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ICO as Crypto-Assets Manufacturing within a Smart City

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Abstract: The digitalization of the economy provokes the rethinking of manufacturing processes. Despite numerous publications related to Industry 4.0 as a manufacturing approach, the production of fully digital and crypto-asset products was poorly researched. Besides having a supplementary role, crypto-assets may form an entire smart city product. The authors assess the manufacturing of smart city products, fully or partially formed by crypto-assets. The initial issuance of the crypto assets was usually addressed as an Initial Coin Offer, or through the process of increasing the issuer's capital. The authors assess the Initial Coin Offer, and address it, like manufacturing to produce products for sale. The authors classify all milestones related to the crypto-assets' issuance, distribution, and revaluation, and assign incomes and expenses to each milestone. Additionally, the ICO-based production costs and revenues were classified according to crypto-asset types, as defined by European Economic Area legislative acts.

Keywords: digitalization; crypto assets; financial services; fintech

1. Introduction

Since the First Industrial Revolution, manufacturing has evolved through several revolutions—from water and steam-powered machines to electrical and digital automated production—making the manufacturing process more complex, automatic, and sustainable so that people can operate machines more efficiently, effectively, and consistently [1]. The Third Industrial Revolution, the digital revolution that has been taking place since the middle of the previous century, is now giving way to the Fourth Industrial Revolution. The distinction between the physical, digital, and biological domains is becoming increasingly muddled due to a convergence of technology [2–7].

Manufacturing physical products is no longer the only aspect of manufacturing. A fundamental change in how businesses conduct themselves has been brought about by changes in customer demand, the makeup of products, the economics of manufacturing, and the economics of the supply chain. Customers seek personalization and customization, as the distinction between consumer and producer becomes hazier. Products become "smart" with the addition of sensors and connections, progressively morphing into platforms and services [8].

With the advent of digital manufacturing, discrete technologies have given way to integrated systems. Industry 4.0, which depicts the Fourth Industrial Revolution, represents a new degree of organization and control of a product's whole value chain, across its life cycle, and promotes intelligent, connected, and decentralized manufacturing. That trend has led to the transformation of the city into a smart city, in addition to the effect of global urbanization. Indeed, the emergence of technologies such as computational intelligence, automation and robotics, additive manufacturing, and human–machine interaction, combined with breakthroughs in data storage and new processing capabilities, are releasing innovations that alter the character and content of production [9]. Moreover, the smart city concept fully corresponds to industry 4.0 since it uses digital transformations of the city environment to benefit residents, businesses, and other stakeholders [10,11].

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One of the technologies that appeared in digital manufacturing is distributed ledger technology, which first arose in 2008. The distributed ledger is a database of issuance and transaction records held in several nodes (computers) that make up a distributed computer network. An electronic distributed ledger is used to share a crypto asset, an intangible digital asset whose issue, sale, or transfer is encrypted and protected by cryptography [12].

The phenomenon of cryptocurrency (crypto assets) is currently transforming into a standard digital transformation tool for products and services [13–15].

Crypto asset development and initial distribution are usually called Initial Coin Offer (ICO). The majority of the researchers, who wrote about the ICO, agreed on the following definition—Initial Coin Offer (ICO) is, based on blockchain technology and smart contracts, a list of actions that entrepreneurs use to attract external funding by issuing tokens without intermediaries [16–21]. They agreed that in correlation with Initial Public Offer (IPO)—when a private corporation first offers its shares to the public, the Initial Coin Offer (ICO) result is the increased capital of the company issuer.

Conversely, researchers who work in the field of accounting classify cryptocurrency assets as goods held to sell, or intangible assets in case the issuer company uses crypto assets for their own needs [22–24]. This opinion is supported by the International Accounting Standards Board (IASB). The development and implementation of the International Finance Reporting System (IFRS) Accounting Standards are the responsibility of IASB members.

In this case, if the digital assets are products for distribution, their development is manufacturing. Their distribution will not lead to a capital increase, but with acknowledgement of the income from distribution—it will be the income from distribution. That classification has both theoretical and practical value since, from the theoretical point of view, it allows for the correct assessment of costs for the issue of digital assets, and it facilitates the development of efficient financial management models for products based on digital assets. Moreover, it can be used in practice for building and implementing effective accounting principles for digital asset issuance, on the level of the city or corporate.

The theoretical value of this approach lies in the fact that it contributes to the development of accounting principles applied for crypto assets; since crypto assets are a rather new form in financial market functioning, the accounting system is still under development for this type of asset, and the requirements for accounting from the practical sphere are under development. Therefore, this research can significantly contribute to the development of accounting principles for digital assets.

The practical value is even higher. The professionals working in the area face problems with accounting these assets, particularly with attributing costs to this or that category, and analyzing the costs associated with crypto assets. Therefore, this study can serve as a basis for creating an efficient model of management for these assets, and also improving the system of accounting them.

The study has a theoretical nature; however, it is exemplified by Rome as a smart city, using the crypto based assets for achieving the KPIs. The authors consider Rome as an example for supporting the theoretical provisions of the authors. Moreover, these provisions can be easily applied to any activities of the city's municipal authorities, using the crypto based products for achieving the set goals.

