 4 officers working for 1 month (20 days/month and 8 h/day)
User friendliness	No	Yes
Planning intelligence	No	Yes
IoT efficiency	No	Yes
UAM image identification	Yes	Yes
Design process modification ability	Perceivable	Robust
Redesign functionality	Poor	Excellent
Metaverse hash tree / UAM future transactions	No	Yes (Robust and scalable)

Metaverse functionalities (coordinated parallel design, same-data sharing, data validation, contractual frameworks, etc.)	No	Yes
Applications	EU decentralized ledger for asylum seekers, smart contracts & metaverse apps are not supported	UAM-age assessment, EU decentralized ledger, digital documentation, smart contracts, metaverse apps

The comparative experiments show that the UAM-age assessment procedure (Blockchain/Gantt implementation framework) can maintain high throughput under large-scale requests (e.g. more than 1.000 unaccompanied minors claim asylum or international protection in a reception and identification camp) and adapt to Blockchain networks under different consensus algorithms with relatively stable performance output (Affes & Alfahdaw, 2023; Basdekidou & Papapanagos, 2024a; Basdekidou & Papapanagos, 2024b; Basdekidou & Papapanagos, 2024c; Basdekidou & Papapanagos, 2024d).

4.3. Discussion

The proposed Blockchain/Gantt implementation framework for the UAM-age assessment procedure is characterized by the following four functionalities and the violation of the GDPR's "*right to be forgotten*" as a limitation.

Safe, Faster, and Easier. The Blockchain/Gantt framework is a safe process and much faster and easier than the traditional approach.

Traceability. A critical functionality for unaccompanied children protection policies (*Provision of the best interest of the child*) (UNHCR, 2021).

Transparency. A critical functionality for unaccompanied children protection policies (*Benefit of the doubt principle*) (UNHCR, 2021).

Forever memory. Once validated, UAM's metadata and complete transaction records are stored permanently, allowing only new information to be added, with no option for past data to be modified (*Benefit of the doubt principle*, *Provision of the best interest of the child*, *Presumption of minority*) (UNHCR, 2021).

Right to be forgotten. The Blockchain/Gantt implementation's "forever memory" confounds the EU-GDPR "*right to be forgotten*" right. Hence, the European Union's "*right to erasure*" privacy law is on a collision course with the proposed Blockchain/Gantt implementation, whose defining feature is that it "never forgets" the vast amount of the UAM information it collects (Articles 17 & 19 of EU-GDPR regulation).

5. Conclusions

Results (of the conducted research answering the research questions)

- Two (2) phases and fourteen (14) tasks have been described.
- The chronological order of the fourteen tasks has been established.
- The task-dependency Finish-Start, Start-Start, Finish-Finish, and Start-Finish relations have been defined.
- For the Blockchain/Gantt implementation framework, a Blockchain and a Gantt chart have been designed.
- Fourteen (14) *smart contracts*, on a per-task basis, have been assigned to various actors involved.

Findings

- Real-time monitoring of unaccompanied minors' protection.
- Children's rights violation control (GDPR rights, benefit of the doubt principle, provision of the child's best interest, presumption of minority).
- Smart contracts support for monitoring UAM-age assessment tasks.
- Execution time is four times faster than that of the traditional centralized approach.
- Stable performance and faster data consistency.
- Decentralized ledger functionalities (planning intelligence, IoT efficiency, UAM image identification, design process modification ability, redesign functionality, metaverse hash tree / UAM future transactions).
- Metaverse functionalities (coordinated parallel design, same-data sharing, data validation, contractual frameworks, etc.)

Novelties

The main contributions of this article are as follows:

(i) The proposed solution enables the migration of the traditional Gantt chart model from a centralized to a distributed architecture to provide visual expression (Blockchain/Gantt integration).

(ii) The proposed solution, through the *smart contracts* assigned to tasks (as multiple chunks in a chronological dependency), effectively improves the flexibility of project cooperation and guarantees versatile project management.

(iii) The proposed solution enables the visualization of the various UAM-age assessment task schedules as a Gantt chart, as well as provides a progress feedback mechanism that assists project and task managers to monitor overall UAM-age assessment procedure/individual tasks completion status and supports real-time adjustments to the project plan.

(iv) Experimental results show that the proposed Blockchain/Gantt integration framework has stable performance and high production metaverse efficiency.

