

## Article

# Secure and Transparent Craftwork Authentication and Transaction System: Integrating Digital Fingerprinting and Blockchain Technologies

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**Abstract:** This study proposes a method that enables craftsmen to define and apply the unique characteristics of their craftworks to distinguish between originals and imitations and to protect and trade their intellectual property rights. In the first step, a digital fingerprint that enables the authentication of the original craftworks was generated by applying hash functions that can digitize various attributes of the craftworks and create a unique ID. In the second step, a blockchain transaction system for the original authentication of the craftwork was developed by applying consortium blockchain technology. This system allows multiple craft-related organizations to participate together, and when a transaction occurs, a smart contract is created and stored on the blockchain, thereby enabling the tracking and management of transaction histories. Furthermore, a DApp was developed that enables buyers to verify the craftwork authentication and access detailed information by scanning the digital fingerprint (QR code) of the craftwork, which is integrated with the blockchain system. In the third step, the research results were evaluated through a satisfaction survey conducted with 121 participants and a usability evaluation with 10 craftsmen, both of which yielded positive feedback. This study successfully realizes a secure and transparent craftwork transaction system that guarantees both security and efficiency through the integration of digital fingerprinting and blockchain technologies.

**Keywords:** craftwork authentication; digital fingerprint for craftworks; blockchain in craftwork trade; craftsmen intellectual property protection; smart contracts for crafts



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## 1. Introduction

A craft is a human activity that adds artistic decoration to tools or objects to make them aesthetically beautiful and useful; so, craftsmen use various materials and methods to create original and useful craftworks. Craftworks, which are creative products with the necessary purposes and functions for humans, contain human emotions and expanded thinking, such as aesthetic, functional, and semantic values. Craftworks are regarded as artworks due to their manual production by experts with considerable experience and expertise in the field. Therefore, craftworks have the value of originality and rarity like artworks. For this reason, craftsmen are proud of their craft and consider the originality of their works important. However, due to the nature of the craft industry, which is centered on one-person development, the originality of many craftworks is not protected in the field.

According to the 2022 status of the craft industry in Korea [1], most craft industries are sole proprietorships (86%) with an average of 2.2 employees, indicating that most businesses have fewer than 5 employees. In addition, the acquisition rate of intellectual property rights (trademark registration 1.5%, utility models 1.4%, patent registration 2.3%, and skilled workers 0.5%) is very low, and design-copying problems occur very frequently. As many as 96.2% of people do not acquire intellectual property rights, and the reason

for not acquiring them was ‘not knowing the importance (necessity) of acquisition and registration’ at 51.0%, followed by ‘not meeting the qualification requirements’ (40.2%), ‘complicated preparation process’ (4.3%), and ‘not knowing the acquisition and registration procedures’ (3.4%). It is not easy to register a patent for a craft product, so ‘utility models’ or ‘design patents’ are mainly used. However, due to the nature of craftworks, rather than producing just one product, many products are produced together, such as ceramic cups, bowls, plates, and bottles. Therefore, it is impossible to acquire intellectual property rights for each craft product because it costs too much. Additionally, since a ‘design patent’ can be granted even if someone makes only one part of someone else’s product different, its effectiveness is low. Consequently, copying craftworks is a big problem, but for these reasons, craftsmen do not acquire intellectual property rights. Also, craftworks are mainly sold directly by personal shops or workshops (89.7%). The utilization of homepages, craft-related fairs or exhibitions, home shopping, shopping malls, duty-free shops, and craft-specialized websites is low. In this way, craftworks are mainly traded directly offline. This is probably because no transaction system properly reflects and protects the originality and artistry of craftworks.

In this study, we enable craftsmen to define and apply the unique characteristics of their craftworks themselves so that they can distinguish between originals and imitations. We also propose a method for them to trade their craftworks while protecting their intellectual property rights. For this conservative and analog craftwork trade industry, we developed a trading system utilizing digital fingerprints and blockchain technology, which are emerging as solutions to the problems of illegal copying, profit distribution, and forgery and falsification [2–5]. In relation to IoT, blockchain offers a way to enhance security, data integrity, and transparency in tracking the life cycle of craftworks, making it a reliable solution for the next generation of IoT-based transaction systems.

For this development, as a first step, we developed a digital fingerprint that applied hash functions that can include attributes that represent various values and characteristics of each craftwork, by utilizing the systematic craftwork metadata classification system developed by our research team [6]. In the second step, we developed a transaction system for the authentication of craftworks by applying consortium blockchain technology, which allows various organizations such as craftsmen and crafts institutions to participate together and manage transaction information flexibly, while limiting the sharing of sensitive information such as personal information, to protect the rights and brands of craftsmen. In the third step, to evaluate the research results, a satisfaction evaluation of the system was conducted with 121 craftsmen, and a usability evaluation of the system was conducted with 10 craftsmen, and they gave positive evaluations in terms of satisfaction and usability.

This study proposes a method to protect the intellectual property rights of craftsmen through a digital fingerprint ID number, which is represented by unique digital data containing various characteristics of the craftwork to distinguish the authenticity of the craftwork and to simultaneously track all transaction histories of craftwork digital fingerprint ID numbers in a blockchain system. In addition, it proposes a reliable method of trading craftworks through the participation of various craft-related organizations.