Given the crypto assets definition conflict mentioned above, due to their active development, crypto asset implementation creates some challenges for the market, especially within the Initial Coin Offer (ICO) which still needs to be well described [20].

Industry 4.0 not only changes manufacturing as a process, but raises questions about the manufactured product itself, its components, and its characteristics in case the distributed ledger technology is used within its production. The production of the products using the distributed ledger technology is already overviewed [25], but researchers did not assess the production process and distribution itself very well.

The production of crypto-asset-based products usually start with crypto-asset issuance. The authors of [26] defined formalization as the critical element of digital product or service

development. They admit that an entirely bureaucratic approach to digital product innovation is ineffective, but some level of formalization of product development is necessary.

The authors of [27] introduce a conceptual distinction between expected and disruptive change that may help to spot the disruptive potential of crypto asset implementation. The authors of [27] provide an analysis of the four stages of change, offered by Causal Layered Analysis, revealing that cryptocurrencies have posed various challenges to conventional currencies. The rise of cryptocurrencies has begun to pose a systemic change threat to long-standing businesses or organizations. An example is by enabling peer-to-peer transactions that are highly cost-effective in international money transfers; for instance, cryptocurrencies have the potential to lower transaction costs by removing or reducing the fees charged by the established middlemen that facilitate transactions.

It is necessary to take into account: (1) the disruptive potential of the implementation of crypto assets, and (2) the poorly researched crypto asset manufacturing process, due to conflict with the crypto assets' issuance goals classifications, in the approach to the manufacturing of crypto-assets and crypto-asset-based products.

When developing such an approach, it is essential to consider the wide range of available crypto assets, and the potential for self-consumption when they are provided to manufacturers. It is also required to classify precisely all events related to issuing crypto assets that have a bearing on accounting.

The goal of this research is to determine the order of accounting events related to the issuance of crypto assets. We speak, in this case, not about stages of issuance but about events, since they do not occur in definite sequence; moreover, they can happen simultaneously or in different orders, or even in some circumstances can be omitted in this way.

The authors determined the objectives of the study to achieve the set goal. They are as follows:

- To classify the issuance of crypto assets as a manufacturing process;
- To determine the IFRS standards for each type of cryptocurrency issued;
- To estimate each event from the point of view of applied IFRS;
- To evaluate whether crypto assets-based products are fit and proper for the smart city goals achievements;
- To assess the costs and revenues, and leverage related to crypto assets.

The research has a certain theoretical value since it determines the ICO as a manufacturing process within the frameworks of Industry 4.0. Moreover, the authors have not come across any research considering the smart city as an issuer of crypto assets.

However, the most value this article has is for practical application, since it develops the procedure of accounting the events related to the crypto assets' issuance within the European Union, which is very important in the contemporary situation.

2. The Changed Concept of the Product

The digitalization of the economy changes the understanding of the concept of the product. After digitalization, each product may, potentially, be composed of three components:

- Non-digital;
- Digital;
- Crypto-asset.

This concept may be explained in the example of a Mug as the product. In case a Mug is sold in a traditional store, it is composed of only Non-digital parts. In the case, in addition to a traditional store, the merchant sells the Mug via e-shop, it is composed of Non-digital and Digital parts. If the e-shop mentioned above accepts crypto assets (such as Bitcoin) as a means of payment, then the product "Mug" comprises all three components.

Such an approach allows fully digital products to exist, when a non-digital part does not exist for the product. Examples of such products are financial services and insurance services [28].

In case crypto-assets or digital parts exist within the product or service, the product or service may be treated as digital [28]. The task of the study is to assess the crypto asset part of the product; therefore, the effect of other parts on the crypto asset and their nature is beyond this study.

The traditional approach for the product, composed exclusively of Non-Digital Parts, is an in-line product-creating procedure, where the drawings are sent to the shop floor for the prototype's fabrication. If the Digital part of the product amends the non-Digital part, then the non-Digital product prototype parameters are used as incoming parameters for the Digital part's development. The Digital part of product manufacturing is conceptually designed and innovated via computer-aided design software and digital technology. The crypto-assets part of the product is manufactured similarly to the Digital part. These designs and procedures are simulated to determine whether it is feasible to manufacture the product. All parts of the product are tested using computer-aided quality control procedures, and it is scrutinized at every stage of the manufacturing process. Supply chain management is also digitalized for efficient inventory and customized items [29].

Digital manufacturing is widely represented in the scientific literature under Industry 4.0 [2,4,6,29]. However, aspects of digital manufacturing of fully digital products, and consequently crypto-based products, were not well developed by researchers. The crypto-based product manufacturing should be represented in the cycle of production, where each workflow milestone should be accessed.

The authors already mentioned the conflict of definitions regarding the Initial Coin offer. The object of the Initial Coin Offer is a crypto asset. Crypto assets were initially developed using the following assumptions:

- The blockchain used: the developers, based on the task, may select the existing blockchain or decide to create a new one for their developing Crypto-asset;
- Definition of all parameters, how the Crypto-asset will interact with the blockchain, and which events this Crypto-asset allows. These parameters are called "smart contracts".
- When the previous two steps are completed (they may even be carried out in parallel), then the internal information technology tools of the blockchain are used. The initial quantity of the crypto-assets' creation process is called Issuance. The total amount of issuance and other parameters are the part of the smart contract, and this information cannot be changed after issuing the Crypto-assets.

