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Socialising The Decision-Making Process: Transaction Provenance Decision Support

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Abstract

This paper extends some current decision-Making and DSS perspectives that were originally identified in Herbert Simon's decision making and action process model, socialising them in theory and practice to account for the effective development of decision support systems that can profitably be incorporated in the context of multisided platform- powered eco-systems. It shows how adopting these extended perspectives enhances the opportunities for supporting socialised (rather than individualised) action and development through "Transaction Provenance Decision Support" (TPDS). It takes as its example SMART.T, a TPDS powered by two multisided platforms enabling trading, provenance-building and socio-economic development. These are (i) a provenance authentication platform, and (ii) a transaction management platform. Together, these platforms offer the core functions needed for a comprehensive TPDS. As discussed in this paper, these functions are: integration of transactions involving private and public goods in TPDS; exploring, and establishing provenance; structuring provenance within the World Wide Web Consortium's Provenance Ontology; authenticating provenance; socialising decision enactment; anticipating good provenance within a transaction network. It establishes the importance of provenance in providing socialised, end-to-end, multisided decision support within the TPDS platform powered eco-systems that will drive the rapidly expanding platform business sector in the future.

Keywords: Provenance; Transaction platform; Trust; Platform-powered ecosystem; Socialised decision support; DSS; Decision Making; Anticipated provenance.

Introduction: Socialising the decision making process; the legacy of Herbert Simon

Herbert Simon's research endeavour offers a powerful process model to study of organisational decision-making an consequent actions, following the tenet that "Understanding organisations should not be predicated on hierarchy but on decision making and the flow of information within organisations that instructs, informs and supports the decision making process (March and Simon (1993, page 3). Simon's (1977) seminal four-phase model for the decision-making process (i.e., Intelligence – Design – Choice –Review) was originally cast within an individualised, holistic, perspective on decision making (Larichev, 1984) whereby:

- In the *Intelligence phase*, the decision maker "searches for the conditions that call for decision";
- In the *Design phase*, the decision maker focuses on "inventing, developing and analysing possible courses of action", thus authoring the outcomes represented in the decision-making model;
- In the *Choice and Review phases*, the decision maker focuses on "selecting and reviewing a particular course of action from those available" according to what has been represented in the model.

Campitelli and Gobert (2010) note that that the research program founded on this model:

> "Offered critical tools for studying decision-making processes that took into account Simon's original notion of bounded rationality. Unfortunately, these tools were ignored by the main research paradigms in decision making, such as Tversky and Kahneman's biased rationality approach (also known as the heuristics and biases approach) and the ecological approach advanced by Gigerenzer and others".

The popularity of these approaches in the decision research community lay in that they offed a way to examine fixed contextual effects on decision-making cognitive styles in within a framework of "biased", economic rationality (Kahneman and Tversky, 2000, Humphreys and Berkeley, 1982), inevitably leading to the conclusion that even experts' use of decision heuristics indicates that they are not rational in their domain of expertise. Gigerenzer places decision making in an ecological environment, finding that that "fast and frugal heuristics are rational because they are adaptive" (Gigerenzer 2020), But the ecological environment is not varied in this model, thus excluding possibilities for investigating and improving the process of making decisions and identification of the facilities and resources that participants need for this.

Nevertheless, research on decision making and DSS development within the process modelling perspective epitomised by Simon's model remains active and has delivered some considerable achievements, although, as Carlsson (2008) and Pomerol and Adam (2008) have observed, these achievements are not always incorporated in the emerging DSS models that are implemented in practice. Pomerol and Adam (2004) explain:

> "A key consequence of Simon's observations and ideas is that decisions and the actions that follow them cannot easily be distinguished. Thus, Decision support systems should primarily be geared as models for action, but action in an organization is a cascade at intertwined sub-actions and consequently DSS design must accommodate human reasoning at a variety of levels, from the strategic level to the lowest level of granularity of action decided by managers."

Pomerol and Adam's claim requires that effective DSS design and development need to be underpinned by a social model of decision making and action, engaging a range of participants at all levels. The analysis presented of this paper takes on board the tenets of each of the stages specified in Simon's process model of decision making, but it also extends individualised perspective inherent in these tenets: socialising this perspective in theory and practice in a way that enables the effective development of a new generation of decision support systems that can profitably be incorporated in the context of platform-powered ecosystems. It reveals how adopting this extended and socialised perspective enhances the opportunities for supporting socialised (rather than individualised) action and development through "Transaction Provenance Decision Support" (TPDS).

