GI Tag Authentication of Channapatna Handicraft Toys Empowered by Blockchain Technology

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Abstract

The handicraft sector in India is significantly prominent in the development of the social and economic status of the country through cultural preservation, promoting creativity, and generating employment opportunities. The Channapatna handicraft, widely known for its rich cultural heritage and skilled craftsmanship in toy making, faces challenges in ensuring product authenticity and preventing counterfeit products. This study addresses these major challenges by leveraging blockchain technology to verify the authenticity of Geographical Indication (GI) tagged handicraft toys. The primary objective of the study is to develop a blockchain-enabled framework that provides transparency, secures the supply chain, and empowers local artisans. A blockchain structure was created with the help of Python and libraries such as hashlib, qrcode, and timestamp for each product. Every block incorporated necessary details such as artisan name, geographical location, and GI authorised user certification. Then, Quick Response (QR) codes were generated for each authenticated product, ensuring verification and preventing counterfeiting. The results significantly display the integration of blockchain technology, which ensures traceability, increases consumer trust, and supports fair trade practices. Artisans benefit from higher market accessibility, while consumers gain confidence in the authenticity of their purchases. This innovative approach fosters artisan empowerment, market expansion, and the sustainable growth of traditional industries.

Keywords: Blockchain, Channapatna Toys, Cultural Heritage, Geographical Indication, Handicrafts, Product Authentication, Supply Chain Transparency, Traceability

Introduction

Handicrafts constitute a critical component of intangible cultural heritage, embodying region-specific artisanal knowledge, indigenous techniques, and traditional design practices transmitted through generational training (Nandisha & Kumar, 2021). These products contribute substantially to regional economies and community-based livelihoods, including aesthetic and historical value (Hashm, 2012). Within the diverse handicraft sectors in India, the Channapatna handicraft toy industry holds significant historical, cultural and heritage relevance. The Channapatna handcrafted wooden toys are distinguished by their vibrant colours, lacquered finish, and use of non-toxic, natural dyes (Anupama & Srilakshmi, 2021). The craft tradition and skill have been passed down through several generations for centuries, and continue to employ a community of local artisans. The origin and the authenticity of the Channapatna toys have been granted Geographical Indication (GI) status under the provisions of the Geographical Indications of Goods (Registration and Protection) Act, 1999. The GI designation confers intellectual property rights to the community of artisans, ensuring that only products manufactured within the designated geographic location using traditional methods can legally bear the Channapatna name (Sowmya, 2020).

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Despite the legal safeguards offered by the GI framework, the sector continues to face persistent challenges such as product counterfeiting, unauthorised mass production, and the absence of end-to-end supply chain visibility (Uma & Krishnan, 2021). These issues not only erode consumer trust but also compromise the economic well-being of genuine artisans. To address these limitations, the integration of blockchain technology is proposed as a robust and scalable solution. Blockchain is a distributed ledger system characterised by cryptographic security, immutability, and decentralised consensus mechanisms (Gaikwad, 2024). Its application in the handicraft supply chain can enable real-time verification of product provenance, enhance transactional transparency, and enforce traceability across stakeholders—from artisans and cooperatives to retailers and consumers (Gao *et al.*, 2022).

The objective of this study was to confirm the authenticity of GI tags on Channapatna toys with the use of blockchain technology in order to establish transparency and trust in the supply chain. Conventional methods of authentication are ineffective and prone to forgery, making it necessary to have an authentic and tamper-proof authentication system. Blockchain technology, with its immutable and decentralised ledger, offers a strong solution by documenting each transaction and authenticating product origin (Koteshwarao *et al.*, 2024). In this context, blockchain-enabled GI authentication systems have been deployed wherein each registered Channapatna toy is cryptographically encoded and stored as a tamper-proof transaction block. By embedding QR codes linked to the blockchain, consumers can access authenticated metadata including artisan identity, raw material sources, and certification details. This digital layer not only fortifies anti-counterfeiting measures but also empowers artisans by minimising intermediaries and ensuring equitable market access.

Review of Literature

The literature review underscores the historical significance of the handicraft sector in various regions, emphasising its role in preserving cultural traditions and providing economic sustenance to artisans. It also discusses the importance of advanced technologies like blockchain applications in this sector to protect and preserve the cultural heritage.