## 2. Background Works

The Korean craft industry is currently facing significant challenges in generating revenue, particularly in the protection of creators’ rights due to the proliferation of counterfeit goods and an opaque transaction system. By integrating digital fingerprints, which can store detailed records and authentication information for each craft, with blockchain technologies that utilize distributed ledger technology resistant to modification, we can verify the authenticity of craftworks and securely manage their records. This approach enables the establishment of a transparent transaction system and the protection of creators’ rights, thereby enhancing the value of craftworks and contributing to increased profits. We investigate and organize the current status of digital fingerprints and blockchain technologies, and explore their applicable areas within the craft industry.

### 2.1. Hash Function in Digital Fingerprinting

Digital fingerprinting is a crucial technology related to the authentication of items. Therefore, we aimed to use this technology to verify the authenticity of craftworks and prevent duplication or forgery. Digital fingerprinting technology is primarily employed in content protection techniques to address issues of copyright protection and traitor tracing in P2P-based content distribution systems [7–13]. This technology is mainly applied to digital images, converting attributes such as color and shape into digital values. However, since craftworks are physical objects rather than digital images, there is a need for a method to represent these craftworks in digital data. Therefore, we sought to digitize the analog attributes of craftworks to apply digital fingerprinting technology effectively.

To achieve this, hash functions were applied to digitally fingerprint the various characteristics of the product through the process of hash encryption, generating a unique identifier for each item. Hash functions began to be utilized when Ronald Rivest developed MD2 in 1989 and MD5 in 1992 [14]. A hash function is a function that converts an arbitrary bit string into a fixed-length bit string, and the result of the hash function is called a hash value. Regardless of the quantity and size of the input data, the hash value is expressed as a bit string of a fixed size determined by the hash function. It is also known as a one-way function because the original data cannot be retrieved from the converted hash value. Due to these characteristics, hash functions have been primarily used for detecting data forgery and alteration, quick data searches, communication security verification, and the safe storage of passwords. Recently, their scope of use has expanded to include electronic signatures, blocking illegal works, determining whether a website has been hacked, securing the reliability of cryptocurrency, and electronic voting.

As such, hash functions in digital fingerprinting are used to uniquely identify data by converting varying amounts of data into a fixed-size hash value. This fingerprint can represent the original data in a concise and unique manner. Hash functions ensure data integrity; even a minor change in the data results in a different hash value when recalculated. This property is crucial in applications such as software distribution, file storage, and secure communication for verifying the reliability and integrity of data. In databases or large-scale systems, hash functions help uniquely identify and index data, which can be useful for efficiently deduplicating, searching, and managing large data sets. Overall, hash functions provide a method for creating digital fingerprints of data for various purposes where uniqueness, integrity, and security are needed. In our project, we aimed to create digital fingerprints for craftworks by digitizing their various attributes through hash encryption and generating a unique identifier for each product.

### 2.2. Current Status of Distribution Platforms Using Blockchain Technology

The craft industry faces challenges in copyright protection and imitation products, resulting in transactions primarily occurring offline at the craftsperson's store. These issues have hindered the growth of the craftwork market. To address these problems, we explored methods to facilitate secure transactions and management by applying blockchain technology in online marketplaces.

Blockchain was developed by Nakamoto (2008) as the underlying technology supporting cryptocurrencies like Bitcoin. Since then, blockchain has expanded beyond cryptocurrencies, being integrated with cryptography, distributed systems technology, and P2P (peer-to-peer) networking technologies, and applied to various transaction and distribution services. Blockchain technology features decentralization, efficiency, security, privacy, transparent consensus, immutability, and automation in its applications [15–18]. Moreover, blockchain technology provides supply chain transparency, not only in terms of origin, materials, and production but also regarding the users and the methods of use of the products [19].

Because blockchain provides a secure framework for cryptocurrencies, it ensures that no one can alter transaction details, with all nodes participating in transactions anonymously. Due to these characteristics, blockchain technology can be widely utilized in

various fields such as the financial sector, medical systems, supply chains, and the Internet of Things (IoT) [20].

Blockchain is a type of public transaction ledger that all participants in a business can verify in real time and is tamper-proof. Whenever a transaction occurs, the corresponding data is recorded in a “block.” This blockchain technology is being utilized in various high-value sectors such as luxury goods sales and high-end fashion rental services [21]. As an example, in Table 1 below, it is used by Everledger for diamond tracking, by the Aura Blockchain Consortium for luxury brands, and by Maecenas and Verisart for trading expensive artworks and antiques. Additionally, it is employed by Chronicled and m2cloud in the distribution of essential pharmaceuticals like vaccines.