Pertinent developments socialising each phase of Simon's decision-making and action process model

Pertinent to the Intelligence and Design phases, Humphreys and Jones (2006) described the evolution of group decision support systems (GDSSs) to enable collaborative authoring outcomes in accelerated solutions environments (Jones and Lyden Cowan, 2002). Here, groups move through phases of scanning the landscape of information and defining the problem, to focussing on finding ideas, the generation of alternatives, and learning to act on prescriptions. Ashcroft and Jones (2018) provide a comprehensive account of the group processes involved in these socialising innovations in organisational decision processes.

Pertinent to the Choice and Review phases, Pomerol and Adam (2008) claimed that "DSS should not only be deliberative but also decisive…most of the time they are NOT and decision makers remain absolutely necessary because action is also intention and commitment". Within an individualised decision support perspective, this requires that the decision maker commit to a course of action that will be implemented in reality by him/herself or those under his/her command and control. In the Review phase, when implementation failure risks arise, the decision maker realises that these risks have to be managed from his/her own resources (Berkeley et al., 1991), But in the case that the individual decision maker does not have the capability or agency to achieve this, the procedural question emerging is "what do?"

Socialising the implementation of the chosen course of action

Traditionally, the decision maker was left adrift in a sea of implementation uncertainty (Humphreys and Berkeley, 1995). But, nowadays, he or she may well be located in a socialised ecosystem where the participants in the ecosystem can take collective and collaborative responsibility for transactions (rather than individualised actions) in order to create and provide the resources and services that are needed for a successful implementation of the chosen course of action.

Here, this course of action is threaded through a network of transactions whereby each of the transacting agents will deliver a part of the resources required to ensure that the course of action is achieved well at all levels (i.e., in a way that, collectively, minimizes implementation failure risk).

The decision maker's immediate focus now changes from "how can I manage this risk well by my own efforts?" to "can several participants in the ecosystem collectively manage this risk by each taking responsibility for specific transactions in the implementation network for the chosen course of action?"

Since all these transactions must have good provenance in order to avoid implementation failure, the decision maker needs to be able to anticipate their provenance in determining how to construct transaction proposals with good provenance and to evaluate participants' transaction offers on the basis of their provenance.

Then, the decision implementation process can be distributed through a network of linked transactions involving a variety of participants (agents and entities) in the ecosystem, supported by a multi-sided TPDS platform that also assembles the results of these transactions into to a socialised system-network dedicated to implementing the chosen course of action with anticipated good provenance.

The following sections discuss the key issues that need to be addressed in order to achieve this socialised decision implementation process effectively, through incorporation as core functions in a comprehensive TPDS. These issues are: integration of transactions involving private and public goods in TPDS; exploring, and establishing provenance; structuring provenance within the World Wide Web Consortium's provenance ontology; authenticating provenance; socialising decision enactment; anticipating good provenance within a transaction network.

Emergence of multisided transaction platforms located in ecosystems

> "A platform is a business based on enabling-creating interactions between producers and consumers. The platform provides an open, participative infrastructure for this interaction and sets governance conditions for them. The platform's overarching purpose is to consummate matches among users and facilitate transaction of goods, services or social currency, thereby enabling value creation for all participants" (Parker et al., 2016).

Since their inception, platforms focusing on social media have been multisided: namely, bound up with users creating, exploring, interpreting and the platform's content data, and employing these data in guiding not only participants' individual actions but also their social transactions with other participants in the ecosystem. Examples of large scale multisided platforms evolved in this way are *Google, Ebay* (Reillier and Reillier, 2017) and *Trip Advisor* (Alaimo et al., 2019). *NextDoor* is an example of a multisided platform that is distributed throughout a federation of local ecosystems [Madsen et al., 2014).

Reillier and Reillier (2017) describe how such platforms have been able to build trust between the platform and the participants in the ecosystem in which they are incorporated, as well as between the participants themselves. They show that this is the key to a platform's success, identifying four key "C" levers enhancing trust as: Credibility (credentials of a participant and/or of products services provided); Contribution (activity generated by participants); Consistency (quality of experiences delivered by participants) and Community (how participants relate to each other within a community).

Alaimo et al., (2019) describe how participants in a platform-powered ecosystem satisfy and enhance a variety of roles and motivations, supported by synergies and complementarities achieved between its constituent multisided platforms which, according to Evans and Gower (2016), may include investment platforms, innovation platforms and transaction platforms.

Successful ecosystems rapidly scale up rapidly when they are resource- or service- specific in ways that strongly reinforce the value or returns of ecosystem participants (Adner, 2017; Reillier and Reillier, 2017; Jacobides et al., 2018).