Indian Handicraft Industries: Status and Challenges

The Indian handicraft sector has a significant role in conserving cultural heritage and providing sustainable employment opportunities, especially for women in rural regions. Hashm (2012) emphasises the importance of the Handicrafts sector in India, boosting the country's economy, and also delving into its present conditions while exploring its untapped potential, also addressing potential threats. (Bhat & Yadav, 2016) conduct an in-depth analysis of the handicraft sector's role as a promising and productive component of the Indian economy, examining its contribution to foreign exchange earnings and evaluating its growth trends and decline over the past fifteen years. According to Chouiraf & Chafi (2018), the handicraft sector accounts for approximately 9% of GDP and 20% of total employment. However, its overall productivity remains comparatively lower than that of corresponding industries in other countries. Fatma & Nigam (2021) focus on numerous government and non-government initiatives aimed at promoting, revitalising, and preserving handicrafts, as well as the effect of these initiatives at the grassroots level. Yadav *et al.* (2023) identify key constructs influencing women entrepreneurship in India, highlighting how it fosters innovation, strengthens cultural and traditional linkages, generates employment, reduces poverty, and contributes to broader socio-economic development. These nationwide concerns regarding authenticity issues to market access limitations are further increased in traditional skilled clusters like Channapatna, which face unique challenges tied to digital visibility and traceability.

Channapatna Handicraft Toy Industry

Channapatna, a GI-tagged toy-making hub in Karnataka, is renowned for its wooden lacquerware crafts. Sudha N Natesh & Bala Koteshwari (n.d.) discuss Indian handicraft marketing, particularly by Channapatna artisans. The study unites old-style craftsmanship with new-fangled marketing in encouraging eco-friendly development within the industry. Anupama and Srilakshmi (2021) delve into the critical role played by the Channapatna toymaking industry in Karnataka's economy, stressing the urgency of revitalising this sector and boosting its international competitiveness Meghasree and Guptha (2024) (Perspectives on Artisan Empowerment in Traditional Handicraft industries: Challenges and Opportunities) studies the problems and prospects that emerge within the scope of traditional handicraft spheres, especially the socio-economic setting of artisans and the issues such as poverty wages and lack of education facilities. Meghasree and Guptha (2024) examine the interfacing of cutting-edge digital technology to increase productivity and open new global markets for the Channapatna handicraft toy makers. The research stresses the necessity of embracing digital solutions to continue the handicraft industry in the face of an increasingly competitive and technology-oriented world. Meghasree *et al.* (2024) discuss the use of AI-driven e-commerce platforms

to improve the global market competitiveness of the Channapatna handicraft toy industry. Attributes such as customised shopping experience, predictive analysis, inventory management, and virtual interaction tools are very important in facilitating cultural conservation and economic viability.

Despite digital interventions, Channapatna's toy industry still lacks robust systems to authenticate products, protect artisan rights, and convey transparency to consumers—gaps that blockchain technology could address.

Potential of Blockchain in verifying product authenticity

The lack of transparency in supply chains and the prevalence of counterfeit products are major threats to brand integrity and consumer trust. Counterfeit products and a lack of supply chain transparency pose significant challenges to brand integrity and consumer trust. Blockchain-based verification systems offer a decentralised and secure solution to authenticate product origin and reduce counterfeiting (Nagar *et al.*, 2023). Kashyap and Subramanian (2023) designed a blockchain-enabled Android application using Kotlin, Hyperledger Fabric, and a Firebase database was developed to detect counterfeit products by verifying barcodes, QR codes, and serial numbers. The system ensures data immutability and transparency, offering a secure and efficient solution for real-time product authentication. (Sobowale *et al.*, 2024) emphasise the role of blockchain in improving authenticity and traceability in complex supply chains by offering immutable, transparent records. Their review highlights both the transformative potential of blockchain and the challenges of adoption, such as system standardisation and resistance to change. (Subapriya, 2023) propose a decentralised blockchain-based supply chain system using QR code verification to enhance product authentication and traceability. Their model leverages tools like Ethereum, IPFS, and Truffle to ensure transparency and security across the supply chain. (Gao *et al.*, 2022) developed a blockchain-integrated traceability structure using Ethereum smart contracts to authenticate product quality in e-commerce. Their hybrid on-chain/off-chain model ensures data integrity and enhances security, particularly for live-streaming commerce. Gudadhe (2023) proposed a blockchain-based product authentication system that ensures transparency, immutability, and verifiability across the product lifecycle. By using smart contracts and cryptographic records, their model enhances consumer trust and combats counterfeiting in supply chains. Fisseha *et al.* (2023) propose a blockchain and NFT-based verification system that assigns each product a unique digital identity, enhancing traceability and security. Their decentralised model offers a scalable and cost-effective solution to counterfeiting, especially in luxury and high-tech markets. These applications, though effective, are largely confined to industrial or luxury products. The adaptation of blockchain for small-scale, GI-tagged handicraft clusters like Channapatna remains underexplored.

