

SUMMIT CITY JOURNAL

A STUDENT RESEARCH
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The Summit City Journal: A Student Research and Creative Endeavor Publication is a publication open to undergraduate and graduate students at Purdue University Fort Wayne and Indiana University Fort Wayne. The goal of this journal is to showcase student research and creative endeavors of all disciplines published in an online format.

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Message from the Team

We are very proud to present the second publication of the *Summit City Journal: A Student Research and Creative Endeavor Publication!* The goal of this journal is to be a research venue run by students, for students. We especially want our publication to highlight areas of study in the visual and performing arts, as well as visual design. In this issue, you will see work ranging from metal smithing work to economic essays. Many creative works are produced in the many areas on campus, and the *Summit City Journal* plans to be a place where such work can be platformed and shared.

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Summit City Journal executive board

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Gender Archaeology and the Case for Female Warriors

Author: Eden Sedwick

Archaeologists have long been interested in the study of violence and conflict. This interest has spanned the vast history of warfare including the methods employed by various societies, the motivations that separate or unite people engaging in conflict, and questions concerning what constitutes warfare and by extension a warrior. In this longstanding fascination with violence and warfare, however, the role of women has long been overlooked or given nothing but a passing mention in the consideration of conflicts both large and small. Women are usually relegated to the category of spoils of war and while they have certainly been and continue to be victimized by proxy of the roles they play in their respective cultures, rarely are they ever considered beyond this in the archaeological record. Though tales of female warriors such as the Amazons and the Valkyrie have existed in written texts throughout history, their basis in reality has been constantly questioned and all too often entirely dismissed. Archaeologists have frequently disregarded these interpretations as well. With the introduction of gender archaeology in the 1980s, the biases that have caused these patterns within the larger discipline have become increasingly apparent. This work aims to show how the questions that gender archaeology asks are necessary to the study of violence and conflict and have proven instrumental in cases concerning a Viking burial in Norway, gravesites in Armenia, and a possible gender-nonconforming individual in Finland in determining to what degree there is evidence for female warriors.

To emphasize the importance of the cases for female warriors that will be presented, a brief discussion of gender archaeology and its aims will help to contextualize the role gender expectations play in interpretation of the evidence. As mentioned above, when gender archaeology emerged as a sub-discipline in the 1980s spurred on by the second wave of feminism in the 1970s it brought to light

inequalities both within the inner workings of the discipline of archaeology itself but also within the interpretation of archaeological remains out in the field. Gender archaeology aims to identify gender bias within academia but particularly in regard to the interpretation of evidence based on the assumption of static male/female gender roles. The internal biases that archaeologists were largely unaware they were carrying into their work (and to a degree still are) have contributed to a study of the archaeological record that is rooted in decidedly Western ideals of a strict gender binary model. Assumptions continue to be made about ancient and faraway cultures that are based on Western concepts that began with Enlightenment ideas championed by the fathers of anthropology. Though as Ghisleni et al. (2016) acknowledge, much has been learned since these early days especially through groundbreaking work by Judith Butler regarding the ways in which gender role performance differs cross-culturally. Western conceptions about sex and gender identity have for many decades been applied to cultures of the past without questioning whether these applications are culturally appropriate or even evident in the remains themselves. It is increasingly recognized within anthropology that gender is not a binary concept, yet the interpretations do not reflect this knowledge as they should because the goals of gender archaeology are not fully integrated into the larger discipline.

In the context of sites where there is a clear history of violence, this has led to concerning assumptions about gender roles based on burial associations which have resulted in the misidentification of remains regarding biological sex. Explicitly, as discussed in this work, human remains are falsely identified as male purely through the presence of grave goods that indicate the burial of a warrior. This sets a dangerous precedent in archaeology because as Moen (2019) states, “when we gender burial assemblages...we

unconsciously impose limitations on the material” (p. 218). That is, the value of modern cultural bias is placed higher than that of the material evidence. When this occurs, the truth in the material remains hidden, potentially forever unless reexamined, and merely reflects our own cultural understandings and expectations. Worse still, when the archaeological evidence reveals something unexpected, such as the existence of a female warrior, the methods and evidence are put under intense scrutiny and frequently outright dismissed (Moen, 2019). Though it is vital to thoroughly investigate when an exciting new discovery has taken place that transcends the majority of known history, these questions are themselves applied with gender bias. For example, atlatls were found in mortuary contexts among men and women. This went unquestioned until it was discovered they were used for the purpose of hunting, upon which it became a controversial issue due to assumed gender roles that assigns man as hunter (Ghisleni et al., 2016). It must be asked at what point are archaeologists standing in the way of the discovery of the past by squabbling over presuppositions they impose? It is the role of a scientific discipline to ask questions when faced with the unexpected, not make appeals to the knowledge of the past in order to align with academic expectations. The following cases presented in this work are examples of what gender archaeology allows us to discover regarding violence and conflict and the role that women have played, which transgresses the roles typically assigned to them in the past and the present.