The majority of the researchers [16–21] believe that Initial Coin Offer is a set of actions, one of which is the issuance of crypto assets. They mentioned the attraction of external funding to the entity that made an Issuance (Issuer) as the purpose of this Issuance.

On the other hand, the International Accounting Standards Board (IASB) and researchers who assess the crypto assets from the accounting perspective classified the crypto assets issued for distribution as accountable under the inventory goods.

These two purposes of the Crypto assets—attraction of the external funding, and object to be sold—form the conflict between the definitions and mean that one of the definitions is incorrect.

ICOs are used as a tool by many financial and non-financial organizations, so the first question that arises before creating the models of accounting systems for companies is the subject of the ICO—a token or a coin.

Although there is no official division into "coin" and "token" yet in the regulatory framework, the authors agree with the definition given by the audit company PWC in its report [30]: The term "token" refers to an asset that provides the owner with additional functionality or utility, whereas the term "coin" typically refers to a cryptographic asset that has the explicit aim of operating only as a medium of exchange.

The authors utilized the European Parliament's classification of crypto assets, in legislative recommendations for crypto assets [31], as a source for classifying the crypto assets. This classification distinguished three categories of crypto assets:

- Utility tokens: these digital assets are released to grant access to digital services or platforms;

- Asset-referenced tokens: they are digital assets that can be linked to a single or a collection of currencies, other digital assets, a single or a group of commodities that are traded on an exchange, or a single or a collection of stocks. Before the publishing of the proposal mentioned above, certain EEA nations passed local legislation governing Initial Coin Offerings (ICOs), in which the tokens linked to the assets are referred to as security tokens;
- Payment tokens: they are crypto assets that are primarily designed to be used as a form of payment (coin, electronic money tokens, e-money tokens).

The European Commission's approach divides crypto assets into three distinct groups. However, the so-called hybrid tokens, which include target uses from several subgroups of tokens, should be classified as belonging to one of the subgroups mentioned above if the proposed product incorporates those target uses.

All three groups of crypto assets actively function and form the ecosystem within the smart city. Researchers have recently attempted to comprehend the industrial ecosystems in smart cities, including smart city industry ecosystems [32] and smart city governance/service/data ecosystems [33–35]. Smart city manufacturers (smart industries) lack precise definitions and classifications, and they are variously categorized based on the research goals and the researchers' personal opinions [32].

Digital manufacturing, like traditional manufacturing, is based on supply chains. Supply chains are mainly digital since the main components (raw materials and services) are also digital. Digital services forming the supply chain for smart manufacturers may be the product of other smart manufacturers or smart consumers. For example, the final consumers of the TripAdvisor application, rating the companies presented by this application, made the principal value for this application.

Considering that the border between manufacturer and consumer has become transparent, manufacturers and consumers of the smart city are called smart users.

3. Methods and Materials

The bibliographical research method was applied to determine the order of events of issuing coins. The bibliographical research was conducted as the expository type to recreate the investigation's theoretical context. To achieve that, the authors use reliable sources and the careful selection and analysis of the material in question. The articles were retrieved from scientific databases such as Scopus, Web of Science. The keywords used for searching were "fintech" AND "cryptocurrency" OR "crypto" OR "blockchain" AND "accountancy" OR "accounting". Another search was related to smart city KPI. The concept of a smart city as an environment for various digital processes was examined. In total, there were 59 sources considered, published from 2011 to 2022.

The IFRS standards were applied to determine the costs [36–39].

The authors examined the information presented by the municipal authorities of Rome for the plans to develop Rome as a smart city in all possible areas [40]. Within the Rome Smart City plan, 81 projects from the 11 areas of intervention were identified and evaluated. A total of 119 city indicators and 120 smart key performance indicators (KPIs) were placed to monitor the plan's progress, replicate successful projects, and intervene in the most critical areas. The indicators represent the expected result in terms of quality of life within the city.

The authors estimated and selected the smart KPIs, which describe the city's digitization level or innovative technologies. Another segment of KPIs was chosen for its capability to be implemented with crypto-asset-based product usage. Further, the authors assessed the smart city KPIs against the possibility of using crypto-asset-based products to implement the Rome municipal authority's strategy.

Then, the determined costs were used as a basis for formulae that are absolutely practical and applicable for solving the problems of financial institutions, and any other companies issuing crypto assets in the smart city and facilitating the development of

Rome within the smart city concept. The practical leverage formula, specified for these institutions, was created based on obtained costs and income formulas.

The authors used the taxonomy of cryptocurrency to use the specific IFRS standards depending on the category of crypto asset. It is essential since the different types of crypto assets use different standards of IFRS.