Research gap and contribution

The verification of GI-tagged Channapatna handicraft toys continues to be a major challenge because of counterfeiting, non-traceability, and low consumer awareness. Before the emergence of digital verification technologies, artisans relied predominantly on manual certification processes, which were vulnerable to forgery and lacked efficiency in verifying product authenticity. While extensive literature underscores the importance of Geographical Indication (GI) tags in protecting traditional crafts, there remains a gap in comprehensive, technology-driven frameworks that ensure secure authentication and end-to-end supply chain transparency. Existing studies highlight challenges such as unauthorised replication, exploitation by intermediaries, and insufficient recognition for artisans; however, few explore technological interventions to address these issues. Blockchain technology, with its decentralised and immutable ledger capabilities, presents a robust solution for documenting product provenance, authenticating artisan credentials, and enabling transparent, traceable transactions. Despite its potential, limited research exists on the integration of blockchain with GI certification in the handicrafts sector. This study aims to bridge that gap by proposing a blockchain-enabled certification and traceability system tailored for Channapatna toys, thereby enhancing trust, transparency, and equitable market value while safeguarding the cultural heritage of the craft.

Novelty and Contribution

This study presents a tailored blockchain solution for the GI-tagged Channapatna handicraft toy industry, addressing gaps in product authentication, artisan recognition, and consumer trust. Unlike generic blockchain applications, the system is lightweight and suited for low-resource, artisan-driven contexts. The key contributions include:

- A custom block structure (Python + hashlib) storing artisan ID, product data, and certification references.
- A genesis block anchoring traceability and ensuring chain immutability.
- Integration of artisan-level metadata, promoting fair trade and visibility.

- QR code-based verification, enabling consumers to authenticate products in real time using secure hashes or transaction IDs.
- Domain-specific validation, being one of the first blockchain models designed for a GI cluster like Channapatna.

The framework bridges the technological gap in cultural preservation by combining decentralised verification with socio-economic upliftment. It offers a scalable, replicable model for other traditional craft clusters.

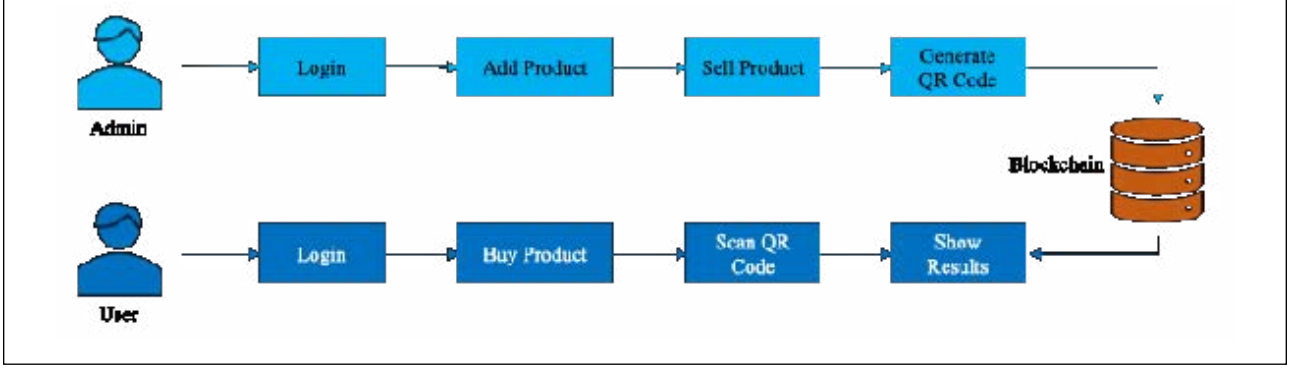
Blockchain integration for product verification