The concept of female Viking warriors has been discussed throughout history, yet they are often thought by many to have been primarily based in mythology and their existence has been widely debated (Hedenstierna-Jonson et al. 2017). The excavation of the Birka burial site dating from the 8th – 10th century BC and located in Eastern Sweden contains one of the largest known collections of Viking burials of which some 1,100 have been excavated already. Originally excavated in 1878, the remains of the individual found at burial site BJ581, which will be the focus of this discussion were determined to belong to a male warrior based on grave goods

alone (and the association of male as warrior) due to the variety of weaponry and lack of domestic items such as agricultural tools (Neil Price et al., 2019). The weaponry that identified this individual as a warrior includes a sword, axe, armor-piercing arrows, a battle knife, two shields, and two horses and a complete set of gaming pieces (Hedenstierna-Jonson et al., 2017). According to Neil Price et al. (2019), these features, particularly the inclusion of a full set of gaming pieces with iron-bound boards were extremely uncommon and indicated tactical and strategic skills which pointed to this being the grave of a high-ranking officer and possibly a mounted archer with an array of fighting techniques. However, upon the first osteological analysis performed in the 1970s the individual was identified as a female, but this was contested until the 2016 tests described by Hedenstierna-Jonson et al. which were then reaffirmed in 2019. The research performed in 2016 consisted of nuclear DNA testing and strontium isotope analysis using samples taken from the left canine and left humerus. Researchers were able to conclude that the individual of site BJ581 was indeed a female who was most likely of nonlocal origin. Further research and analysis of the landscape and the textiles worn by the individual of BJ581 served to confirm and add greater context to the find of this female warrior. Regarding the landscape, the grave was located “outside the gate of the Birka hillfort and adjacent to two other burials containing numerous weapons” (Neil Price et al., 2019). Additionally, not only was this site noted to be a burial ground for the rich but was also located near the garrison building containing a variety of weaponry. Lastly, the clothing worn by the individual in BJ581 was indeed unusual (particularly the tasseled cap) which pointed to a person of a high-ranking warrior status. When analyzed by a Birka textile specialist, it was found that these items belonged to a probable cavalry commander under immediate direction of a royalty war leader (Neil Price et al., 2019).

All of this evidence adds up to the clear conclusion of the existence of a female warrior of the Viking Age. Yet despite this evidence and previous precedence for female warrior burials as specified by Moen

(2019) such as the shield maiden in Norway, the graves of two female Vikings in York buried with weapons, and a young woman buried with a battle axe in Denmark, this discovery was met with much attention and the results were questioned. The reasons for these questions unfortunately appear to be rooted in gender bias within archaeology, as some went so far as to suggest that the researchers had looked at the wrong bones, while others argued that military equipment is not enough to identify a burial site as that of a warrior. Here, we see the gender bias within academia that not only questions the researchers' abilities but also refutes the archaeological evidence. This is reminiscent to claims of prehistoric peace as discussed by Keeley (1996) in which a Belgian archaeologist with experience in excavation of many Iron Age burials was criticized for identifying burial sites as warrior graves because they contained spears, swords, shields, a male corpse in armor, and in some examples the remains of a chariot. Despite the archaeologist's experience in the field and the evidence of weaponry indicative of warfare, those clinging to the notion of a "pacified past (Keeley, 1996, p.18)" in which prehistoric peoples are believed to be naturally peaceable and not prone to violence, refused what was the most likely conclusion in favor of other interpretations. One such interpretation was the function of the weapons in these graves as purely symbolic, which was also suggested in the Birka case as mentioned by Hedenstierna-Jonson et al. (2017). Again, while these questions are not inherently wrong, it must be considered if the fact they are being asked is reasonable given the context of the finds and the experience of the archaeologists in question. Nevertheless, these archaeological finds indicate that the accounts of female warriors in Viking culture have a clear basis in history and require anthropology's further investigation into the existence of female warriors cross-culturally.

Some further examples of female warriors are from two Early Armenian period sites. The first burial discussed referred to as N 17 was discovered in the Armenian Highlands at the Bover I site which was a necropolis dating to somewhere between the 8th-6th century BC. According to Khudaverdyan et al.