4. Results

As mentioned above, the Initial Coin Offer (ICO) is the issuance and initial distribution of crypto assets. The subject of this process is the crypto-asset. As the authors have shown above, the crypto-asset is a part of the product; therefore, the Initial Coin Offer is the product issuance. For example, if a utility token is issued within the supercar test drive voucher product, and this product is distributed electronically via emails, then this product has crypto and digital parts. Nevertheless, if the cryptocurrency is issued, which is used as a payment means within the blockchain, this product will have only the crypto part.

4.1. Capital Increase Method vs. Manufacturing for Further Sale

4.1.1. ICO as Capital Increase

Ref. [41] their article defined the following capital increase methods:

- Increase the capital through the issuance of shares;
- Increase the capital by incorporating reserves;
- Increase the capital by debt conversion;
- Initial Public Offer and further value of shares on the stock exchange changes.

All these methods were focused on two approaches—increase the number of issued shares of the company, or increase the value of its shares.

Some authors still compare the ICO and IPO [42,43]. Within the IPO, the number of shares increases. After those are sold to the public, within the ICO, the new crypto assets are issued and sold to the public. An investor obtains a firm's share in an IPO, but in an ICO, they receive a token that does not reflect company shares. This is how they vary from one another.

According to [22–24] the accounting approach to crypto assets shows that crypto assets should be registered within the issuer balance sheet in the inventory. Keeping in mind that it is the product for sale, which also does not support the opinion that crypto assets' issuance and distribution are the methods by which to increase equity value.

Given what is mentioned above, the authors believe that the Initial Coin Offer goal is not to increase the capital.

4.1.2. ICO as Manufacturing

Manufacturing is typically used to describe an industrial production process where raw materials are turned into completed goods sold on the market. Today, manufacturing is regarded as an integrated concept at all levels, from the equipment and production systems to the overall company activity [44].

The ongoing and consistent emphasis on product innovation has resulted in the conceptualization of comparable large-scale investment and product development roadmaps for important industry participants, which has led to a similar range of new product options in the market. As a result, there is less product differentiation, and no company has been successful in the market competition [45]. As the stage advances to the following step, the business adds higher levels of customer service and sophisticated approaches to solve customer problems. Customers begin to view the products and services as an integrated solution that addresses all of their needs, rather than as discrete items [46].

Modern production is related to business process management [5], solving the following issues:

- Analysis of processes;
- Definition of structure between processes;

- Choice of management method;
- Modeling and optimizing the processes;
- Performance measurement and diagnostics system.

In the case of digital manufacturing, business process management is related to the management of the digital processes related to the crypto-asset-based product [7].

Applying the Business Process Management steps to crypto-assets manufacturing may show whether the same approach applies to the issuance of crypto assets.

Table 1 represents the stages of management of crypto-assets issuance process.

Table 1. Business Process Management Steps for crypto-assets' issuance. Source: generated by the authors.

The Process	Crypto Assets Issuance Stage
Analysis of the processes	Definitions of the following: • General product features • Distribution channels • Blockchain type or exact blockchain • The limitations if any
Definition of structure between processes	• Definition of the legal and technical structure as the interaction between issuer–distributor–buyer
Choice of the management method	Definition—how the total issuance and its quality will be controlled
Modelling and optimizing the processes	Product testing in accordance with the product oversight and governance principles [47]
Performance measurement and diagnostics system	Product monitoring in accordance with the product oversight and governance principles [47]

Product oversight and governance are principles that the European Central Bank promotes and requests to be used by asset management companies and all financial institutions [47,48].

Consequently, product oversight and governance principles are the innovations within crypto asset and financial product manufacturing. The stages of the crypto-assets' issuance accordingly correspond to the manufacturing cycle of the business processes.

Given those mentioned above, the authors define Initial Coin Offer as the manufacturing method.

4.2. Crypto Assets Manufacturing

As the Fourth Industrial Revolution, or "Industry 4.0" [2–6,49,50], has just emerged, traditional manufacturing processes and organizational and commercial paradigms are being tested and disrupted. As a result, all and any crypto assets issuers should deal with the new product life cycle typical to the product they develop or manufacture. The crypto-asset-based products have their life cycle, which issuers should use in their development and manufacturing.

Since the crypto-asset-based product or service life cycle is similar to any product or service life cycle within Industry 4.0, it is possible to apply the same business management method [5]. Although numerous publications regarding cryptocurrencies and crypto assets exist [12,17,51–56], the authors decided to assess the stages of crypto-asset manufacturing.

The authors developed the crypto-asset-based products or services lifecycle milestones. The authors assess the milestones of the crypto assets' manufacturing lifecycle, related directly to the issuance of the crypto asset part of the product, and these milestones are as follows:

- Definition of a subgroup of crypto assets and development of parameters of a smart contract;

- Determination of the issuance method;
- Issuing crypto assets using specific parameters of a smart contract;
- The distribution model of crypto assets (payment in fiat currency or other crypto assets);
- Circulation of the crypto assets;
- The Disposal method of crypto assets.

Following the Business Process Management [5], the crypto assets' lifecycle is defined, and issuers may build the processes (technological, accounting, legal, marketing, and so on) concerning each milestone of the lifecycle.

4.3. Smart City KPI Assessment

Since the issuer of crypto-asset-based products considered in this research is a smart city, the authors examine Rome which has the most notable presence of reality businesses, with 300,000 businesses operating within it [40].