This study aimed to develop a blockchain-based authentication framework to verify the GI tags of Channapatna handicraft toys. The research began by defining the problem through an in-depth analysis of the economic and perceptual impact of counterfeit products on Channapatna toys. A comparative assessment was conducted to evaluate the benefits of GI tagging for artisans and its influence on market positioning. Primary data was collected through structured surveys and semi-structured interviews with key stakeholders—artisans, wholesalers, and retailers—to identify current authentication practices and their shortcomings. Insights from this phase guided the architectural design of the proposed system.

The framework was implemented by designing a custom block structure that encapsulated metadata such as artisan ID, geolocation, address, GI certificate number, timestamp, and a cryptographic hash to ensure data integrity. These blocks were linked sequentially in a blockchain, with each block referencing the hash of its predecessor to maintain immutability. Verified artisan and product data were encoded into blocks and assigned unique QR codes for real-time authentication. A QR-based interface was developed to enable users to verify authenticity while rejecting duplicate scans. System validation involved re-evaluation of hash linkages to confirm tamper resistance and data provenance. The results demonstrated that the blockchain-based system provided transparent, traceable, and secure authentication, strengthening consumer trust and improving market access for local artisans.

The use of blockchain technology for product authentication of Channapatna toys via QR code scan increases authenticity, transparency, and trust. Channapatna toys, being traditionally handcrafted and made of eco-friendly materials, are usually subjected to forgery threats and challenges in verifying authenticity. Through the use of blockchain-enabled QR codes embedded in them, every toy can be individually identified and tracked, so that customers receive authentic handcrafted products, as shown in Figure 1. When scanned, the QR codes contain detailed information including the artisan's information, raw materials utilised, and authenticity certification. This information is kept on a decentralised blockchain ledger, hence tamper-proof and against fake alterations. It is easy for consumers to authenticate the toy's genuineness using a smartphone, which earns artisans recognition and safeguards them against fake competition. From a supply chain point of view, integration with blockchain facilitates real-time monitoring, providing higher transparency from manufacturing to sale. This platform benefits retailers and e-commerce websites by giving them a secure marketplace where buyers can safely buy authentic Channapatna toys. Moreover, government agencies and NGOs can promote fair trade, ensuring that artisans are properly compensated.

Figure 1: System architecture for a blockchain-based authentication system for Channapatna Handicraft Toys.



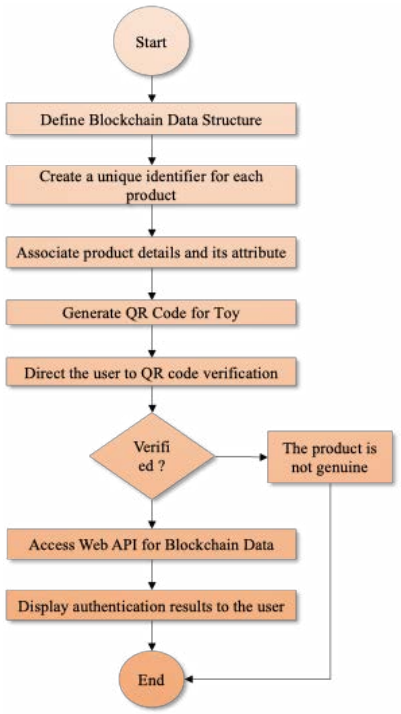
Source: complied by author

Blockchain QR codes also increase consumer interaction, create greater appreciation for handcrafted items and improve the reputation of the industry across the world. The platform also allows warranty tracking and product recalls to ensure more effective quality control and customer satisfaction. Furthermore, blockchain integration diminishes manual verification processes, enabling sustainability through a reduction in paperwork and enhanced efficiency. Through the use of blockchain-enabled QR codes, the Channapatna toy industry is able to link traditional craftsmanship to contemporary technology, ensuring its future sustainability and competitiveness in the international market.