(2019), this site experienced frequent conflict as part of the Urartian kingdom whose "people and land were repeatedly attacked by Iranian-speaking nomads" (p.120) and faced destruction of resources and raids from Scythians and various nomadic tribes due to being at the geographically significant crossroads between historical conflicts in Europe and Asia. Of note to this work, the authors also mention the fact that Urartian kings were known to have fought their enemies alongside their wives on horseback and upper-class women were historically documented to join in the fighting during times of war (Lastivertsi, 1968, Xenophon, 1976, as cited by Khudaverdyan et al., 2019). This fact is significant in the case of burial N 17 belonging to a young woman approximately 20 to 29 years old who had strong muscular attachments, particularly the pectoralis and deltoid muscles which showed evidence of regular use of drawing a bow (Lieverse et al., 2009, cited by Khudaverdyan et al., 2019). Additionally, the distal tibia, femurs, and gluteal muscles all indicate military activities such as horse riding (according to Capasso, Kennedy & Wilczak, 1999, as cited by Khudaverdyan et al., 2019). All of this evidence serves to back up the historical accounts of female Urartian warriors who fought on horseback. This individual also appeared to be a person of high status due to burial contents of ceramic vessels and a jewelry set that traditionally identified her as such (Khudaverdyan et al., 2019).

As for the injuries entailing her status as a warrior, N 17 had several injuries stemming from an embedded arrow in her femur at an earlier date and "acute force perimortem traumatic lesions" (Khudaverdyan et al., 2019, p.125) on the pelvis and legs which are posited to stem from a hatchet or a sword. The woman survived being shot with the arrow and it remained embedded in the bone and showed signs of healing. It appears that she died from the close-range attacks of multiple people by either sword or hatchet which most likely occurred in battle. As to the scale of warfare fought by this individual, the authors note that it is possible she died as part of a raid as the close-range attack is indicative of interpersonal violence. There are those who make the case that so-called primitive, small-scale warfare is not in fact warfare at all and

thus this evidence does not add up to this Early Armenian woman being a warrior (Keeley 1996). However, historically, we know that this area faced very frequent conflict and as in many pre-state or early state societies, conflict is an ever-present part of life. It would thus be reasonable to agree with Keeley's notion that the scale of war, if limited by size and resources, does not keep it from being true and total war as experienced by those who live and have lived under its constant threat.

Similarly, the other two burials in Armenia to be discussed were found at a Jrapı cemetery. Located in the Armenian highlands, Jrapı was likely to have been an area of frequent violence and warfare due to the fact that it was bordered by Turkey and Georgia and was known to have frequently interacted with these neighboring populations (Khudaverdyan et al., 2021). As explored by Keeley (1996), frontiers such as this one are common places for warfare to break out, as fighting can frequently ensue over competition related to availability of resources, especially in times of environmental stress. Two sets of remains dating from the transition of the Late Bronze Age to Early Iron Age (somewhere between 1150-900 BC) were found inside the tomb of Burial N 3. These remains were incomplete but able to be identified as women with the age of the first skeleton found to be between 45-50 years old and the second skeleton from 16-20 years old (Khudaverdyan et al., 2021). Khudaverdyan et al. (2021) also report on the physical attributes of these remains including their physical strength in life and the injuries they sustained before death. Both women appeared to be very physically strong and well-trained, most likely in archery, and similar to the woman found at the Bover I site, they showed signs of having frequently ridden on horseback. Notably both women also appear to be of high status based on grave contents of sardine beads, clay pots, a dagger with a wrist handle, and four bronze arrows (Khudaverdyan et al., 2021).

Both sets of remains had injuries that the authors identify as being caused by maceheads and arrows. The first set of remains had an antemortem injury with signs of healing on the right parietal bone that

appeared to have been caused by a blunt object and most crucially had "a bended bronze arrowhead stuck in the intercostal space (p. 529)", which led the researchers to conclude that this was the cause of the woman's death (Khudaverdyan et al., 2021). The second skeleton of the younger woman suffered from an injury to the lower jaw by a sharp-edged weapon which had healed. She also had a healed canal in the tibia appearing to be from an arrowhead similar to the manner of the injury of N 17 at the Bover I site, though the arrow itself was not present, and her cause of death is not known. Both skeletons had signs of blunt force head trauma caused by either a mace, pick, or a sling, and though both were deemed to be intentional and signs of conflict rather than an accident, both women survived these blows and showed signs of remodeling. All of these injuries indicate that these women actively took part in violence and warfare within their communities (Khudaverdyan et al., 2021). Also of note, their burial contexts also indicate a warrior status as both women were buried with their personal weapons (arrows and a dagger) and the dagger was even placed in the right hand of the first skeleton and as the author notes, this placement is rare among graves of women in Armenia (p. 531).