Applications

Apart from the specific UAM-age assessment procedure, potential applications of the proposed Blockchain/Gantt framework include a common EU decentralized ledger for refugees, digital documentation of the European asylum legislation, *smart contracts* (financial services), and metaverse applications (better tracking of developmental aid and charitable donations, etc.) for refugees.

Suggestions (for further study)

Future research should study the collision between the EU "*right to erasure*" with the proposed Blockchain/Gantt implementation of the UAM-age assessment procedure, whose defining feature is that it "never forgets" the vast amount of the UAM information it collects.

Considering the relatively limited number of unaccompanied children applying for asylum at the given time at the pan-European level[1], as well as

[1] According to Eurostat data, in 2022 in a total of 222,100 applications for asylum from children, 19% of them were unaccompanied (i.e. 42,199). Therefore, taking into account the

the fact that the term “unaccompanied minor” has a temporal dimension, a solution could be found with the yearly reconstitution of the UAM-blockchain (every 1st January) with age-updated blocks for the unaccompanied minors (<18 y.o.).

Implications of Blockchain Technology for Ethics

Blockchain technology has been heralded as a game-changer in a variety of sectors, including healthcare and finance. However, there are ethical issues that need to be taken into account with every new technology.

Data security and privacy: Blockchain technology has important ethical ramifications. Every transaction is accessible to network participants, despite the fact that it is sometimes portrayed as a private method of transaction. This raises concerns about the control of personal data and possible abuse by businesses or governments.

The Effects of Blockchain Technology on Society

Financial and social inclusion: Undoubtedly, blockchain technology's ability to advance social and financial inclusion is still unmatched, and it has the potential to have a profound effect in this area. People who have trouble accessing traditional financial institutions can now easily engage in the global economy thanks to the implementation of blockchain-based solutions.

Furthermore, by providing borderless payment systems, which function more quickly and effectively than the current systems, blockchain technology can help remove obstacles to traditional financial services and significantly lower prices. Up to 30% less money might be spent on banking infrastructure if blockchain technology is implemented.

Disclaimer (Artificial intelligence)

The Author hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

---

coming of age, the number of less than 150,000 UAM in the EU is estimated on a current basis (https://ec.europa.eu/eurostat).

References

Affes, H.S., & Alfahdaw, M.A.M. (2023). Digital Entrepreneurship in the Light of Contextual Leadership Intelligence: An Analytical Study in a Sample of Iraqi Private Universities. *Asian Journal of Economics, Business and Accounting*, *23(21)*, 71-81. https://doi.org/10.9734/AJEBA/2023/v23i211118

Andersen, E. (1971) Comparison of Tanner-Whitehouse and Greulich-Pyle methods in a large scale Danish survey. *Am J Phys Anthropol, 35*, 373–376, https://doi.org/10.1002/ajpa.1330350312

Basdekidou, V., & Papapanagos, H. (2024a). The impact of FinTech/Blockchain Adoption on Corporate ESG and DEI Performance. *WSEAS Transactions on Business and Economics*, *21*, 2145-2157. https://doi.org/10.37394/23207.2024.21.177

Basdekidou, V., & Papapanagos, H. (2024b). Blockchain Technology Adoption for Disrupting FinTech Functionalities: A Systematic Literature Review for Corporate Management, Supply Chain, Banking Industry, and Stock Markets. *Digital 2024, 4*, 762–803. https://doi.org/10.3390/digital4030039

Basdekidou, V., & Papapanagos, H. (2024c). The Use of DEA for ESG Activities and DEI Initiatives Considered as "Pillar of Sustainability" for Economic Growth Assessment in Western Balkans. *Digital, 4*, 572–598. https://doi.org/10.3390/digital4030029

Basdekidou, V., & Papapanagos, H. (2024d). The mediating role of the corporate culture in the relationship between Blockchain adoption and ESG performance. *SSRN J.* https://doi.org/10.2139/ssrn.4636791

Basdekidou, V. & Papapanagos, H. (2023). Empirical Model for Estimating Sustainable Entrepreneurship's Growth Potential and Positive Outlook, *Baltic J. Modern Computing, 11*, 181-201. https://doi.org/10.22364/bjmc.2023.11.1.11

Basdekidou, V. (2021). Agile Entrepreneurship Innovation in Fashion Design Thinking During COVID-19 and Beyond: Reimagine Education to Create Skills for Fashion Business, *International Journal of Economics and Finance, 13(8)*, 1-7. https://doi.org/10.5539/ijef.v13n8p1

Basdekidou, V. (2019). Trading CSR/CSE leveraged inefficiency. *International Journal of Financial Engineering and Risk Management (JFERM), 3(1),* 95-109. Inderscience Publishers, Genèva, Switzerland. https://doi.org/10.1504/IJFERM.2019.096655

Basdekidou, V. (2018a). Corporate green CSR/CSE management based on a metadata analysis. *Journal of Economics, Management and Trade*, *21*, 1-12. Sciencedomain International Publisher, New York /London /Delhi.