Transaction Provenance Decision Support (TPDS) in the SMART.T Ecosystem.

This paper takes SMART.T as an example of a comprehensive TPDS platform, in order to explore its functions that are relevant to the issues identified above in the section on *socialising the implementation of the chosen course of action.* The SMART.T platform was developed by World Reserve Trust Technologies (starting in 2017) and is now fully operational (Hill et al, 2020).

In TPDS ecosystems, like those powered by the SMART.T platform, all participants are permissioned and accredited within a system founded on universal transparency, trust, and engage in collaborative transacting where all sides benefit. This is essential in order that all sides can collaborate to implement a chosen course of action successfully.

In such ecosystems, essential provenance data is socially generated: focusing on transaction construction, authentication and exploration, with transaction validation socialised through collaboration between provenance explorers and notaries. This makes a strong contrast with crypto-currency platforms that operate within non-permissioned eco-systems founded on individualisation, anonymity and subversion of trust, promoting greed and speculation (He et al., 2016; Casey and Vigna, 2018; Lyons and Courcelas, 2019).

SMART.T's Functional specification

The current version of the SMART.T platform incorporates the following two multisided platforms and capitalises on the synergies and complementarities between them:

(i) The *Multisided Provenance Authentication Platform which* comprises:

- Ecosystem Ontology Model;
- Tapestry Access (historical provenance database) Module;
- Provenance Search (machine intelligence and human inputs) Module;
- Document Extraction Module;
- Provenance Analytics (interrogation and visualization) Module; and,
- Anticipated Provenance Synthesis Module.

(ii) The *Multisided Transaction Management Platform which* comprises:

- Agent and Entity profile management Module;
- Collaborative Contract Construction (group facilitation techniques (supporting the collaborative authoring of outcomes) Module;
- SMART.T Silubi™ Transitive Token (transaction management) Module; and
- Verification and Validation (system and commentary) Module.

At the technical level, these multisided platforms integrate the W3C (World Wide Web Consortium)'s provenance Ontology (PROV-O) for the representation of transaction data (Moreau and Groth, 2013) and distributed ledger technology (Rauchs et al., 2017) to provide a comprehensive transaction processing system that explores, assesses and validates the provenance of all the entities transacted in accord with the W3C Provenance standard and stores the verified transaction records transparently and immutably in a permissioned blockchain (Lyons and Courcelas, 2019).

Creation of trust and shared understanding in TPDS ecosystems powered by SMART.T

SMART.T creates trust and shared understanding among the participants in the TPDS ecosystem as they use the multisided platforms, building and benefitting from collaborative provenance exploration, validation and improvement. This constitutes a shared creative resource for building and maintaining safe, productive, and creative environments, with full transparency about people's transactions in the real word, banishing suspicion by proving that there are no grounds for it.

The SMART.T Platform performs well, in regard of the four "C" levers in building trust identified by Reillier and Reillier (2017), as follows:

- *Credibility:* participants gain accreditation and build good, socially visible and verified provenance both for themselves and for the entities they transact, through the use of SMART.T's multisided platforms.
- *Contribution*: participants collaboratively construct transactions with good provenance, benefiting all parties, and share in their collective enactment as, through taking on the roles of provenance explorers and transaction validators, they contribute to knowledge about the nature and value of transactions and transactors.
- *Consistency:* maintained in the high quality of information delivered to participants through use of the Prov-O framework and distributed ledger technology, providing transparency and universality.
- *Community:* participants in SMART.T -powered ecosystems community relate to each other through trust, positive sentiment, consensus building and collaborative enactment thus enhancing social awareness and generating intellectual and social capital (Yu, Garcia-Lorenzo and Kourti, 2017).

Integration of transactions involving private and public goods in TPDS

The discussion above on socialising the implementation of the chosen course of action described how the decision implementation process can be distributed through a network of linked transactions involving a variety of participants (agents and entities) in the ecosystem, supported by a multi-sided TPDS. Here, people come together as Agents because they want to trade something. Agents are accredited participants in the ecosystems powered by TPDS platforms. They play an active role in forming and implementing transactions. The roles that Agents may take on include: sender, receiver, explorer, notary, regulator, etc. The entities that they transact include: services, products, rights, licences, and ownership. Both private (closed) and public (open) transactions are conducted within the same, integrated, transaction management system and transaction records entered in the same unified transaction provenance tapestry. This strengthens the TPDS's provenance search capacity.

When people transact because they want to trade something, their transactions come in pairs, since making a specific trade exchange involves agents making reciprocal transfers of two entities.