The Armenian remains from both sites clearly show bioarcheological evidence of having taken part in violent conflict that is consistent with the historically known conflict-ridden areas in which they lived. Khudaverdyan et al. (2021) also note that these female warriors appear to be consistent with Armenian iconography that depicts armed female riders as seen on vases and bronze belts (p.531). This correlates with the fact that their physique is representative of daily life that reflects the activities of the men who also took part in battle, such as riding horses and adept archery skills. The conditions of burial, especially that which identifies them as high-status women may have something to do with their ability to be classified as warriors, but nevertheless it establishes and confirms that there is precedence in the archaeological record for female warriors.

The last case concerns an individual found in Suontaka

Vesitorninmäki, Finland dating to AD 1050-1300. This set of remains differs from the previous two because it had previously been interpreted to be a woman due to the lavish clothing and feminine accessories associated with it. These included two oval brooches on the shoulders, a twin-spiral chain-bearer that may have been used as a pendant on the chest, and a small pinnacular brooch on the waist. Additionally the remains were wearing fine fur clothes, laid in feather bedding, and also included a hiltless sword blade with silver inlays, a sheathed knife, a sickle, and a bronze-hilted sword (Moilanen et al., 2022). The authors identify this grave as very unusual due to the fact that although it was not unheard of for axes, spearheads, and other weapons to be buried with female remains, swords are especially rare and when this does occur, they are very often lacking in jewelry and other feminine accessories (Mägi, 2002, Gardela, 2013, Moisio, 2016, Lund & Moen, 2019, Simniškytė, 2007, as cited by Moilanen et al., 2022). This site has served as an example of a female warrior in the Late Iron Age and early medieval societies; however, due to the rare example of the grave contents with female remains some posited that this grave had previously contained two sets of remains, with the suggestion that the weapons had belonged to a male. The authors of this article studied the microscopic animal hair and fiber remains from the soil taken from the grave and performed analysis of ancient DNA to determine the chromosomal sex of the warrior and set out to determine if the grave ever did in fact contain two individuals.

The hair and fiber remains showed the individual to have been buried in fine fur clothes indicative of status and wealth. The researchers found that the size of the pit could only fit one corpse and there was no different coloring of the soil which would point to another decomposition layer (Moilanen et al., 2022). All objects except the bronze-hilted sword (which appeared to have been buried later perhaps to hide it) could be definitively connected to the individual in the grave. Regarding the chromosomal sex of the remains, they “found overwhelming evidence that the genetic data of the Suontaka individual most closely resembled an XXY karyotype (p.50).” The

condition that causes this sequence is known today as Klinefelter syndrome which typically results in the anatomical appearance of a male. This evidence in combination with the female-attributed clothing and the hiltless sword, which notably showed no signs of battle in contrast to damage on other contemporary swords in the area is extremely unusual (Moilanen, 2015, cited by Moilanen et al., 2022). There are many possible explanations as to why a probable male-presenting individual was dressed in female clothing and buried with stereotypically masculine items. It is impossible to know how this individual conceived of and performed their gender roles within their time and there are many factors that would contribute to how they were perceived by their peers. Historical accounts range from reactions of humiliation and shaming (Price, 2002, Raninen, 2008, Hedeager, 2011 as cited by Moilanen et al., 2022) to toleration and acceptance (Zachrisson, 1997, Solli, 1999, Price, 2002, Raninen, 2008, Weismantel, 2013, as cited by Moilanen et al., 2022) in early Scandinavian societies. The elaborate context of the burial site and the obvious care and treatment shown to the individual communicate a great level of respect, wealth, and prominence in their time despite the apparent mixture of gender characteristics present in the grave that may have reflected a mixture of gender characteristics as experienced in their life.

It is hard to know if the individual found at Suontaka experienced warfare because there is so little bone material left to evaluate and the weapons show no signs of battle damage. Nevertheless, they were given a burial that reflects a warrior status, and this was taken to be a warrior’s grave for many years based on the grave contents alone. It is not surprising based on the previous examples that this individual’s warrior status was questioned primarily due to the fact that they were buried in female clothes and the suggestion that a male warrior must have also been present at this site was the primary impetus for this research which uncovered the true chromosomal sex of these remains. Though this example is not like the others that have been presented here, it is mentioned to highlight the assumptions often made by archaeologists studying violence and conflict. The first assumption highlighted

throughout all examples is that which is made based purely on burial goods, which can misidentify and apply incorrect gender identities for all potential remains whether perceived male or female. The second assumption relates to that important aspect of gender archaeology that argues we cannot apply the expectations and culturally constructed perceptions of gender today and apply them frivolously to the past because we do not have the ability to reconstruct and truly know how these gender roles were experienced and enacted by these individuals in their lived contexts. Though there will always be those who break patterns and norms of their respective times and cultures, archaeologists first need to look at the available archaeological evidence before determining what those norms are and be prepared to discover norms they previously did not know existed.