**Table 1.** Blockchain platform examples.

Blockchain Platform	Explanation
Everledger ( <a href="https://everledger.io/">https://everledger.io/</a> , accessed on 5 August 2024.) 2015~2024	Provides a blockchain service that tracks the production process and transaction history of diamonds, preventing fraud by digitizing the quality assurance of diamonds. It extracts the unique characteristics of diamonds and stores them on the blockchain, along with certification numbers and high-resolution photos. Everledger collaborates with insurers, banks, and online markets by sharing APIs to track the resale status online.
Aura Blockchain Consortium ( <a href="https://auraconsortium.com/">https://auraconsortium.com/</a> , accessed on 5 August 2024.) 2021~2024	The Aura Blockchain Consortium, used by brands like Louis Vuitton, Prada, Bulgari, Cartier, and Hublot, is a blockchain platform designed to ensure the authenticity and traceability of luxury goods. It provides customers with secure, verifiable digital certificates, enhancing transparency and trust in the luxury market.
Maecenas ( <a href="http://www.maecenas.co">www.maecenas.co</a> , accessed on 5 August 2024.) 2017~2024	Maecenas is a blockchain-based platform that allows fractional ownership of fine art. By Tokenizing artworks, it enables investors to buy and trade shares in masterpieces, democratizing access to the art market.
Verisart ( <a href="https://verisart.com/">https://verisart.com/</a> , accessed on 5 August 2024.) 2015~2024	Verisart is a platform that leverages blockchain technology to certify and verify artworks and collectibles. It provides artists, collectors, and galleries with digital certificates of authenticity, ensuring the provenance and legitimacy of art pieces.
Chronicled ( <a href="http://www.chronicled.com">www.chronicled.com</a> , accessed on 5 August 2024.) 2014~2024	Chronicled is a blockchain-based supply chain platform focused on providing transparency, security, and efficiency in various industries, including pharmaceuticals and luxury goods. It ensures the traceability and authenticity of products from origin to end user.
m2cloud ( <a href="http://www.m2cloud.kr">www.m2cloud.kr</a> , accessed on 5 August 2024.) 2019~2024	M2cloud provides pharmaceutical supply chain management services that track transaction histories and integrate IoT devices to monitor the delivery and storage conditions of pharmaceuticals. It manages the authenticity and proper handling of pharmaceuticals on the blockchain network, offering services to verify their authenticity and effectiveness.

Blockchains can be classified into three types, public, private, and consortium blockchains, as shown in Table 2 below. All three types share the characteristic of being immutable, meaning transaction records cannot be altered and all participants can verify the transaction history in real-time. However, there are differences in the scope of the participants and the permissions granted [22].

**Table 2.** Blockchain type comparison.

public blockchain	An open blockchain network that anyone can freely participate in. Participation is allowed without the need for approval from an authoritative organization.ex) Bitcoin, Ethereum.
private blockchain	A closed blockchain network where only predetermined organizations or individuals can participate. It can be considered an exclusive blockchain of a particular group.ex) Hyperledger Fabric, R3 Corda.
consortium blockchain	A blockchain that lies between a public and private blockchain. It allows participation and usage only by certain groups, with permissions granted for joining and leaving the network.ex) Quorum, Energy Web Foundation

In this study, we adopted a consortium blockchain approach due to its ability to flexibly manage participating organizations, while restricting the sharing of sensitive information such as personal data. The craft industry involves various stakeholders, including the creators of the craftworks, the stores selling the craftworks, and related craft associations. Multiple craftsmen can be involved in the creation of a single craftwork piece due to the many processes it entails. Therefore, a consortium blockchain, which allows for flexible management based on the number of related individuals and organizations, is appropriate.

In this way, the completed craftwork goes through a digitalization process using a hash function to store various pieces of information such as raw materials, characteristics, artist, and appearance and is stored in the blockchain transaction system as a unique digital fingerprint. When a craftwork transaction occurs, the owner's information is updated on the blockchain. A final consumer can track the characteristics of the craftwork, the distribution process, and product history. Additionally, in the case of resale as a second-hand product, the purchase route, owner, and authenticity certification are proven through the blockchain. In this way, the application of blockchain technology can protect the rights of the creator by authenticating the uniqueness of the craftwork and managing the transaction process more transparently and efficiently.

### 3. Materials and Methods

This research was conducted in three stages. Firstly, a digital fingerprint for craftworks was developed by applying hash functions based on annotated metadata utilizing a craftwork classification system. Secondly, a transaction system for authenticating craftwork originals was developed by applying consortium blockchain technology, which allows multiple organizations to participate and manage it flexibly. Finally, to evaluate the usefulness of the developed results, a user satisfaction and usability evaluation was conducted among craftsmen.




#### 3.1. Development of Craftwork Digital Fingerprints (Identification Number) Using Hash Functions

To create a digital fingerprint that can distinguish the originality of a craftwork in a craftwork trading system, it is necessary to generate a unique data value that represents the detailed attribute values of each craftwork. The characteristic of the hash function is that, regardless of the length or size of the input value, it produces a fixed-length data value (hash value). This makes it easy to store and search in a database. Various detailed attributes of the craftwork, such as the ID, specifications, photo, craftsman name, company name, material, glaze, clay, production method, and decoration technique of the craftwork, are generated as an encrypted string of a fixed length through a hash algorithm to create a unique data value of the craftwork. Additionally, even a slight difference in the input value to the hash function results in a completely different value. This means that even if only one attribute of the craftwork is different, a completely different hash value is generated, making it an effective factor for distinguishing between craftworks. Furthermore, while

the same attribute value always produces the same hash value, it is not possible to reverse-engineer the original attribute value from the hash value, ensuring high security. In this way, the unique ID of the craftwork can be characterized through the hash function.

As described in Figure 1 above, when all the attributes of a craftwork are collected and applied to a hash function, a hash value is derived by the hash function algorithm. This derived value serves as a unique ID for the craftwork. This ID is stored in the blockchain to authenticate the originality of the craftwork and to track its transaction history. The craftwork ID is then generated as a QR code, which can be attached to the craftwork. Users can scan the QR code to verify the authenticity of the craftwork, view its transaction history, and access detailed attribute information, including the company name, maker, clay material, glaze, use, specifications, shape, production method, and decoration technique.