There are four major variants of this process involved in trading goods in the private domain These are: Barter, Buy/Sell, Transfer of Rights and Gift/Acknowledgement, as shown in Figure 1.

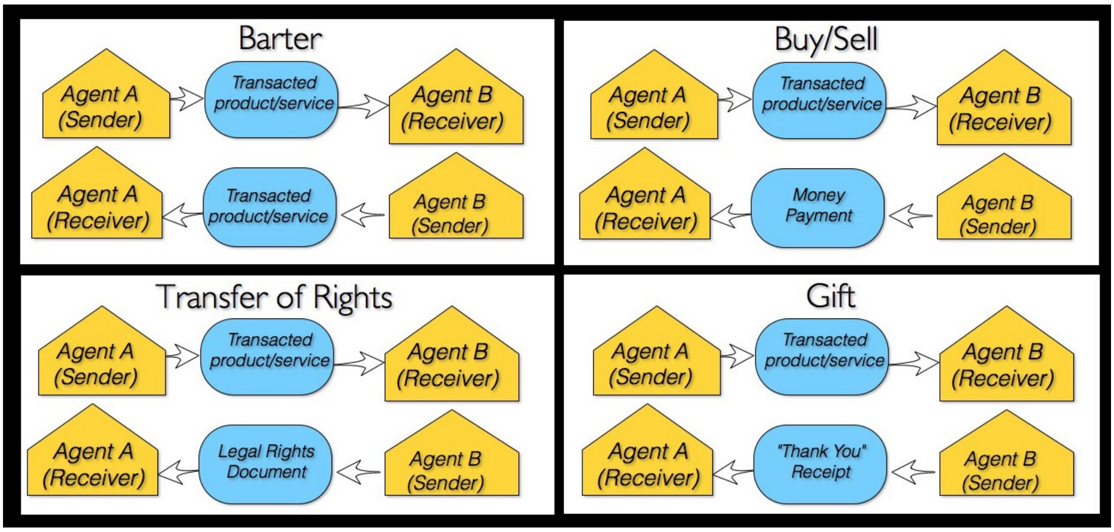

Figure 1: Four variants of transaction pairs for trading private goods

Transferring privately owned goods into public ownership

When a resource entity to be transacted is essentially a product showcasing an agent's know-how, this may involve transferring the entity into the public domain in order to povide an opportunity for wide access that reduces collective implementation failure risk.

At their time of creation, all goods are entities located in their creator's private domain, but the agent who created them, or is their current owner, can transfer them into common ownership by depositing them in an archive that holds ans serves goods in in the public domain (examples are Internet Archive, Vimeo, Flickr and Wikipedia)

When depositing in entity (master copy of a book, photo, video, app etc.), an agent may specify the terms of its Creative Commons use licence to ensure the users keep the goods in public domain and that the historic provenance of each entity involved can be clearly established, starting with the provenance of its creator and time and place of its creation. Lessig (2008) describes this process as "Using private rights to create public goods".

Goods deposited in the public domain can exist as multiple copies, open to borrowing or copying (or, in the case of digital video, streaming) via an *access entity copy request,* made via the TPDS's transaction management platform. There should be no charge for access, but the specification of the accessor's borrowing and sharing rights should also be included in the transaction.

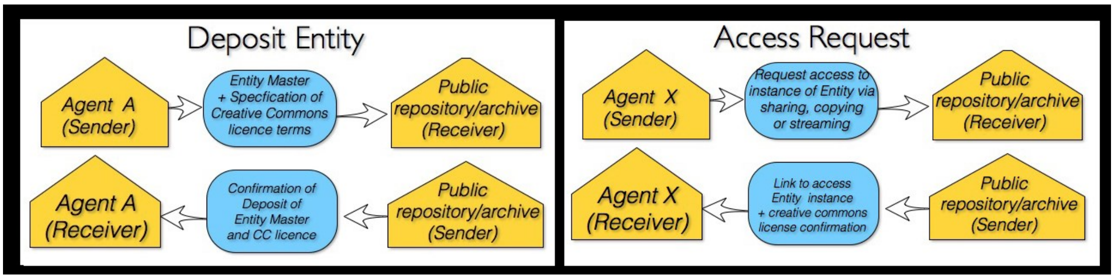

Figure 2: Deposit and Access transaction pairs for public goods

Exploring and establishing provenance

The general definition of Provenance, according to Wikipedia[1] is:

> *"The chronology of the ownership, custody or location of a historical object, starting with its creation/first owner…. The primary purpose of tracing the provenance of an object or entity is normally to provide contextual and circumstantial evidence for its original production or discovery, by establishing, as far as practicable, its later history, especially the sequences of its formal ownership, custody and places of storage. The practice has a particular value in authenticating objects".*

The processes of investigating provenance and creating transaction provenance records, with the aid of SMART.T's multisided transaction authentication platform, and builds on the World Wide Web Consortium's *Provenance Ontology*, PROV-O (Moreau and Groth, 2013) where *provenance* is defined as "a record that describes the people, institutions, entities, and activities involved in producing, influencing or delivering a piece of data or a thing, which can be used to form assessments about its quality, reliability or trustworthiness". The starting point of PROV-O is a small set of classes and properties that can be used to create simple, initial provenance descriptions.