This work does not set out to declare that female warriors were common throughout any particular culture or time period, but rather to call attention to the interpretation of the evidence where it does exist. It is of interest that the remains of all of the individuals discussed appeared to be buried in contexts that indicated they were people of high status and in some cases definite wealth. The degree to which all of these people were able to subvert likely gendered expectations may in fact have been afforded to them by the level of status which throughout history has awarded more freedom to those who hold positions of power. However, this observation and all others that have been made about the cases discussed in this work serve to highlight an important aim of gender archaeology that is beneficial to studies of violence and conflict: when identifying human remains all potential aspects of identity must be considered including that which can be identified through bioarcheological evidence, burial and site contexts, and historical and ethnographic data, without reading the expectations of modern academia onto the identities of the past. Only when we have done so will the truth in the material evidence, including the reality of female warriors, be able to speak for itself.

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Looking to the Future: The Benefits of Blockchain Technology in the Audit Industry

Author: Lucas Blevins

Abstract

Blockchain technology has emerged as a transformative force across various industries, presenting significant potential benefits for the audit industry. This research paper explores the future coming advantages of integrating blockchain into audit processes, addressing critical issues in accuracy, reliability, decreased cost, and increased efficiency. The paper contends that economic changes, such as interest rate hikes, may render audit opinions outdated by the time they are issued. The research methodology employs a qualitative approach, drawing on existing literature and data to assess the benefits of blockchain technology in the audit industry. Using the EBSCO database, the authors gather information on blockchain, centralized and decentralized databases, distributed databases, and audit-related keywords. Thematic analysis is applied to identify patterns and trends in blockchain implementations across various industries. The findings reveal that blockchain technology has already demonstrated significant positive impacts on efficiency, cost reduction, reliability, and acceptance in diverse sectors. The research suggests that embracing blockchain positions businesses as innovators, fostering a competitive edge in a digital landscape.

Keywords: Blockchain Technology, Audit Industry, Cryptocurrency, Blockchain Technology Benefits, Acceptance of Blockchain, Blockchain Regulation

Introduction

The digital form of technology is changing rapidly every day, especially with the continued governance and limitation surrounding international finance and cryptocurrency. Out of a survey completed by over 1,000 executives from public corporations and CPA firms, the majority agreed that technology used for

financial reporting and the laws surrounding what they are reporting are not yet in line with each other, nor are they sufficiently supporting the information for which they are reporting leaving them with increased risk. Laws and regulations surrounding tax and audits are not showing any signs of slowing down, and a technology must be found that can accurately, and safely report critical information (Krawczyk, Chen, & Dirienzo, 2021).

In accordance with this, audit plays a vital role in the international finance market, considering its complexity. National audit firms face a time constraint with the enormous amount of work that is placed on these firms globally. Global markets rely on an Auditor's opinion to make sound, accurate investment decisions. A single material misstatement can cause not only a firm to collapse, but any stakeholders in that firm to suffer as well. Greater attention needs to be paid involving judgement and decision making to ensure what is being reported is accurate (Alexandre & Roberto, 2021). Though emerging rapidly, automation is struggling to keep up with the strenuous laws and regulations being passed globally, leaving auditors with more work, and continued education requirements in both accounting and IT.

The purpose of an audit is to form a view on whether information presented in a financial report, reflects the financial position of the organization at a given date (PWC, 2023). Recent years have shown an increase in corruption scandals in North America, particularly in the developed banking and financial sectors, despite a massive expansion in auditing by international firms (Shore, 2021). A cause of this may be due to the increased global legislation surrounding financial reporting, and a demand for automation in the accounting industry.

Blockchain technology was founded and implemented

in 2008 and is growing out of its early stages in a decentralized way. This was found to serve more purposes than just the financial market in 2018. Audit has found its use for blockchain, but it is still in its early stages. A small number of audit firms has taken on blockchain technology to discover and test its possibilities and potential (Deloitte, 2018).