The Municipality Administration plans to invest in instruments that support the regeneration, expansion, and development of the city's entrepreneurial and economic fabric, while promoting best practices in the region. It has also proposed its model of economic growth, which aims to:

- Streamline and facilitate the interactions between the public sector and private sector to create an ongoing, mutually beneficial discourse that benefits the entire community;
- Encourage firms to be more competitive to increase employment numbers, as well as productivity, efficiency, and human capital;
- Promote the formation and growth of synergies, exchange, and transfer of knowledge by identifying and implementing good practices for entrepreneurship development, which will benefit the region's overall economic and social structure.

Rome's municipal government has chosen KPIs following these goals, and is assessing the effectiveness of implementing the smart city concept. Table 2 represents the possible use of the crypto-asset-based products for achieving these KPIs.

Table 2. Rome city smart KPIs and application of crypto-based products. Source: generated by the authors.

KPI Name	KPI Description	Crypto-Based Products
Places used for coworking	The number of coworking spaces. Coworking is sometimes referred to as the "new form of work" and is an example of the collaborative and sharing economy [57].	The coworking space management has two aspects which crypto asset products may manage: • Considering that space or objects (meeting rooms, working places) are usually limited, it may be controlled by issuing and circulating access tokens (utility tokens) or something based on them. • The services of the coworking spaces may be paid for by the crypto-asset-based products (such as cryptocurrency).
Multiple online services or streamlined procedures for starting a business or engaging in commercial activities	The number of businesses registered online.	Services related to starting a business or engaging in commercial activity from the perspective of the processes, may be divided into three parts: • Conducting the service itself. Smart Users may use crypto-asset-based products for the payments of the service. • Identification of the applicant. Smart Users may use crypto-asset-based products to verify the identity of the applicant. • Submitting to the applicant publicly verified extracts. Applicants may submit such documents via the blockchain.

Table 2. *Cont.*

KPI Name	KPI Description	Crypto-Based Products
Number of requests submitted online	Business models digitalization	• Conducting the service itself. Smart Users may use crypto-asset-based products for the payments of the service. • Identification of the applicant. Smart Users may use crypto-asset-based products to verify the identity of the applicant. • Submitting to the applicant publicly verified extracts. An applicant may submit such a document via the blockchain.
Presence of the Economic Development Plan for at least 3 years	Smart City KPI is not directly connected to the crypto-asset-based products and services.	
Number of Knowledge Sharing events (conferences, meetings, etc.)	The number of conferences and events organized in the city.	• The tickets for such events may be sold as a crypto-asset-based product. • Payments for these events may be made by crypto-assets, such as cryptocurrency. • If they have limited access, the proceeding of the conferences may be available per presenting the crypto-asset-based ticket.
Presence of the city brand on the platforms of e-commerce	The Rome city brand within the payment platforms, payment products, or development of its payment platform for smart city users	• Development of own payment planform, based on the blockchain technology • The cryptocurrency issue with the city brand joins B2B (Business-to-Business) and B2C (Business-to-Customer) payment across the smart city.
Number of participants who support the city's brand	The presence of the city brand in the image or marketing campaign of the products or services represented by the business forms the city's economy.	
Smart city products/service sales volumes	Number of transactions and sales volumes generated by the businesses presented within the smart city	• Own blockchain-based payment platform B2C and B2B will increase intra smart city payments volumes • Tax payments (such as F24 (national tax payment system)), via the same smart city payment platform, will increase intra smart city payments volumes • City utilities and services concentrated within the same platform will increase intra smart city payments volumes
Presence of the server clusters for the economic development (at the level of the city and districts)	Server clusters for the digital economy are manufacturing, management and distribution infrastructure. Their existence, availability and location determine the sustainability and success of the smart city.	• Server clusters are, in some way, coworking manufacturing infrastructure. Taking into account that contemporary servers may be segregated into areas, with the allowance of access for separate groups of users—one server cluster may be used by different smart users or producers of the smart city. • Server cluster managing companies may use crypto-asset-based keys to control these accesses • Server cluster managing companies may accept crypto-assets payments (including within the smart city's own payment platform) for the services offered by the server cluster entities.

Table 2. *Cont.*

KPI Name	KPI Description	Crypto-Based Products
Number of initiatives for the development of SMEs (Small and Medium Enterprises)	Achieving a high number of SME initiatives is not the goal by itself. The main target is to achieve an increased number of effective working initiatives, which will help develop small and medium enterprises.	• Smart city may widely use crypto assets and blockchain for such init-iatives such as: • Network for crowdfunding • Easy way of inter-payments • Supporting SMEs with the standard payment acceptance solution (B2C and B2B) based on blockchain

Table 2 shows that crypto-asset-based products may be blockchain-based or any existent crypto-asset-based. Both cases require that the product base is new, or in an existent crypto asset.

Due to innovation, businesses within the smart city may increase profits by offering clients unique goods and services that cater to their constantly shifting wants and preferences [46].