A TPDS that incorporates a multi-sided provenance authentication platform, founded on PROV-O, enables us to establish and explore and authenticate the provenance of an entity involved in any particular transaction of interest transaction right back to its first transaction in which it was involved, marking that entity's "creation". This trace provides the *Historical Provenance Chain* for that entity: a time-ordered sequence of the complete set of transaction records involving the specific entity. The record for each transaction specifies the transaction type (barter, buy-sell, transfer of rights, gift, deposit or access) and

[1] https://en.wikipedia.org/wiki/Provenance

providing data regarding the provenance attributes "when", "where", "what", "how", and "why", building on and extending the World Wide Web Consortium's *Provenance Ontology*, PROV-O.

Structuring provenance within PROV-O

The starting point of PROV-O is a small set of classes and properties that can be used to create simple, initial provenance descriptions. The three primary classes (i.e., *entity*, *activity* and *agent)* relate to one another and to themselves, using the properties shown in figure 3 where the PROV-O descriptions are specialized for use within structured Transaction Provence platforms.

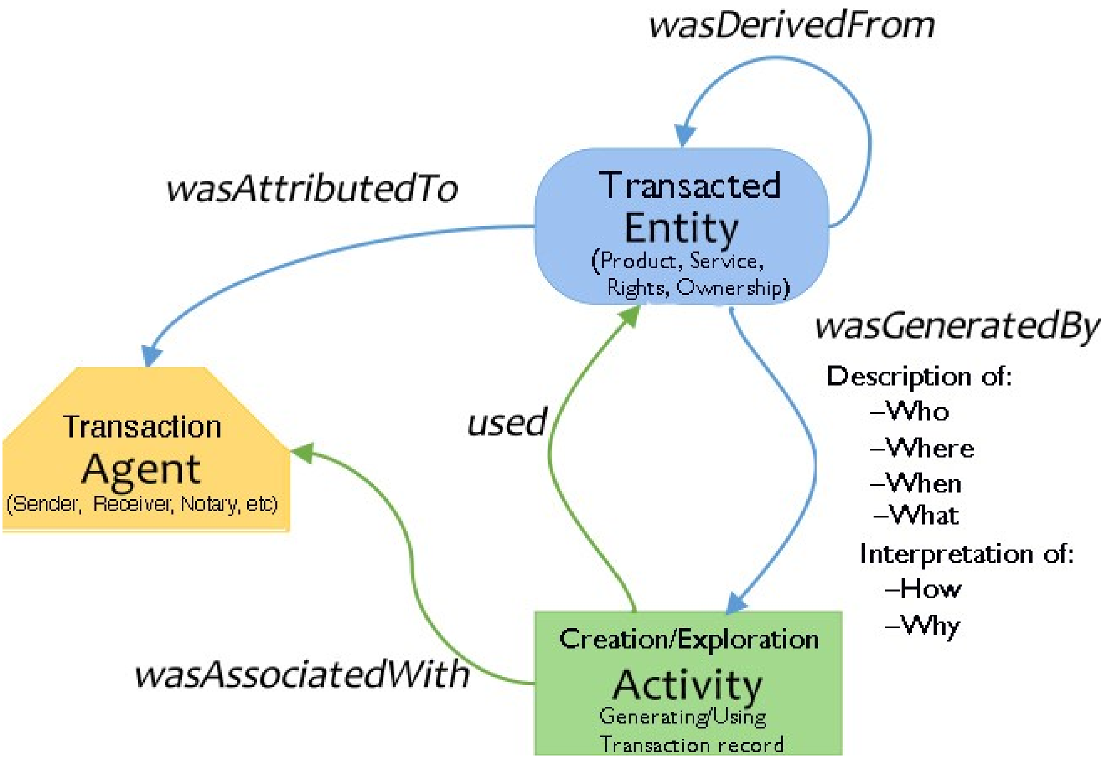

Figure 3: PROV-O Framework, specialised for transaction provenance decision systems

In TPDS employing the PROV-O framework, where Agents (transactors) and Entities (the objects that they transact as private and public goods) are described with unique, transparent ("real-life") identifiers it is possible to establish explore and authenticate the provenance of an entity involved in any particular transaction of interest, right back to its first transaction in which it was involved, marking that entity's "creation". This trace provides the *Historical Provenance Chain* for that entity: a time-ordered sequence of the complete set of transaction records involving the specific entity. One can also trace the historical provenance chain for any agent involved and, in so doing integrate that agent's creations and transactions of both private and public goods into an overall account of the agent's provenance.