Blockchain has a shared database for transactions in a peer-to-peer network, meaning that everyone using the technology is keeping track of transactions in the same place. A benefit that arises from this infrastructure type is that it is a good solution for people who do not trust one person or a group (Tyagi, Dananjayan, Agarwal & Thariq, 2023). This is a vital point made by the authors, given the topic of this research paper. The purpose of an audit is to prove a point, and verify that the information being presented is correct, and accurate in good faith. Blockchain technology is appealing to the audit industry, because it helps prove that information being presented to the audit team is reliable and accurate, and increases stakeholders' faith in the company, as well as the audit company's standard audit report (Bible, Raphael, Riviello, Taylor & Valiente, 2017).

In the past few years, specifically 2020 to present, concern has grown rapidly over whether audits on the banking industry have been accurate, despite being issued a positive outlook on the banks by their audit firms, specifically KPMG – one of the big four accounting firms. Three failed banking audit clients of KPMG failed in the past recent years, and their relationships with banks have become questionable. Given KPMG's expertise and reputation, their reasoning on issuing a positive SAR is questionable, despite these banks failing shortly after, along with thousands of investors losing their cash dollar investment, which is arguably partially KPMG's wrongdoing (Lacone, 2023).

Some of this issue can be partially blamed on the fact that auditing of financial statements are not “real-time” audits. As of 2020, audit reports are typically released after 25 to 120 days after the period end. Real-time auditing and reporting may become more common in the future with AI (AICPA, 2020). However, as of

this date, financial audits are not being reported in real time. Linking this back to the bank failures, the audit firms may argue that significant economic changes such as interest rate hikes affected their business ventures so detrimentally that from the time in which they were audited to just a few months later, could have changed the opinion in which they should have given (Ho, 2023).

In a study done regarding the ability of blockchain technology and its ability to process data and transactions in real time, a few of the cloud frameworks in which blockchain operates stand out. The frameworks of AWS cloud and ESP32, enables automated execution of pre-defined rules and regulations. As a result of this, it was concluded that the frameworks can detect and respond to security threats in real time, on an average of 109,450 transactions in real time (Aliyu & Liu, 2023).

What are the future benefits of blockchain technology in the Audit industry? As will be discussed later in this paper, blockchain has only begun to expand its capabilities outside of cryptocurrency in 2015, and has since discovered hundreds of capabilities, that are for the most part theoretical today, considering that today its main use is still primarily cryptocurrency.

The remainder of this work is organized into the following four sections. First, there is a literature review looking at prior literature that informs this study. The next section includes methodology, including both the research question and experiment design. The third section includes the research findings. Finally, the research ends with conclusions, including limitations and future research.

Literature Review

Blockchain technology is new and emerging technology, making its way across all industries in today's world. It stems from the founding of Bitcoin in 2008, which was the first decentralized cryptocurrency that also provided an innovative data management technology,

which is now known as blockchain technology. In

its beginning, it was able to ensure data validation without disruptions from intermediaries. It had been, and still is conceived as a financial technology by most researchers. Beginning in 2015, with the emergence of a new crypto currency called Ethereum, blockchain technology began revolutionizing its uses and processes, and had begun its emergence into different uses other than just financial technology (Lopez-Sorribes, Rius-Torrento & Solsona-Tehas, 2023). Blockchain is defined as a decentralized, collectively maintained, and cryptographically secure distributed database that cannot be tampered with. In theory, through the nodes of its network, the data information in a cycle is stored in a block by cryptographic methods, then each of those blocks are connected in a time sequence and a chain structure that then forms a blockchain. The purpose of blockchain being decentralized is that there are no extraordinary hubs in the blockchain network, and every hub has similar privileges and commitments. Any node has the right to access the data block list and read the data information in it. Nodes do not affect one another, and if one node is damaged, it does not affect the rest. Within the meaning of blockchain being “trustless” it signifies that blockchain is efficient and transparent in the process of recoding information in a very secured way, and no changes can then be made to a transaction once entered into the blockchain (Gai, Gu & Qin, 2022).

Nodes are like a tree structure, or in other terms a network and are used for connecting information. Examples of nodes include computers, data terminal equipment including wireless technology, etc. In terms for this paper, the focus of nodes will refer to its use for computers. This includes it acting as bridges, switches, hubs, and modems, which all actively manage data flow; servers, which provide services to other devices through internet servers; internet nodes, which are used in centralized databases by the external nodes flowing through to a main central node (Osman 2022).

The difference between decentralized and centralized databases is that in decentralized, records are stored in a distributed network of computers called nodes, rather than in one large central repository, such as a

bank. In this type of system, users can transact directly without a central intermediary, which saves time and expenses. See figure 1 and 2 for a visual representation of the difference between decentralized blockchain nodes and a centralized system (Hoffman 2020).