### (1) Decide which attributes among the systematized metadata of crafts to use.

no	ID	Photo	Company	Creator	Craft field	Material 1	Material 2					Purpose of use		Form					Manufacturing Methods		Decoration Techniques		Size (mm)
							Clay Body		Glaze			Purpose of use 1	Purpose of use 2	Form 1 (Body)	Form 2 (Top)	Form 3 (Rim)	Added Form 1	Added Form 2 (Attachment)	Manufacturing Methods 1	Manufacturing Methods 2	Decoration Techniques 1	Decoration Techniques 2	
							Clay Body1	Clay Body2	Glaze 1	Glaze 2	Glaze 3												
139	C03477		Daily Diary	Oh Seong Gi	Ceramic Crafts	Ceramic	Mixed Clay	Clay Body Mixing	-	-	-	Ewer	Tea Ewer	Egg shaped	Square	-	-	Spout, handle, lid	Wheel throwing	Electric wheel throwing	japan lacquer	japan lacquer	110 x80 x60
163	C03563		Doya	Kim Se Hyeon	Ceramic Crafts	Ceramic	White Porcelain Clay	Silk Clay	Transparent oil	Glossy oil, Matte oil	Transparent matte	Lidded Bowl	Lidded Bowl	Horizontal sphere shaped	Square	-	-	lid, high heel	Wheel throwing	Electric wheel throwing	Glazing Techniques	Colored Clay	145 x145 x165
217	C03617		Park Jong Jin Studio	Park Jong Jin	Ceramic Crafts	Ceramic	White Porcelain Clay	White Porcelain Clay	Transparent oil	Matte oil	Transparent matte	For Display	figurative Object	Square shaped	Square	-	-	-	Handbuilding	-	Glazing Techniques	Colored Clay	165 x140 x130

### (2) Derive the hash value by inputting the feature values of the craft into the hash function.

ID	Photo	Company	Creator	Craft field	Material 1	Material 2					Purpose of use		Form					Manufacturing Methods		Decoration Techniques	
						Clay Body		Glaze			Purpose of use 1	Purpose of use 2	Form 1 (Body)	Form 2 (Top)	Form 3 (Rim)	Added Form 1	Added Form 2 (Attachment)	Manufacturing Methods 1	Manufacturing Methods 2	Decoration Techniques 1	Decoration Techniques 2
						Clay Body1	Clay Body2	Glaze 1	Glaze 2	Glaze 3											
4byte	TBD	Utf8	Utf8	1byte	1byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	2byte	4byte	4byte	4byte	4byte

Hash Function  
 $f(x)$

= D8Q819R1994F949

Hash value  
QR code



(3) A QR code with a unique hash value is attached to the craft.

(4) The generated hash value becomes an ID that distinguishes the craft, and the transaction history for each craft is stored on the blockchain.

### Blockchain-based craft distribution system

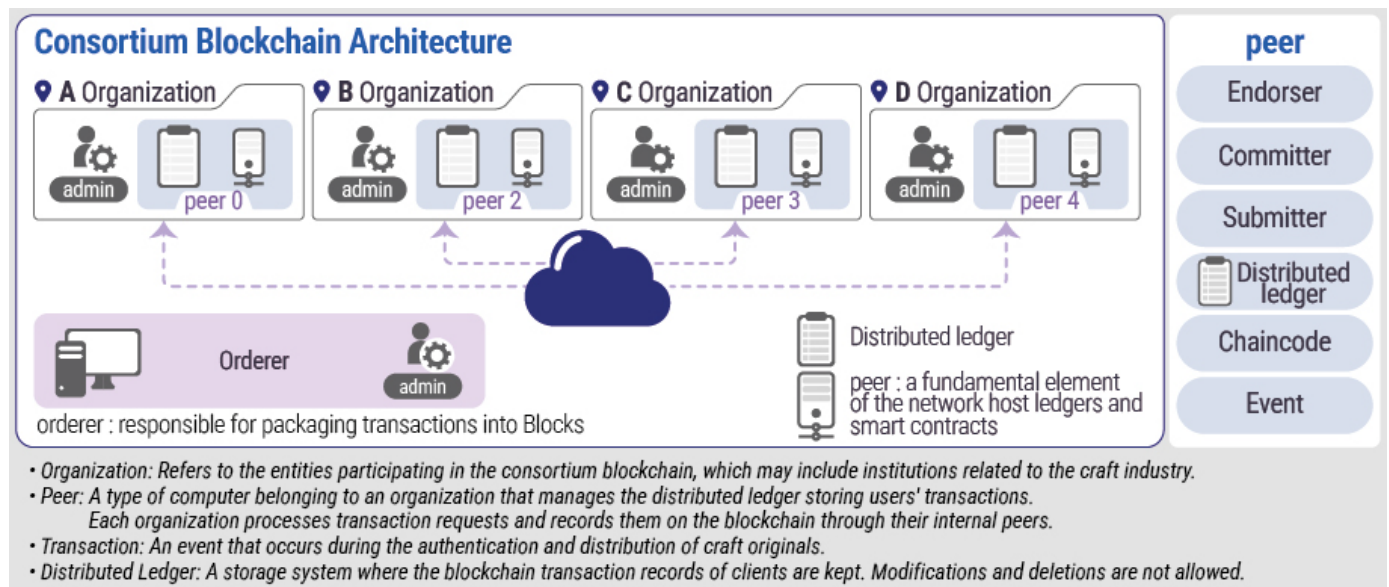
Craft Classification ID	Owner	Owner Changes	Purchase Date
D8Q819R1994F949	A	1	2022-11-19
B6V553B2546S891	B	0	2020-05-05
A1F038D2341Z023	C	0	2023-06-17
M923N1Q147D243	D	1	2021-10-18