4.4. Crypto-Asset-Based Product Production Accounting

4.4.1. IFRS Approach for Accounting Lifecycle Milestones Related to Event Manufacturing

When a Crypto assets issuer assesses the accounting techniques for the crypto-asset-based products, accounting approaches should be bonded to the events related to the lifecycle milestone. Each event forms costs associated with the crypto-assets issuer, which includes the total costs of crypto-asset-based product manufacturing.

Summarizing the essence of Table 3, the authors define the formula for the calculation of the crypto-assets costs:

$$TC = LF + SF + TF \quad (1)$$

where

- TC is Total manufacturing costs;
- LF is License Fee (fixed costs per issuer);
- SF is Salary or supplier fee (fixed costs per issuer);
- TF is Transaction cost (variable fee, depending on the number of issued crypto assets).

Following the IFRS, accounting of the crypto assets is related to the purpose of issuing the crypto assets [22]. The IFRS committee recognized that cryptocurrency, if it is intended for sale, must be accounted for following the IAS2 Inventory standard [36]. The authors believe that this approach to accounting can be extended to all types of crypto assets. Examples of crypto assets held for sale include the following ones:

- Crypto assets held by the Company for exchange;
- Crypto assets under management (for example, storing crypto assets in wallets for company clients);
- Crypto assets issued or held for sale.

The IFRS committee also determined that if crypto assets are stored in an enterprise and not for sale, then such crypto assets must be accounted for following IAS 38 Intangible Assets. Examples of such crypto assets can be crypto assets issued for the company's needs.

The IFRS Committee recommended applying IFRS 2.3b for commodity brokers and traders when accounting for crypto assets [36]. Accordingly, commodity brokers and dealers are encouraged to carry their inventories at fair value or less as it costs to sell. However, it is recommended that the change in fair value be reflected in profit or loss in the period when this fair value changed. The document specifies that if an entity measures crypto assets at fair value, paragraphs 91–99 of IFRS 13 Fair value apply.

The purpose of using this standard is to determine the price of goods hosted in inventory [38]. Following the standard, "The inventory cost must include all purchase

costs, processing fees, and other expenditures incurred to maintain the inventory in its current location and condition."

Table 3. Manufacturing costs. Source: generated by the authors.

Milestone	Event	Cost/Incomes
Definition of a subgroup of crypto assets and development of parameters of a smart contract	*Selection of the crypto assets type:*	
	For Utility tokens	No costs
	For Payment tokens	Fees for registering with the AML (anti money laundering) control entity (license fee)—fixed costs
	For Asset-referenced tokens	Fee for registering as an asset management or financial institution. (license fee)—fixed costs
	Selection if customers crypto assets will be held in the "accounts" of the issuer:	
	Yes	Fees for registering as the crypto wallets' holder (license fee)—fixed costs
	No	No costs
Determination of the issuance method	No accounting related events	
Issuing crypto assets using certain parameters of a smart contract	*If the issuing method provide use of the blockchain:*	
	No	No costs
	Yes	Fees of the blockchain for the issuance (transaction fee)—variable costs
	The physical crypto assets' issuance	Salary or contractual fee for the issuance (salary or supplier fee)—fixed costs

As mentioned above, the product price is equal to TC (total manufacturing costs), per accounting for it within the company inventory or intangible assets. The IAS2 Inventory does not allow for taking into account the positions with 0 costs in inventory [58]. Considering that the issuance of crypto assets may not have direct costs, crypto assets are placed in inventory at the estimated initial selling value. All emission, expressed in this value is taken into account in the company income.

4.4.2. IFRS Approach for Accounting Lifecycle Milestones Related to Event Distribution

The issuer or crypto-asset-based product distributes only crypto-asset products issued with such purpose. The distribution has only two options:

- When for crypto assets, buyer pays by "traditional currencies" (fiat currencies);
- When the crypto asset's buyer pays in other crypto assets.

The purpose of the ICO, if it is not produced for the issuer's consumption, is to sell the issued crypto assets. The issuer then applies IFRS 15 Revenue from Contracts with Customers to sell goods to customers [22]. Application of the IFRS 15 is linked to the ownership right passage from the seller to the buyer; otherwise, the researchers shall assess such cases separately. Such cases are out of the scope of this article.

Applying the IFRS 15 allows crypto-assets' producers to account directly for the selling price, as product selling incomes are accounted for in profit and loss (PL).

The authors contend that to clarify whether IFRS 15 may account for revenues from such transactions, it is essential to consider the scenario in which the sale of issued assets is carried out at the expense of other crypto assets. This standard does not apply to "non-monetary transfers between businesses of the same line of business to facilitate sales to clients or potential customers," as stated in IFRS 15 paragraph 6. This standard will not be applicable, for instance, to an agreement between two oil corporations to promptly swap oil to fulfill consumer demand in several designated locations. Since both exchanged items

fall under the inventory category, this transaction should be considered barter from an accounting perspective.

According to the authors, the item is the same in this case, which is why revenue recognition under IFRS 15 does not apply to comparable transactions. The same corporation will act as both a supplier and a buyer of the same thing simultaneously, adding expenditures and profits while exchanging the same commodities. Treating crypto assets similarly, or even more equally, is prohibited given that they are provided for various goals, distinct smart contract specifications, and clients.