. Participants can also establish and explore the provenance chain for any agents of interest acting in sender and/or receiver roles, from the most recent transaction in which they played a role, right back to their earliest transaction within the ecosystem powered by the TPDS plaform.

Moreover, these entity-provenance and agent-provenance chains interact at every transaction in their establishment, thus constituting the *provenance tapestry* that underpins the investigation, validation, and establishment of provenance. "Tapestry" refers to the structure of this provenance data representation where these links are assembled as *provenance threads* that are woven together to make the complete provenance net representation (Yang et al., 2018). A rich historical example of this process is the making of the Bayeux Tapestry (Bouet and Neveux, 2019). However, the tapestries of antiquity were static and two-dimensional whereas the tapestry underpinning the SMART.T transaction provenance decision system is dynamic and labyrinthine, like a rhizome (Deleuze and Guattari, 1988).

With the aid of the interactive apps incorporated in a multisided provenance authentication platform, implemented with in a TPDS, one can search both (i) the tapestry of provenance threads for all the SMART.T managed transactions ever made in that ecosystem (structured provenance) and (ii) the whole World Wide Web (unstructured provenance) in tracing and authenticating the provenance of entities traded as private and public goods, as well as the provenance of the agents who traded them.

Provenance as an active indicator of value

In traditional DSS perspectives, the evaluation of decision alternatives is individualised and passive: the decision maker makes value trade-offs between alternative courses of action under consideration on a set of attributes according to the value-wise importance of these attributes for himself or herself in the decision context (Humphreys and McFadden, 1980; Wang et al, 2008).

This procedure can be socialised through *provenance search* whereby the decision maker finds out how the value of an entity (product or service) specified in a decision alternative was created and modified in transactions involving Agents of interest to the decision maker throughout its history. This is an active and socialised approach to establishing subjective value in anticipated transactions involving these entities.

Support for collaborative authoring and implementation of transaction contracts

In a multisided provenance authentication plaform, implemented in a TPDS like SMART.T, all parties involved in a transacting of goods or services needed in a decision implementation process, distributed through a network of linked transactions, can collaborate in the process of constructing the contracts for the these transactions.

Initially, the individual participants who are potential candidates for “resource sender” or “resource receiver“ roles are supported by the provenance authentication platform in investigating the provenance of possible partners for the transaction and entities proposed for transaction. The sender may also wish to investigate provenance of the receiver, and vice versa, particularly where the resource entity transacted is a service rather than a product.

All contracting parties are supported by the multisided transaction management platform in the collaborative construction of the transaction contract (and supporting documentation) employing techniques facilitating collaborative authoring of outcomes, like those described by Humphreys and Jones (2006) and Ashcroft and Jones (2018, section 2).

Then, once the transaction contract has been agreed among all the parties, contract’s text and related documents ere parsed within the TPDS’s transaction management platform to provide the transaction record specifying “who” transacts “what”, “when”, “where”, “how” (descriptive) with optional interpretive comments on “how” and “Why (i.e., to what purpose)”. This record is inserted in the blockchain for the distributed ledger (Rauchs et al., 2018) that stores immutably, in a time-ordered sequence, all the transactions that have ever been attempted (successfully or otherwise) in ecosystems powered by DPRS plaform that conform to, and implement, PROV-O. After the transaction record has been verified and validated, the results pass the results to the smart contract modules that will be involved in implementing the transaction.

Authenticating Provenance: Transaction verification and validation

Once a transaction record is marked as “constructed”, that record must be successfully verified and validated, thus authenticating its provenance, before the actual transaction can be initiated. Verification can be performed automatically in a TPDS like SMART.T, but validation requires transparent transaction data mining (Boehm, 1984; He et al., 2017). In the context of TPDS-powered ecosystems, the participating “miners” are explorers, as they access the provenance tapestry with the aim of exploring, assessing and improving provenance as a force for good. They explore intersecting entity-provenance and agent-provenance chains, linked by, and grounded in, transaction records carrying rich semantic content (in text and images) about “who", "where", "when”, and "what” for each transaction, with accompanying comments on “how" and "why" the particular transaction was made.