**Figure 1.** The development process and implementation method of a hash function applied to craftwork characteristics.

### 3.2. Development of a Blockchain-Based Craftwork Transaction System

The craft industry tends to be easily copied, so a certification process is very necessary for the craft trade. To address this problem, a system was designed using consortium blockchain technology that allows multiple organizations to carry out certification together. The original craftwork certification transaction platform was designed to manage the blockchain network by forming a consortium of craft-related organizations or companies with the same purpose. The reason for using the consortium blockchain is that if the craftsman who created the craftwork certification and the craft-related public institution or organization certify it together, it will be more reliable. Additionally, a single craftsman may work on a craftwork from start to finish by himself, but due to the nature of the craftwork process, several craft experts may be involved in different processes. For instance, one craftsman may design and shape the piece, a decoration expert might handle the embellishment, and a lacquer craft expert could be responsible for the finishing lacquer. In such cases, the craftspeople involved in each process can proceed with the certification

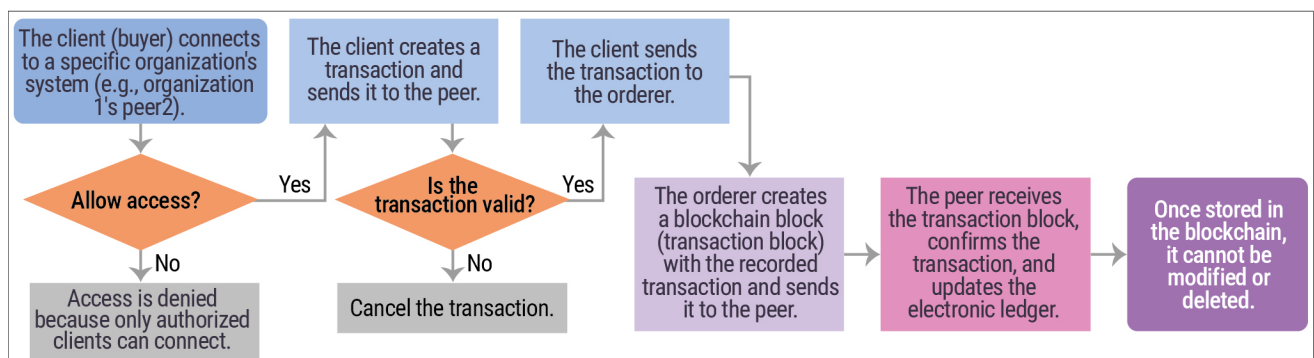
together. Therefore, as shown in Figure 2, it was made possible to add multiple certification organizations. In addition, information such as the original creator (craftsman) of the craft, craftwork attribute information, and transaction process can be transparently disclosed, but to limit the disclosure of the transaction information of participants, information such as the current owner can be restricted from disclosure through encryption, thereby protecting privacy.



**Figure 2.** Consortium blockchain system architecture.

The consortium blockchain architecture implemented in this study is shown in Figure 2 below.

The purchase of craftworks proceeds as follows within the above consortium blockchain architecture, as shown in Figure 3.



**Figure 3.** Transaction flowchart within the craftwork transaction blockchain system.

- ① The client (user) connects to a peer of a specific organization to trade craftworks;
- ② Once connected, the client generates trade proposal requests (registering details about the craftworks, who the buyer of the specific craftwork is, or whether the owner of the specific craftwork has changed) and sends them to the peer;
- ③ The peer confirms the received transaction proposal and responds to the client;
- ④ The client that received the response sends the transaction to the orderer (an internal system that processes transaction proposals);
- ⑤ The orderer creates a blockchain block (a transaction block in which transaction history is recorded) based on the blockchain consensus algorithm (an algorithm

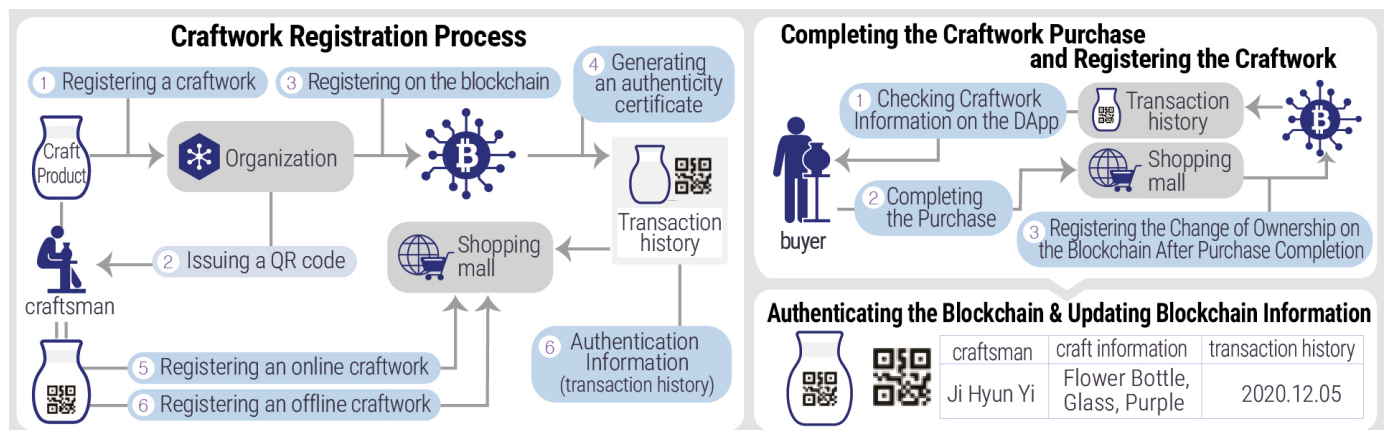
that determines whether the transaction history is trustworthy) and sends it back to the peer;