That means that both the buyer and the seller should recognize revenue from the sale of goods following IFRS 15. In the authors' opinion, their sale does not fall within the exclusions of paragraph 6 of this standard. Issuers should calculate the amount of income following paragraph 66 of IFRS 15, which defines non-cash consideration, and requires that revenue be measured at fair value. Following the above, fair value can be defined simply as the selling price for fiat currencies.

Due to the high volatility of crypto assets, the current spot price for receiving crypto assets should be fixed at the time of sale. The authors note that the spot price in the fiat currency of the issued crypto assets, since most likely their market equivalent will not exist when they are released, and the spot price of the crypto asset, which the issuer receives in return, should be taken.

4.5. Write off Costs for the Sold Crypto Assets

The weighted average cost method in accounting is one of three approaches to estimating inventory. It determines the average cost of all inventory based on individual costs, and the quantity of each item in stock. When the issuer issues many crypto assets, he can value each lot at a different fair value. When using the weighted average cost method, the value of the goods available for sale is divided by the units available for sale, and the following is usually used.

$$PW_{cat} = Q \times \frac{TS_{cat}}{TQ_{cat}} \tag{2}$$

where:

- PW_{cat} is a write-off of sold crypto assets costs;
- Q is the quantity of sold crypto assets;
- TS_{cat} is the total value of the crypto assets per type (category) in inventory;
- TQ_{cat} is the total quantity of the crypto assets per type (category) in inventory.

Apart from the write-off costs, there are also costs related to the distribution; the issuers pay these costs as a blockchain transaction fee for the crypto assets' transfer to the buyer, which is affected only by the number of the miner, persons, or entities, which confirm the transactions in a blockchain [59]. Due to this, the total distribution costs are as follows:

$$TC_{cat} = PW_{cat} + TF_{cat} \tag{3}$$

where:

- TC_{cat} is a total distribution cost;
- PW_{cat} is a write-off of sold crypto assets costs;
- TF_{cat} is a transaction fee for transferring crypto assets via blockchain. The transaction fee differs per crypto asset since it is determined by the blockchain related to the crypto asset, and used for the transaction.

Circulation and disposal events are presented in Table 4.

Table 4. Circulation and disposal events. Source: generated by the authors.

Milestone	Event	Cost/Incomes
Circulation of crypto assets	Transfer of the crypto assets by blockchain.	Fees of the blockchain for the transaction processing in blockchain (transaction fee)
	Revaluation of the crypto assets in the Inventory:	
	For Utility tokens	Issuers shall not evaluate it. Following its purpose, they should not form the market.
	For Payment tokens	Shall be revaluated against the market price. The revaluation result is analyzed yearly within the annual report: • It may form revaluation incomes (Revaluation income), if the value is registered on Credit • It may for on costs), if the value is registered on Debit
	For Asset-referenced tokens	Revaluation of the assets referenced crypto assets is more complicated than for the payment tokens, since referenced assets shall also be reassessed. The revaluation result is analyzed yearly within the annual report: • It may form revaluation incomes (Revaluation income), if the value is registered on Credit • It may form revaluation costs (Revaluation costs), if the value is registered on Debit
Disposal of crypto assets	*Lost/stolen crypto assets:*	
	Own use (intangible assets)	The total value of the lost or stolen crypto assets shall be written-off to the lost/stolen expenses (lost/stolen product cost). Issuers shall calculate the write-off value based on the inventory/intangible assets value.
	Crypto assets held for sell or exchange (inventory)	
	Crypto assets under management (for example, storing crypto assets in wallets for company clients)	In such cases, issuers shall recover the crypto assets; if this is impossible, the customer should receive compensation per market price. • If the market price is lower than the issuer calculated crypto asset value, then issuer writes off the value of lost crypto assets to the lost/stolen expenses (lost/stolen product cost). Issuer shall calculate the write-off value based on the inventory/intangible assets value. • If the market price is higher than the issuer calculated crypto assets value, then issuer writes off the value of lost crypto assets to the lost/stolen expenses (lost/stolen product cost). Issuer shall calculate the write-off value based on the inventory/intangible assets value. However, the difference between the market value of stolen/lost crypto assets and the balance value is written off as Sunk Costs.
	Expired crypto assets	
	Own use (intangible assets)	The total value of the lost or stolen crypto assets should be written-off to the lost/stolen expenses (lost/stolen product cost). Issuer should calculate the write-off value based on the inventory/intangible assets value.
	Crypto assets held for sell or exchange (inventory)	
	Crypto assets under management (for example, storing crypto assets in wallets for company clients)	

Following Table 3, the revaluation process differs for diverse crypto asset types. According to the IFRS, the revaluation of assets with unlimited helpful life is only conducted using market value. However, there is no common market since a utility token is a cryptocurrency asset offered to end users as an access key for some IT systems. The authors contend that this particular class of cryptocurrency assets is not subjected to revaluation.

According to the IFRS, the revaluation of payment tokens, which are assets with an unlimited useful life, is only conducted using market value. There is a typical market

(on cryptocurrency exchanges) for this class of crypto assets where the issuer may find the current market price. The methodology for defining the payment token market price still needs to be developed. Therefore, the issuer should develop its methodology for the market price definition.