Figure 1: Centralized Database

A centralized database is one that is located, stored, and up kept at a singular location, with no competing databases. This location is often operated off a single computer or database system, such as a server or node. Users can then access the centralized database through an external computer has been given access through the centralized node, and then turns into its own database. One issue that has historically arisen with a centralized database is that it is not secure, meaning that although data flows efficiently and orders are in place, the people located at the centralized database are able to manipulate information without the external users every knowing, considering there is only one point of control (Wale 2023).

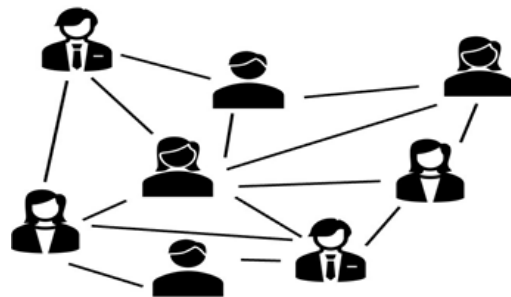


Figure 2: Decentralized System

A decentralized system is used by a consensus of network participants, or nodes, without one single node or server having complete control. Transactions that take place in a decentralized system are in an

open, public ledger, which ensures transparency and immutability. Decentralized systems have the capability surpassing centralized systems in terms of safety and security. Decentralized systems are currently not fully regulated, meaning there is no law in order surrounding public decentralized databases, as a result halting the development of blockchain's capabilities (Zhang, Xu, Xie, 2022). Decentralized databases are known as cryptographically secure distributed databases. These secure databases are the complex cryptographic techniques that ensures data integrity, confidentiality, and authenticity within the distributed database. Data is immutable, meaning that once data enters the database, it cannot be retroactively tampered with. Nodes within these databases agree on the validity of a transaction using complex formulas and algorithms. Each piece of data entered is known as a block, and each block is linked to the previous block creating a secure, traceable chain of transactions. Data is secured in these databases through encryption (Kotter, Martin-Bonmati, Brady & Desouza, 2021).

Financial accounting audit is the highest form of assurance that a CPA can give and is intended to provide a user of financial information with the assurance of the accuracy of the financial statements reported by a company. The auditor aims to detect any material misstatements. The CPA obtains an understanding of a company's internal control and assess fraud risk. The CPA must also be completely independent of the company, meaning that in no way are they associated with the company either directly or indirectly. A CPA will issue a standard audit report, which expresses an opinion on whether the financial statements presented are fair, in all material aspects. They must also report all material weaknesses within the company they are issuing the report for. The use of the standard audit report is for creditors, investors, and any other stakeholders in the company (AICPA 2015).

Auditing really gained traction as a necessity after the stock market crash of 1929, when Congress passed two acts of federal legislation – The Federal Securities Laws. The crash in 1929 was a result of mistakes, fraud, and speculation. This required all SEC registrants to

have their financial statements audited by independent CPAs, beginning it's increase in demand for auditing services. Fast-forward to the 21st century, one of the most significant accounting scandals at the company Enron, leading FASB (Financial Accounting Standards Board) to issue new accounting standard requiring consolidation of certain variable interest entities. Due to this scandal, FASB is now funded by the government, and federal laws surround any manipulation and or fraud of material misstatements on financial statements. This requires companies to be compliant with the laws and regulations in place, or otherwise face jail time (Levy, 2020).

Current day audit relies heavily on the use of automation. Auditors handle heavy amounts of data, so this allows auditors to analyze, use predictive analytic formulas, ensure quality and consistency, and select samples much more efficiently rather than manually calculating the data. Auditors are also able to audit in real time, rather than auditing a previous period (Chen & Wang 2022).

Methodology

For this research, the authors used existing research and data to find the benefits and increased efficiency using blockchain in the audit industry. Researchers used the EBSCO database to find articles with keywords such as blockchain, centralized databases, decentralized databases, distributed databases, cryptographically secure databases, audit, accounting audit, efficiency, cost, etc. These keywords were used together in different combinations to discover several articles. Using the thematic analysis, the following formula will be tested based off of blockchain's current uses comparing it's four factors listed below before and after to test the null hypothesis H_0 :

$$H_0: \text{AVG} (E + C + R + A) \geq 70\%$$

Where AVG represents an average of the sum of E (efficiency increase), C (cost reduction / less employees), R (increased reliability), and A (Acceptance for use). This formula represents the average satisfaction rates based on pre-existing