Proposed Blockchain Framework

The application of a tailor-made blockchain for Channapatna toy GI tag verification adopts a systematic approach towards verifying the authenticity of the product, ensuring traceability, and avoiding fraud. The methodology entails various primary steps, ranging from establishing the structure of the blockchain to deploying it across the Channapatna supply chain, as shown in Figure 2.

Figure 2: Flowchart diagram for a blockchain-based authentication system for Channapatna Handicraft Toys.



Source: complied by author

The proposed system utilises blockchain technology to ensure authentication, transparency, and traceability for GI-tagged Channapatna toys. The flowchart represents the operational workflow of registering and verifying handcrafted toys in a tamper-resistant distributed ledger system. Each step is mapped to a functional module in the implementation, leveraging cryptographic security and smart indexing.

Step 1: Define Blockchain Data Structure

The first technical step is to implement the blockchain environment using Python. A custom SHA-256 hashing algorithm is used to create cryptographic hashes that link each block to the previous one, ensuring immutability. The blockchain structure is designed to store critical metadata fields, including:

- Unique Toy ID
- Artisan's Name and ID
- GI Registration Number
- Verification Status

This structure serves as the foundational ledger for tracking transactions and modifications associated with each toy.

Algorithm 1

```
class Block:
  def _init_(self, index, artist_name, geotag,
address, application_number, previous_hash):
    self.index = index
    self.timestamp = time.time()
    self.artist_name = artist_name
    self.geotag = geotag
    self.address = address
    self.application_number = application_
number
    self.previous_hash = previous_hash
    self.hash = self.calculate_hash()
  def calculate_hash(self):
    block_string = f»{self.index}{self.
timestamp}{self.artist_name}{self.geotag}
{self.address}{self.application_number}{self.
previous_hash}»
    return hashlib.sha256(block_
string.encode()).hexdigest()
```

A Blockchain class is implemented to manage the chain of blocks. The blockchain starts with a genesis block, which is the first block in the chain. The add block method is used to add new blocks to the chain. Each new block is linked to the previous block using its hash.

Step 2: Create a unique identifier for each product

Upon initialisation, a genesis block is generated, marking the beginning of the blockchain. This block serves as the root node and is hardcoded into the system. It contains predefined metadata that acts as

a reference point for validating subsequent blocks. The genesis block also includes a hash signature and a dummy transaction to validate the hash linkage process.

Algorithm 2

```
class Blockchain:
  def _init_(self):
    self.chain = []
    self.create_genesis_block()
  def create_genesis_block(self):
    self.chain.append(Block(0, «Genesis», «0,0»,
    «None», «0000», «0»))
  def add_block(self, artist_name, geotag,
  address, application_number):
    previous_block = self.chain[-1]
    new_block = Block(len(self.chain), artist_
    name, geotag, address, application_
    number, previous_block.hash)
    self.chain.append(new_block)
```

By anchoring the chain with the Genesis Block, the system ensures **verifiable continuity**, preventing unauthorised insertion, deletion, or alteration of records, and reinforcing the trustworthiness of artisan-product mapping across the lifecycle of the toy.

Step 3: Associate product details and their attributes

Each new toy produced and verified for GI compliance is added to the blockchain as a transactional block. At this stage, artisan-related information and certification details are recorded as a secure block, cryptographically linked to the previous block. This ensures Tamper-proof storage of authenticity credentials, non-repudiation for artisan contributions and transparency in product origin and manufacturing methods. By doing this, the system guarantees that any future attempts at forging a GI tag or modifying records are computationally infeasible.

Algorithm 3

```
blockchain = Blockchain()
blockchain.add_block("Smt, Thulasi",
"Muniyappanadoddi, Taluk Channapatna,
Post: Lalaghatta, District: Ramanagar – 562
160, Karnataka", "Ramanagar, Karnataka", "23")
blockchain.add_block("Shri. Raju. B",
"96, Muniyappanadoddi, Taluk: Channapatna,
Post: Lalaghatta, District: Ramanagar –
562 160", "Ramanagar, Karnataka", "24")
blockchain.add_block("Shri. Ramu", "Kalanagara,
Taluk: Channapatna, District: Ramanagar–
512160", "Channapatna Toys, Ramanagar,
Karnataka", "25")
```

Step 4: Generate QR Code for Toy

To bridge the physical and digital systems, a unique QR code is generated for every toy registered in the blockchain. This QR code contains a secure link to the toy's blockchain record, enabling real-time traceability for supply chain actors, consumer-level access to origin data and visual authentication via simple scanning tools. Each QR code is dynamically mapped to the corresponding blockchain block hash, maintaining a one-to-one relationship between the physical product and its digital twin.