The provenance tapestry may be accessed at any time by anyone accredited within the eco-system in whatever role they are currently playing (e.g., historian, validating notary, actual or potential “sender” or "receiver" of an entity). There is no need to manufacture an extrinsic system of “miners’ rewards” since their exploration is intrinsically rewarding as it enables personal growth in expertise (Casey and Vigna, 2018). It also develops *provenance capital* (Intellectual capital + Social capital) among the participants in the ecosystem, catalysing opportunities for social and economic development and improving the quality of life (Yu et al., 2017).

Socialising decision enactment

In the Review phase of Herbert Simon's (1977) model of the decision making process, the decision maker, having chosen a course of action, with the intention and commitment to make a success of his or her choice in practice, needs to engage in enactive management (Garcia de la Cerda et al., 2018). Within the ecosystem, the decision maker has the opportunity to implement this course of action socially through a series of transactions, where participants in the ecosystem transact, supported by a TPDS plaform, transact in order to create and provide collectively the full set of resources and services with authenticated good provenance that are needed for successful implementation of the chosen course of action.

These transitions are linked in a multi-level network where, located at the top level, is the main transaction that organises the transactions at lower levels in the network that collectively implement the course of action chosen by the decision maker, effectively socialising decision enactment. This meets the DSS design criterion specified by Pomerol an Adam (2004) that:

> "Decision support systems should primarily be geared as models for action, but action in an organization is a cascade at intertwined sub-actions and consequently DSS design must accommodate human reasoning at a variety of levels"

In fact, it extends this design criterion to "*accommodate human reasoning, investigation and action in authenticating and implementing transactions with good provenance,* at a variety of levels".

Anticipating good provenance within a transaction network

Use of a TPDS's multisided provenance authentication platform can help the decision maker to anticipate and improve provenance throughout a multi-level transaction network designed to implement a chosen course of action.

In the implementation process within this multi-level network, the top-level (main) transaction is initiated first and remains open (in progress) until all the sub-transactions at lower levels in the network have been confirmed and completed. This gives the decision maker the opportunity to ensure that the main transaction will exhibit good provenance and, thus enabling the decision maker's chosen course of action to be implemented successfully.

For example, Figure 4 demonstrates the decision maker's use of the *anticipated provenance synthesis module* in SMART.T.s multisided provenance authentication platform in building a contract between Agent A (the decision maker) and Agent B for the main transaction. Here, agent A needs to be able to deliver entity X to Agent B for this decision enactment strategy to succeed. But, in order to do this, there are also two sub-transactions at the lower level in the network that also need to be managed successfully for the decision enactment strategy to succeed.