- ⑥ The peer receives the transaction block from the orderer and confirms the transaction history. It also updates the entire ledger. It then notifies the client that it has been updated;
- ⑦ The client receives an update notification and the transaction history storage process is complete;
- ⑧ Transaction histories stored in the blockchain cannot be deleted or changed in the future.

Through the above process, the craftwork transaction process is transparently recorded among the participants.

### 3.3. Blockchain Technology-Based Artifact Registration and Authenticity Management Process

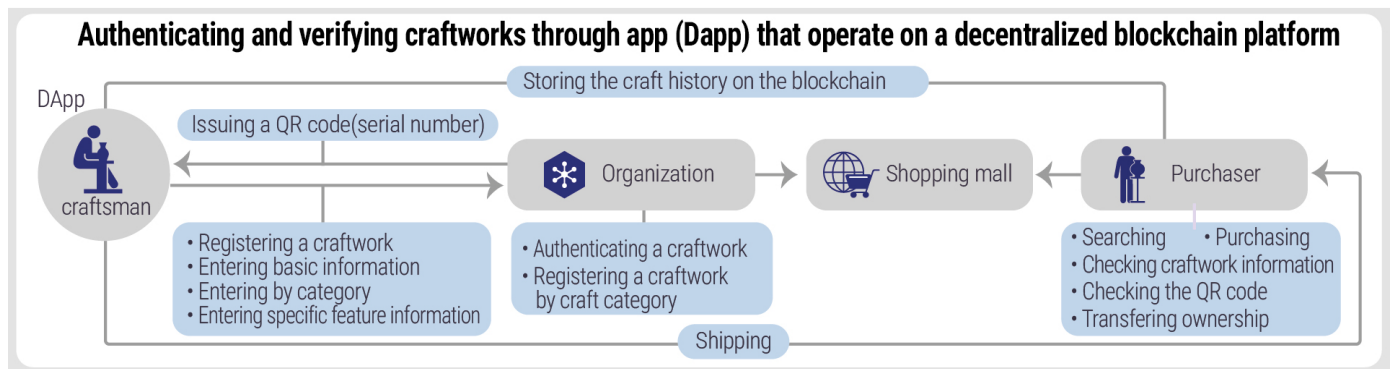
The original craftwork authentication function is linked with a blockchain transaction system. First, unique digital identification information is created using the distinctive characteristics of the craftwork. This is mapped to an ID number assigned to the craftwork, and then a unique digital fingerprint, or QR code, is generated. This digital fingerprint plays the same role as existing copyrights or design rights. As shown in Figure 4, if a craft-related organization manages a blockchain transaction platform and a craftsman registers photos and detailed information about their craftwork on the platform, the organization issues a QR code for the craftwork. At the same time as the QR code is issued, it is registered on the blockchain and a certificate of authenticity is created, which is also registered on the online shopping mall so that immediate transactions are possible. In addition, whenever a craftwork is traded, the transaction history is stored on the blockchain, and when the corresponding QR code of each craftwork is scanned, the transaction history and product characteristics are verified to confirm authenticity. In addition, when a craftwork is traded on an online shopping mall, the original creator of the craftwork can track the transaction history through this platform, so it is possible to track where his or her work was traded or resold.



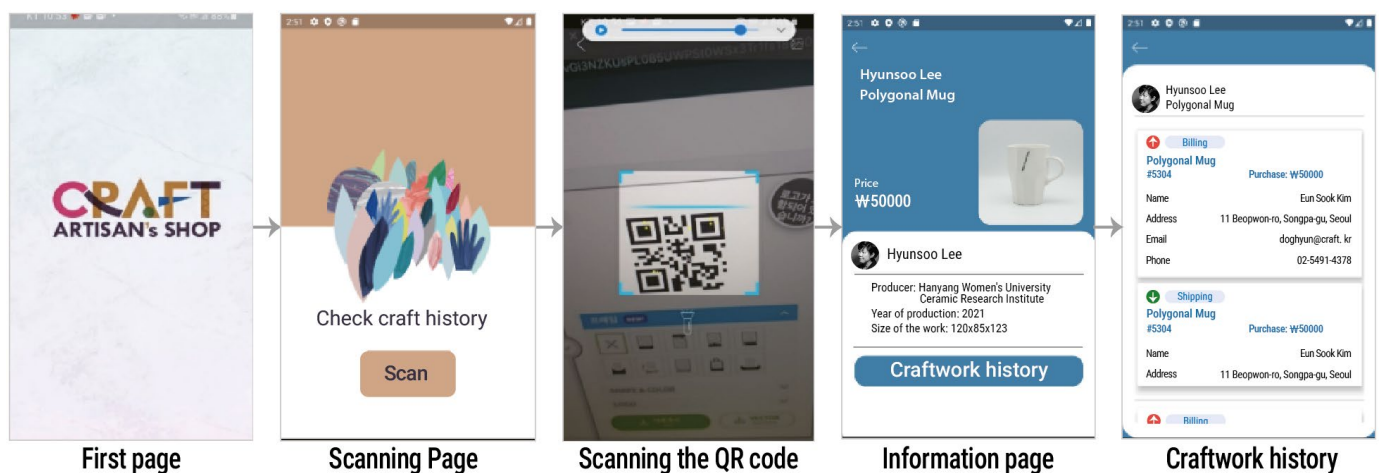
**Figure 4.** Certification management structure for registration and authenticity of craft products.