Re-valuation resulting formula:

For crypto assets held for sale

$$Rev_{cat} = I_{cat} - MR_{cat} \times QI_{cat} \quad (4)$$

where

- Rev_{cat} is the revaluation result per each crypto asset;
- I_{cat} is the value of inventory per crypto assets;
- MR_{cat} is the market rate of the crypto asset;
- QI_{cat} is the quantity of re-valuated crypto assets in inventory.

For crypto assets for own use:

$$Rev_{cat} = IA_{cat} - MR_{cat} \times QIA_{cat} \quad (5)$$

where

- Rev_{cat} is the revaluation result per each crypto asset;
- IA_{cat} is the value of intangible assets per crypto assets type;
- MR_{cat} is the market rate of the crypto asset;
- QIA_{cat} is the quantity of re-valuated crypto assets in intangible assets.

If MR is positive, it represents the revaluation costs—otherwise, revaluation incomes.

5. Conclusions

The smart city concept requires the inevitable rethinking of different processes across all its subsystems; new products require new manufacturing and distribution approaches. The authors assessed the smart city of Rome, and the possibility of achieving its KPIs via implementing crypto-asset-based products. The results show that all Rome smart economy KPIs, except one, are achievable by implementing crypto-asset-based products. This fact shows the high value of this research to the smart city, Rome; if the products based on the digital assets are the possible solution to achieving that KPI, their smart city will be highly likely to manufacture them. However, the assessment of the digital manufacturing stages, and related accounting events conducted by the authors, will allow smart city management to correctly develop the business plan, and further build an effective and transparent accounting approach.

It creates additional possibilities for both smart cities, which receive the additional tool for implementing its KPIs, and for the financial market dealing with digital assets since these assets can be applied to a wider range of objects. The crypto assets are very popular among city residents; while scientists and governments discuss the viability of digital assets, the young generation actively uses them. Therefore, in implementing a smart city, KPIs will be facilitated by actively using this tool.

ICOs have supplanted traditional sources of funding for blockchain-based start-up businesses. They launch new goods based on crypto assets, market them, and then utilize the revenue from sales to launch related programs and products. These businesses have collected more than $30 billion in revenue through ICOs [16]. In light of those mentioned earlier, transparent accounting procedures are required, including producing comprehensible and comparative yearly reports for the firms themselves, and the market as a whole.

The authors rethink the Initial Coin Offer process, composed of the crypto asset's issuance and distribution, by examining the accounting procedures for each milestone associated with the issuance of crypto assets. The authors clearly show that the first issuance of crypto assets is unrelated to the issuer's capital raise. As a result, it is inaccurate to equate the Initial Coin Offer (ICO) to an Initial Public Offering (IPO), in the definition

of an ICO. When a company makes an initial public offering, its ownership shifts from private to public, and investors become the firm's shareholders. However, IFRS-based evaluations of the ICO indicate no evidence of the issuer developing any responsibility to the purchasers of the crypto assets. As a result, the authors propose categorizing the process as the manufacturing of crypto assets, in the context of the ICO. This approach allows the smart city to develop more flexibly and use digital asset-based products, since the users do not use the capital of the smart city authorities; vice versa, they buy smart city manufactured products.

The authors defined the crypto assets' lifecycle, and assessed incomes and expenses related to all its events. The issuer should treat them as products in inventory. The discussion which arises from this research is related to the revaluation of crypto assets. As the authors have shown, issuers (companies) should re-evaluate the crypto assets held for sale. Accordingly, the current crypto assets' value methodology must be developed.

This study has a set of limitations: the crypto-asset products, as a possible solution for the smart city KPIs, were compared to the Rome smart city KPIs; the KPIs of other smart cities were not examined, which is the limitation of this study.

The next limitation is connected to the fact that the authors do not consider energy costs separately; these costs are supposed to be a part of the suppliers' expenses, and correspondingly they are accounted for in these types of costs.

Managerial Implication. This paper is the first one devoted to the theoretical exploration and evaluation of the procedure regarding how crypto-based assets may assist the smart city in achieving its KPIs; it uses the example of the smart city of Rome. The study report also provides a thorough overview of ICO accounting stages and IFRS-based accounting procedures. The authors classify the ICO process as manufacturing.

Practical/Social Implications. This study offered ways for calculating ICO manufacturing expenses for smart cities with practical ramifications. The same approach is also applicable to companies working within the smart city. The study defines expenses of the further manufactured crypto-assets, or their based product distribution stages, and their accounting under the IFRS. A clear and transparent accounting approach will lead to clear and transparent smart city financial reports, and such transparency is in the public interest.

Future Research. Future research can be focused on the blockchain type, which is more suitable for usage within a smart city. On one hand, use of the traditional blockchain, such as Ethereum, is simple due to developed protocols and approaches. However, on the other hand, considering that these networks are energy-consuming, maybe the new approach: nodes (blockchain points of the transaction approval and holder of the entire blockchain value copy) are assigned only to the transactions, approved by the Smart City and presupposed to control the confirmation process expenses and decrease energy consumption.

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