Basdekidou V. (2018b). Corporate governance & digital entrepreneurship: Cloud metadata accounting. *Archives of Current Research International*, *12(2)*, 1-9. https://doi.org/10.9734/ACRI/2018/39247

Basdekidou, V. (2017). The Overnight Return Temporal Market Anomaly. *International Journal of Economics and Finance*, *9(3)*, 1-10. http://dx.doi.org/10.5539/ijef.v9n3p1

Basdekidou, V., & Styliadou, A. (2017a). Technical Market Anomalies: Leveraged ETF Trading with Daily and Intraday Temporal Functionalities. *Business and Economics Journal, 8(1)*. http://dx.doi.org/10.4172/2151-6219.1000275

Basdekidou, V., & Styliadou, A. (2017b). Corporate Social Responsibility & Market Volatility: Relationship and Trading Opportunities. *Int. Bus. Res., 10*, 1–12. https://doi.org/10.5539/ibr.v10n5p1

Basdekidou, V., & Styliadou, A. (2017c). Corporate Social Responsibility Performance & ETF Historical Market Volatility. *Int. J. Econ. Financ. 2017, 6*, 30–39. https://doi.org/10.5539/ijef.v9n10p30

Bergmanis, T., & Pinnis, M. (2022). From Zero to Production: Baltic-Ukrainian Machine Translation Systems to Aid Refugees, *Baltic J. Modern Computing*, *10(3)*, 271–282. https://doi.org/10.22364/bjmc.2022.10.3.01

Bőgel, G., Brzozowski, J., Czerska-Shaw, K., Mátyás, L., & Tausz, K. (2024). Refugees: economic costs and eventual benefits. In: Mátyás, L. (eds) *Central and Eastern European Economies and the War in Ukraine. Contributions to Economics* (pp. 241-291). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-61561-0_8

Cummaudo M, De Angelis D, De Micco F, Campobasso C, & Cattaneo C (2021). The "forensic paradox" of aging unaccompanied minors in the migration crisis: why medicine and forensics are a must, *J Forensic Leg Med, 79*, 102133, https://doi.org/10.1016/j.jflm.2021.102133

Dorber, J., & Council of Europe (2019). Age Assessment for Children in Migration - A human rights-based approach. https://www.coe.int/children

European Commission (2023). Policies on reception, return, and integration arrangements for, and numbers of, unaccompanied minors – an EU comparative study. Brussels: European Migration Network, 2023.

Franceschetti, L., Merelli, V.G., Corona1, S., Magli, F., Maggioni, L., Cummaudo, M., Tritella, S., Angelis, D., & Cattaneo, C. (2022). Analysis of interrater reliability in age assessment of minors: how does expertise influence the evaluation? *International Journal of Legal Medicine* 136, 279–285. https://doi.org/10.1007/s00414-021-02707-8

Gantt, H.L. (1919). Work wages & profits (Henry L. Gantt, 1916); Organizing for work (Henry L. Gantt, 1919); The Gantt chart a working tool of management (Wallace Clark, 1923). https://mosaicprojects.com.au/PMKI-ZSY-025.php#Process1

Hanke, P., & Vitiello, D. (2019). High-Tech Migration Control in the EU and Beyond: The Legal Challenges of "Enhanced Interoperability". In: Carpanelli, E., Lazzerini, N. (eds) Use and Misuse of New Technologies. Springer, Cham. https://doi.org/10.1007/978-3-030-05648-3_1

Hasanagas, N.D., Styliadis, A.D., & Papadopoulou, E.I. (2010a). Environmental policy and science management: Using a scientometric-specific GIS for E-learning purposes, *Int. J. Comput. Commun. Control, 5(2)*, 171-178. https://doi.org/10.15837/ijccc.2010.2