The process by which craftworks are authenticated in the blockchain transaction system is as shown in Figure 5 below.

Furthermore, a smartphone application (DApp) has been developed that is linked to the blockchain network, as illustrated in Figure 6 below. Upon scanning the QR code of the craftwork with a mobile phone, the buyer can visually ascertain the craftwork's authenticity in real time and can also view transaction history information. Additionally, an immediate purchase is possible, and information on ownership transfer is registered on the blockchain at the same time as the purchase.



**Figure 5.** Registration and certification process of craftworks in a blockchain system.



**Figure 6.** Blockchain network-integrated smartphone application (DApp).

Currently, the supply chain of the craft industry is becoming more complex, and the problems of counterfeiting and increasing opacity can be effectively managed and operated with visibility and transparency through the application of blockchain technology. Furthermore, a single digital fingerprint in the form of a QR code can simultaneously secure copyright and design rights, identify the authenticity and transaction history of craftworks in real time, and enable craftwork creators to track the history of their craftworks at every point in the supply chain. This allows them to understand individual buyer preferences, thereby enhancing agility, value creation, cost reduction, and transparency.

### 3.4. Smart Contracts

A smart contract is a digital electronic contract function that allows agreements to be executed within a blockchain network. In the Hyperledger Fabric system developed in this study, it is referred to as “chaincode”. Smart contracts are automatically executed when a valid transaction occurs between parties participating in a blockchain-based transaction. The primary function of a smart contract is to automatically register transaction details on the blockchain. When a valid transaction occurs between users, the smart contract enables the transaction details to be stored and updated on the blockchain, as shown in Figure 7. This allows participants in the craftwork transaction process to verify recipient records, usage periods, and other relevant details. When data such as the unique craftwork ID, owner, ownership changes, and purchase timing are transmitted to the blockchain, the smart contract aggregates this information and stores the transaction details on the blockchain.

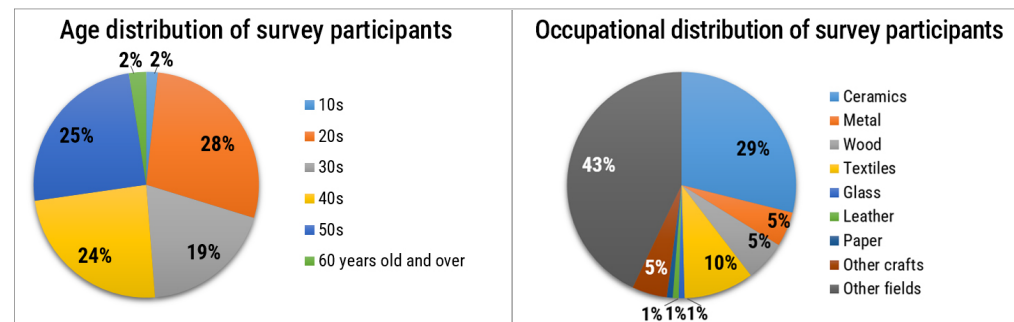
Craft Classification ID	Owner	Owner Changes	Purchase Date
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B6V553B2546S891	B	0	2020-05-05
A1F038D2341Z023	C	0	2023-06-17
M923N1Q147D243	D	1	2021-10-18

**Figure 7.** Example of a transaction statement to be stored on the blockchain.

#### 4. Experiment Results

##### 4.1. Satisfaction Evaluation of the Original Craftwork Authentication Blockchain Transaction System

A satisfaction survey on the original craft products authentication and distribution system was conducted with 121 attendees at the annually held “Craft Trend Fair 2022” in Korea. Among the respondents, 83.5% were women, with the largest age group being in their 20s (28.1%), followed by those in their 50s (24.8%) and 40s (24%), as shown in Figure 8. The respondents included both craftsmen and craftwork buyers, and among the craft fields, ceramic craftworks were the largest at 28.8%. The answers to each question were evaluated on a scale from 1 (strongly disagree) to 5 (strongly agree).



**Figure 8.** Age and occupation distribution of experimental participants.

After allowing the original craftwork authentication transaction system utilizing blockchain technology to be experienced, the respondents were asked to evaluate their satisfaction as shown in Table 3. In response to the first question, “Do you think this digital fingerprint containing detailed information about the craft product is helpful for craft product authenticity verification?”, 82% of the respondents answered that it was helpful. In response to the second question, “Do you think the craft product authenticity verification system using blockchain technology will help protect craftsmen’s works?”, 79% of the respondents answered that it was helpful on average. In response to the third question, “Is a certification-based transaction system more helpful to artisans than general craftwork transaction sites?”, 83% of the respondents answered that it was more helpful. Overall, the evaluations were positive, with comments such as “It seems that theft or plagiarism of the work can be prevented with the creation of a QR code that can indicate the attributes of one’s craft product”, “It is good that complicated processes such as copyright can be omitted”, and “It seems that it will help protect the work because it includes the creator’s information”.