Algorithm 4

```
scanned_qr_codes = set()  # A set to track which
QR codes have been scanned
scan_timestamps = {}  # Dictionary to store scan
timestamps for each block

def generate_qr_code(block):
      qr_data = f»Block {block.index}:\nArtist:
{block.artist_name}\nGeotag:    {block.geotag}\
nAddress:      {block.address}\nApplication No:
{block.application_number}»

    print(«QR  Data:\n», qr_data)   #  Debugging
step

   qr = qrcode.QRCode(
       version=1,
       error_correction=qrcode.constants.ERROR_
CORRECT_L,
       box_size=10,
       border=4,
   )
   qr.add_data(qr_data)
   qr.make(fit=True)

        img = qr.make_image(fill=»black», back_
color=»white»)
   filename = f»qr_block_{block.index}.png»
   img.save(filename)
   print(f»QR Code generated for Block {block.
index}: {filename}»)
```

A function, scanned_qr_codes is implemented to simulate the scanning of QR codes. It checks if a QR code has already been scanned and prevents duplicate scans. The function displays the artist's details when a QR code is scanned for the first time.

Step 5: Direct the user to the QR code verification

At the point of sale or during customs inspection, the QR code is scanned by a retailer, distributor, or consumer using a mobile application or dedicated web interface. This initiates the verification process by querying the blockchain for associated records.

Algorithm 5

```
def scan_qr_code(block_index):
   current_time = time.time()
```

```
    # Show block details before checking if it has been scanned
    print(f»Block {block_index}:»)
     print(f»  Artist: {blockchain.chain[block_index].artist_name}»)
     print(f»  Geotag: {blockchain.chain[block_index].geotag}»)
    print(f»  Address: {blockchain.chain[block_index].address}»)
     print(f»  Application No: {blockchain.chain[block_index].application_number}»)
    # Check if the QR code has already been scanned
    if block_index in scanned_qr_codes:
         print(«Error: This QR code has already been scanned. Cannot scan again.»)
        return
    # First scan, so add it to the set and record the timestamp
    scanned_qr_codes.add(block_index)
    scan_timestamps[block_index] = current_time
     print(f»QR code scanned successfully for Block {block_index}. You have 10 seconds to complete the process.»)
    # Countdown for 10 seconds
    remaining_time = 10
    while remaining_time > 0:
        print(f»Time remaining: {remaining_time} seconds», end=›\r›)  # Overwrite previous line
        time.sleep(1)
        remaining_time -= 1
    # Check if 10 seconds have passed since the first scan of this QR code
          time_since_scan = current_time - scan_timestamps[block_index]
    if time_since_scan > 10:
         print(«\nError: Scan time expired. You cannot scan this QR code after 10 seconds.»)
return
     print(«\nScan valid within the 10 seconds window!»)
```

Step 6: Verify Integrity and Authenticity

The system performs a comprehensive validation routine to determine whether the scanned block is present in the blockchain**,** unaltered since its creation and correctly linked with its preceding block. This process is executed by re-hashing and cross-verifying block data against the stored hash chain. Any inconsistency flags the item as unauthentic or tampered with. Only when the hash chain is intact and the record matches the original input is the toy marked as genuine.

Algorithm 6

```
    print(f»Block {block.index}:»)
    print(f»  Artist: {block.artist_name}»)
    print(f»  Geotag: {block.geotag}»)
    print(f»  Address: {block.address}»)
    print(f»  Application No: {block.application_number}»)
    print(f»  Block Hash: {block.hash}\n»)
print("Blockchain created with QR codes. Scan to view details!")
```

Step 7: Access Web API for Blockchain Data

If the verification is successful, the system accesses the blockchain via a RESTful Web API. This API exposes read-only access to essential toy metadata and offers a clean user interface. It ensures public access without compromising ledger security**,** compatibility with front-end applications (mobile, kiosk, browser) and Real-time access to verified GI tag records**.** The API also handles user authentication and permission levels for different stakeholders (*e.g.*, government bodies, retailers, consumers).