Hasanagas, N.D., Styliadis, A.D., Papadopoulou, E.I., & Sechidis, L.A. (2010b). E-Learning & environmental policy: The case of a politico-administrative GIS, *Int. J. Comput. Commun. Control, 5(4)*, 517–524. https://doi.org/10.15837/ijccc.2010.4.2509

Hidayat, F., Nur, I., Maftukhin, & Akhyak (2022). Legislation on Determining the Parentage of a Born-Out-of-Wedlock Child Based on the Perspectives of the Best Interest of Child and Progressive Fiqh. *Asian Research Journal of Arts & Social Sciences 16*, 13-31. https://doi.org/10.9734/arjass/2022/v16i130275.

Kwarteng, A.H. (2018). Is International Law Really Law?. *Asian Research Journal of Arts & Social Sciences, 5 (4)*, 1-9. https://doi.org/10.9734/ARJASS/2018/39608

Li, D., Han, D., Xia, B., Weng, T.-H., Castiglione, A., & Li, K.-C. (2022). Fabric-GC: A Blockchain-based Gantt Chart System for Cross-organizational Project Management, *Computer Science and Information Systems, 19 (3)*, 1213–1240. https://doi.org/10.2298/CSIS123456789X

Li, D., Han, D., Weng, T.H., Zheng, Z., Li, H., Liu, H., Castiglione, A., & Li, K.C. (2021). Blockchain for federated learning toward secure distributed machine learning systems: a systemic survey, *Soft Computing, 26*, 1-18. https://doi.org/10.1007/s00500-021-06496-5

Liang, W., Fan, Y., Li, K., Zhang, D., & Gaudiot, J. (2020). Secure data storage and recovery in industrial blockchain network environments, *IEEE Transactions on Industrial Informatics, 16 (10)*, 6543–6552. https://doi.org/10.1109/TII.2020.2966069

Magaji, T., Ahmad, M.Z., & Apandi, L.S.B.A. (2018). "Assessing the Legal Frameworks for the Protection of Internally Displaced Persons (IDPs) in the North-Eastern Nigeria". *Asian Research Journal of Arts & Social Sciences,* 7 *(4)*, 1-10. https://doi.org/10.9734/ARJASS/2018/45550.

Rozzi, E. (2017). The new Italian law on unaccompanied minors: a model for the EU? – EU Immigration and Asylum Law and Policy, Assoc. per Gli Stud. Giuridici Sull' Immigrazione. http://eumigrationlawblog.eu/the-new-italian-law-on-unaccompanied-minors-a-model-for-the-eu/

Sinaga, A.Y., Zulyadi, R., & Siregar, T. (2023). Legal Analysis in the Settlement of SHM Forgery Crimes That Result in Losses to Other Parties Is Associated With (Study of Decision Number 252/Pid. B/2015/ PN. PMS) in Indonesia. *Asian Research Journal of Arts & Social Sciences*, *20 (3)*, 14-23. https://doi.org/10.9734/arjass/2023/v20i3448.

Smith, T., & Brownlees, L. (2011). Age assessment practices: a literature review & annotated bibliography. https://www.basw.co.uk/system/files/resources/basw_104139-3_0.pdf

Styliadis, A.D. (2007). E-learning documentation of historical living systems with 3-D modeling functionality, *Informatica 18(3)*, 419-446, https://doi.org/10.15388/Informatica.2007.186

Styliadis, A.D., Patias, P.G., Zestas, N.C. (2003). 3-D Computer Modeling with Intra-Component, Geometric, Quality and Topological Constraints, *Informatica 14(3)*, 375-392, https://doi.org/10.15388/Informatica.2003.028

Styliadou, A. (2018a). Land Law and Property Management in Greece: Expropriation Cases & Blockchain Functionalities. *Asian Research Journal of Arts & Social Sciences*, *7(4)*. https://doi.org/10.9734/ARJASS/2018/44998

Styliadou, A. (2018b). Introducing a Corporate Registry with Spatial, Cadastre and CSR Functionalities. *RevCAD Journal of Geodesy and Cadastre*, *24*, 173-182, [Online].

https://www.ceeol.com/search/articledetail?id=807385 (Accessed Date: November 8, 2024).

Styliadou, A (2018c). Expropriation & Compensation in Greek Land Property Law in Comparison with the ECHR: Reviewing Cases and Discussing Property Management with DLT/Blockchain Functionalities. *RevCAD Journal of Geodesy and Cadastre*, *24*, 183-192, [Online]. https://www.ceeol.com/search/articledetail?id=807387 (Accessed Date: November 12, 2024).