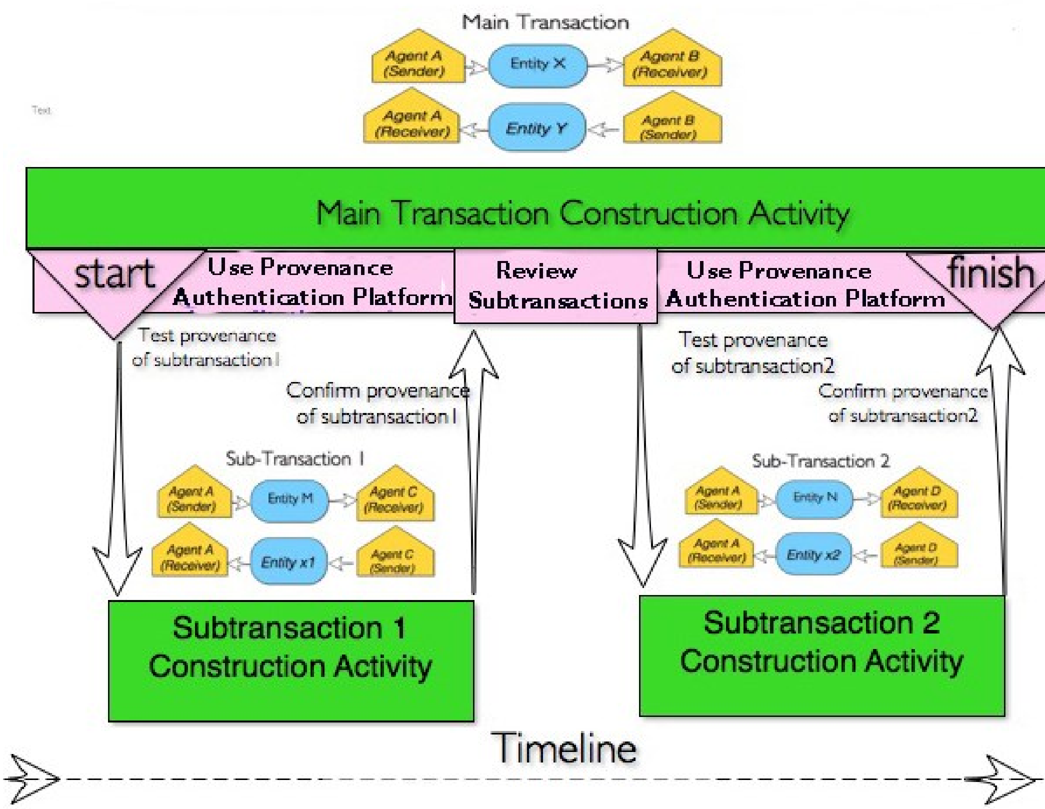

Figure 4: Anticipating provenance within a two-level hierarchical transaction network.

These two sub-transactions involve Entities x1 in transaction1 and x2 in transaction2 that must be delivered successfully to Agent A by third parties (subcontractors), that is, Agent C in the case of Entity x1 and Agent D in the case of Entity x2. Agent A needs to obtain successful results regarding Entities x1 and x2 in order to deliver Entity X successfully in the main transaction.

The enactive management problem that the decision maker (Agent A) initially faces is how best to incorporate sub-transactions in the hierarchy, with proven good provenance, verified and validated on their completion, prior to completion of the main transaction, thus ensuring the good provenance of the main transaction as verified and validated on its completion. The Provenance Authentication platform supports the decision maker's handling of this problem through the following stages:

1. The provenance authentication platform is employed to anticipate, test and improve the provenance of sub-transaction 1 as it is being built.
2. The whole multi level transaction structure (comprising 2 levels in this basic example) is reviewed in order maximize the synergies and complementarities between sub-transaction 1 (as now built) and sub-transaction 2, the specification of which may now be modified to achieve this.
3. The provenance authentication platform is employed to anticipate, test and improve the provenance of sub-transaction 2 as it is being built.

Given that both sub-transactions now have good provenance and good synergies and complementarities between them, the *main* transaction now has good provenance, enabling the chosen course of action to be implemented socially and successfully within the ecosystem.

Conclusion

This paper has illustrated how socialising key decision support perspectives within each the four phases of Herbert Simon's model of the decision making process (i.e., Intelligence, Design, Choice and Review), enables both understanding and implementation of new possibilities for effective decision support in multisided transaction ecosystems.

The paper took as its example SMART.T, a TPDS powered by two multisided platforms enabling trading, provenance-building and socio-economic development (Hill et al, 2019). These multisided platforms are (i) a provenance authentication platform, and (ii) a transaction management platform. Together with their synergies and complementarities, theses platforms provide the core functions needed for any comprehensive TPDS, as described in this paper.

What emerges is the central importance of Provenance, via its representation (in the PROV-O framework), exploration, investigation, authentication and anticipation, in providing socialised, end-to-end, multisided Transaction Provenance Decision Support. This enables the effective development of a new generation of transaction provenance DSS that will increasingly drive the rapidly expanding platform business sector (Reillier and Reillier, 2017) in the future.

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Patrick Humphreys is Emeritus Professor of Social Psychology at the London School of Economics and Director of the London Multimedia Lab for Audiovisual Composition and Communication. He led the LSE RTD team on the EU FP7 CADIC project ("Cross-enterprise assessment and development of Intellectual Capital"(www.cadic-europe.org). Previously he directed the project "Creative Partnerships: Pathways to Value" for the Arts Council England and led the RTD team for the European Union framework 6 Project " InCaS: Intellectual Capital Statement, Europe".

He has expertise in innovative and creative decision-making, decision support and transaction provenance platforms powering ecosystems and enhancement of resources for health, culture, development, and networking. He was Director of the EU DG1 ALFA Network "CHICA" (Community Health Information, Communication and Action), linking research projects and training of researchers in UK, Spain, Greece, Brazil, Peru and Cuba. He has directed, for the British Council and the UK Department for International Development, Regional Academic Partnerships on Organizational Development with Novosibirsk State

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Patrick Humphreys has been involved in initiatives on organisational transformation, business innovation clustering and community development and small business sector development in many countries. He is a Fellow of the Royal Society for Arts, Industry and Commerce. He is a past chair of IFIP's Working Group 8.3 and holds IFIP's Silver Core Award. In 2018 he received the award "Innovative Leader of the Year" at the Entrepreneurs, creatives and innovators festival, Beijing,