Step 8: Display Authentication Result

The verified information is displayed on the user's screen, confirming the toy's legitimacy. This includes:

- Unique Toy ID
- Artisan's Name and ID
- GI Registration Number
- Verification Status

This transparency not only improves buyer trust but also adds value to the artisan's reputation, supporting ethical and sustainable manufacturing. The transaction concludes with the delivery of a verified, authenticated Channapatna toy to the end user. The system also updates the toy's journey through the supply chain if applicable, further enriching traceability.

Results and Discussion

The combination of SHA-256 hashing, timestamping, and QR code integration plays a vital role in ensuring transparency, protecting artisans from counterfeiting, and uplifting their livelihoods. By linking each block securely through cryptographic hashing, the system creates a tamper-proof digital record, preserving the authenticity of Channapatna toys. Timestamping helps track the exact time of transactions, maintaining a clear history of ownership and production. Figure 3 displays the QR code and its results upon scanning and provides the details of the toy and the artisans.

The associated blockchain record includes critical metadata such as the artisan's name, geolocation (Muniyappanadoddi, Taluk Channapatna, Post: Lalaghatta, District: Ramanagar – 562160, Karnataka), and the GI Authorised User Certificate Number: 23. This data has been cryptographically secured and stored as

Figure 3: QR code results for Block 1 for Artisan 1.



Source: complied by author

an immutable block within the blockchain network. Upon scanning the QR code, users are directed to a real-time digital interface that displays authenticated details from the blockchain ledger. This seamless integration of blockchain and QR code technology ensures transparency, provenance, and authenticity of the handcrafted product. By making artisan and certification details instantly verifiable to consumers and stakeholders, this implementation enhances trust, prevents counterfeiting, and promotes the cultural and economic value of genuine Channapatna toys.

The proposed blockchain-based traceability system was developed as a conceptual prototype to address issues of product authentication, artisan visibility, and consumer trust in the Channapatna handicraft toy industry. While not implemented in a live environment, the system design was tested in a controlled coding setup using Python to simulate block creation, hash linking, and QR code generation. Simulated scenarios, such as forged block entries and consumer-side verification, demonstrated the potential for detecting tampering and enabling real-time traceability. The inclusion of artisan-specific data within each block also highlights the framework's alignment with fair trade and GI protection goals. Though empirical validation is pending, the prototype offers a promising foundation for future pilot deployment and stakeholder testing.

Conclusion

The study demonstrates how blockchain technology can authenticate GI-tagged Channapatna toys, ensuring transparency and preventing counterfeiting. By assigning each toy a unique digital identity with verifiable details, consumers can confirm authenticity via QR codes, fostering trust and direct artisan-to-buyer connections. This reduces middlemen exploitation, ensures fair pricing, and enhances global market access for artisans. Blockchain also improves supply chain efficiency by recording every stage of production and distribution, ensuring ethical sourcing and reducing fraud. The transparency appeals to ethical consumers, helping preserve traditional craftsmanship while encouraging sustainable practices. Future integrations with AI and IoT could optimise production, automate quality control, and enhance market competitiveness. As blockchain adoption grows, it could transform the handicraft sector, promoting fair trade, protecting intellectual property, and modernising traditional crafts while maintaining cultural heritage. This innovation empowers artisans, ensuring they receive due recognition and sustainable earnings. The combination of blockchain technology and QR codes revolutionises the authenticity and traceability of Channapatna toys. A decentralised ledger ensures tamper-proof records, secure transactions, and global market acceptance. Key advancements include enhanced provenance tracking, where blockchain records a toy's journey from the artisan to the buyer. Scanning a QR code reveals details such as artisan information, materials, and certification, preventing counterfeiting and ensuring recognition for government-certified artisans. Smart contracts will enable fair trade and secure payments, automatically compensating artisans upon delivery, eliminating middlemen, and ensuring fair royalties. A decentralised marketplace powered by blockchain could also allow artisans to sell directly to consumers, boosting earnings and reducing reliance on third-party retailers. These innovations promise a transformative future for Channapatna toys, preserving craftsmanship while leveraging modern technology for transparency, fair trade, and global reach.

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