Styliadou, A., & Williamson, S.P. (2018). NYSE: Emotional Control Sharing Trading Psychology. *Asian Research Journal of Arts & Social Sciences 5(3)*. https://10.9734/ARJASS/2018/39351

Thevissen, P.W., Alqerban, A., Asaumi, J., Kahveci, F., Kaur, J., Kim, Y.K., Pittayapat, P., Van Vlierberghe, M., Zhang, Y., Fieuws, S., & Willems, G. (2010). Human dental age estimation using third molar developmental stages: accuracy of age predictions not using country specific information, *Forensic Sci Int, 201*, 106–111. https://doi.org/10.1016/j.forsc iint.2010.04.040

UNICEF (2022). Progress for children: Achieving the MDGs with equity / The CRC-30 years. https://www.unicef.org/media/86431/file/Progress_for_Children-No.9_EN_081710.pdf

UNHCR (2021). Refugee children – Guidelines on protection and care. Geneva: UNCHR. https://www.unhcr.org/media/refugee-children-guidelines-protection-and-care

UNHCR (1997). Guidelines on policies and procedures in dealing with unaccompanied children seeking asylum. Geneva: UNHCR. https://www.unhcr.org/media/guidelines-policies-and-procedures-dealing-unaccompanied-children-seeking-asylum

Xiao, T., Han, D., He, J., Li, K., & de Mello, R. (2021). Multi-keyword ranked search based on mapping set matching in cloud ciphertext storage system. *Connection Science, 33*, 1-18. https://doi.org/ 10.1080/09540091.2020.1753175

Yang, R., Wakefield, R., Lyu, S., Jayasuriya, S., Han, F., Yi, X., Yang, X., Amarasinghe, G., & Chen, S. (2020). Public and private blockchain in construction business process and information integration. *Automation in Construction, 118*, 103276. https://doi.org/10.1016/j.autcon.2020.103276

Yang, P., Xiong, N., & Ren, J. (2020). Data security and privacy protection for cloud storage: A survey. *IEEE Access,* 8, 131723-131740. https://doi.org/10.1109/ACCESS.2020.3009876

Zhang, J., Guo, M., Li, B., & Lu, R. (2021). A transport monitoring system for cultural relics protection based on blockchain and the internet of things. *J. Cult. Herit*, *50*, 106-114. https://doi.org/10.1016/j.culher.2021.05.007

Zhaofeng, M., Weihua, H., & Hongmin, G. (2018). A new blockchain-based trusted DRM scheme for built-in content protection, *EURASIP J. Image Video Process, 91*. https://doi.org/10.1186/s13640-018-0327-1

Zheni, L. (2022). Legal Regulation on Cyberbullying of Children. *Asian Research Journal of Arts & Social Sciences, 17 (4)*, 21-26. https://doi.org/10.9734/arjass/2022/v17i430314

Zhu, P., Hu, J., Li, X., & Zhu, Q. (2021). Using blockchain technology to enhance the traceability of original achievements, *IEEE Trans. Eng. Manage***,** 1–15. https://doi.org/10.1109/TEM.2021.3066090

Abbreviations

BIA - Best Interest Assessment
BID - Best Interest Determination
CRC - UN Convention on the Rights of the Child
DLT - Distributed Ledger Technology
EC - European Commission
GDPR - General Data Protection Regulation / EU law
IOM - International Organization for Migration
UAC - Unaccompanied alien children.
UAM - Unaccompanied minors[2]
UASC - Unaccompanied and separated child
UMC - Unaccompanied migrant children[3]
UNHCR - United Nations High Commissioner for Refugees

[2] According to the Directive of the European Parliament and the Council 2013/33/EU an unaccompanied minor is defined as "a third country national or stateless person below the age of eighteen, who arrives on the territory of the Member States unaccompanied by an adult responsible for them whether by law or custom, and for as long as they are not effectively taken into the care of such a person, or a minor who is left unaccompanied after they have entered the territory of the Member States".

[3] IOM considers "unaccompanied children" to be children, as defined in Article 1 of the Convention on the Rights of the Child, 1989 (CRC), who have been separated from both parents and other relatives and are not being cared for by an adult who, by law or custom, is responsible for doing so.