**Table 3.** Satisfaction evaluation results of the original craftwork authentication blockchain transaction system.

Question	Results
1. A digital fingerprint reflecting the craftwork attribute classification system for authenticating craft products has been created. Do you think this digital fingerprint containing detailed attribute information about craftworks can help in authenticating craftworks?	<p>82% Positive answer</p>
2. Do you think the original craftwork authentication blockchain transaction system will help protect craftsmen's works?	<p>79% Positive answer</p>
3. Is a certification-based transaction system more helpful to artisans than general craftwork transaction sites?	<p>83% Positive answer</p>

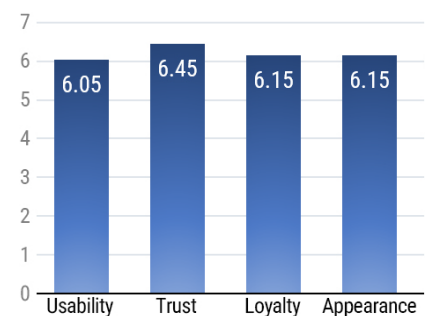
#### 4.2. Usability Evaluation of the Original Craftwork Authentication Blockchain Transaction System

A usability evaluation was conducted on the developed original craftwork authentication blockchain transaction system with 10 craftsmen who operate workshops selling their craftworks in Yanglim-dong Craft Village in Gwangju, South Korea. The craftsmen were asked to upload their craftworks to the system, authenticate the originals by scanning QR codes, and track the transaction history before evaluating the system. The evaluation consisted of questions about the system's usability, trust, loyalty, and appearance, using the SUPR-Q usability evaluation method [23], with responses ranging from 1 (strongly disagree) to 7 (strongly agree).

As shown in Table 4 above, the evaluation results showed that the craftsmen responded positively to all questions, with particularly high scores for trust. This indicates that they have confidence in the system's ability to protect their craftworks during trading. Regarding the original craftwork certification transaction system, most respondents appreciated that it offers a distinction from general industrial product trading. There were also suggestions to include safety inspection certification information and handling precautions in the craftwork information.

**Table 4.** Usability evaluation results of the original craftwork authentication blockchain transaction system.

Evaluation Question		(n = 10) (Cra = 0.91)			
		Mean		SD	
Usability	1 Is it easy to use overall?	6.00	6.05	1.25	0.99
	2 Is it easy to register this craftwork?	6.10		0.74	
Trust	3 Do you think this technology will positively impact product craftwork sales?	6.40	6.45	0.70	0.84
	4 Do you think the original craftwork authentication blockchain transaction system is useful for sales and preventing fraud?	6.40		1.26	
	5 Do you think the app with blockchain technology is useful?	6.60		0.70	
	6 Do you think ‘the original craftwork authentication blockchain transaction system’ is more helpful to artisans than a general craftwork transaction site?	6.40		0.70	
Loyalty	7 Would you recommend this system to friends or colleagues?	6.00	6.15	1.25	0.96
	8 Will you use this system after it is fully developed?	6.30		0.67	
Appearance	9 Is the presentation of this system clean and simple?	6.10	6.15	1.20	1.21
	10 Do you think this system is well designed?	6.20		1.23	



## 5. Conclusions

This study utilized the craftwork attribute classification system to generate a unique digital fingerprint of a craftwork by applying hash functions, enabling the original authentication of the craftwork. Additionally, by applying consortium blockchain technology that allows various craft-related organizations to collaborate, a blockchain transaction system for authenticating original craftworks was developed that automatically generates a smart contract upon the occurrence of a transaction, stores it on the blockchain, and tracks and manages the transaction history. Furthermore, DApp was developed, which enables buyers to verify craftwork authentication information and transaction histories by scanning the digital fingerprint of the craftwork through interworking with this system. The integration of digital fingerprints and blockchain technologies has resulted in the creation of a secure and transparent craftwork transaction system that guarantees both security and efficiency.

The system met with approval from those in the craft industry. Craftsmen particularly noted that the system's greatest advantage is its ability to systematically register information about craftwork items by categorizing them by attributes such as color and material, thereby creating a unique digital fingerprint. They indicated that this feature could serve as an effective tool for clearly differentiating between genuine and counterfeit or imitation items and that, unlike complex and often ineffective design patents, this easy and

unique authentication method and transaction-tracking function could provide a valuable opportunity to protect their craftworks.

The market trend indicates that the trade of artworks and valuables is shifting from offline to online platforms. In particular, if high-value items such as unique artworks, craftworks, and jewelry are properly authenticated, online markets may offer a safer environment for their trade. The ability to authenticate and track transactions for such valuable items is a crucial function, and the system proposed in this study effectively addresses this need. Beyond the craft industry, the integration of blockchain and digital fingerprint technologies presented in this study can be applied to other IoT environments, such as supply chain management, smart logistics, or asset tracking, where the authentication, traceability, and secure management of valuable items are essential.

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