research, testing whether the benefits from implementation will reflect a positive relationship with an increase in efficiency, a decrease in cost, an increase in reliability for use, and an increase in acceptance for use. Alternatively, the alternative hypothesis will be assumed correct based on the following formula of H_a :

$$H_a: \text{AVG} (E + C + R + A) \leq 70\%$$

The null hypothesis is that the implementation of blockchain technology in the audit industry does not reflect a benefit to audit firms due to decreased efficiency, increased cost, decreased reliability, and decreased acceptance for use. The expected research that will be used to test the formula above for the hypothesis will be based on the results of previous research findings of the impacts that blockchain technology has already displayed through its current uses, and non-current uses. The thematic analysis will be used to test the hypothesis, comparing current, already implemented blockchain technology to its factors of cost, efficiency, acceptance, and reliability to its old ways. The average of the findings will then be summed together for each factor, resulting in an analysis of pattern. The types of data to be used are those from peer reviewed, journal articles and surveys. The expected results of this study are expected to support the hypothesis.

Findings

This segment describes the results and findings of this study, which were determined by analyzing preexisting research and data. Sources were evaluated to identify consolidated, summarized findings in attempt to find the average results and answer the research question of whether or not implementing blockchain technology into the audit industry would be beneficial. Blockchain technology is currently already implemented in multiple industries, including the supply chain for the retail industry. In regard to efficiency and cost, it's been found that blockchain has improved it's effectiveness exponentially. This is due to the elimination of intermediaries given that it operates on a decentralized system, a massive reduction in administrative tasks such as paperwork and it's errors which result in a decrease in overhead and transaction

costs, and eliminates the need for a third party to verify transactions (Muruganandham, Dinesh 2022).

De Beers Group, which is a diamond consortium that specializes in mining and the sale of diamonds at a retail level, have already implemented blockchain technology in their supply chain. It is currently using blockchain through distributed diamond blockchain. It starts at the source and provides tamper-proof source assurance at scale, which enables consumers to provide an immutable record of a diamonds source, and assurance of what is being purchased (De Beers Group, 2022). This speaks to the research question of reliability and acceptance – consumers who are purchasing diamonds are given more assurance and reliance on their purchase, due to the fact of blockchain technology tracking the course and information of diamonds from source to sale.

Blockchain has entered the food production supply chain, due to increased demands in the traceability of foods for health and ethical reasons. In a research study of companies that currently have blockchain technology implemented for purposes of food traceability, it was found that the use of blockchain technology that used real-time data and monitoring, resulted in having positive implications for improving food movement management, reductions in food loss, and food recall incidents (Bosona, Gebresenbet 2023). This proves to the research question that costs were reduced because of improved food loss, and food recalls. It also adds support to the fact that the information reported through the blockchain technology is that the food is more reliable. The food is tracked more effectively, resulting in less food recalls. This results in a favorable response of consumers in accepting the companies use of blockchain technology.

Additionally, a research study was conducted on users of the Maritime supply chain. These users all interact and pay third parties the facilitate cargo flow and exchange of information, causing a high overhead price to the company. Select users were selected to test the use of blockchain in their supply chain, which also eliminates the need for a third part, and eliminate the need for a third party in the supply chain. The findings of this study conclude that it is economically beneficial

to the select users, as they are able to eliminate a substantial amount of overhead costs as discussed above (Carlan, Sys, Vanelslander 2022).

A public oil company out of Abu Dhabi, called Abu Dhabi National Oil Company, collaborated with IBM to track oil from the well, all the way to the customer using blockchain technology. The primary purpose of this implementation was to track how much Carbon Dioxide was used to make products, and the information on the Carbon Dioxide was automatically recorded onto a decentralized block. The agreement of this implementation was signed and implemented by numerous regulators in Abu Dhabi, with hopes to reduce risk and increase safety for health (ADIPEC 2022). The research presented by this company has resulted in decreased costs, by eliminating the high need of a third party for tracking and administrative tasks, increased efficiency through eliminating third party involvement, proved its acceptance by attaining regulator acceptance, and has proven to be reliable as the tracking of carbon dioxide is more accurate today, than it was before.

FedEx, a shipping company has also implemented its own blockchain database, primarily for the use of data storage to offer customers immediate time responses on their disputes and helping them receive information in a more streamlined manner (Sirsty, 2021). In relation to the research question presented in this paper, FedEx has provided proof of reducing costs by automating complaints from customers, therefore eliminating the need for some of its customer service representatives, it's proven that it's accepted in the customer service, and shipping industry, it provides accurate, reliable answers to customers and users, and has increased efficiency for the company

by linking responses to transactions within the blockchain database.

Table 3 summarizes the testing of the hypothesis using the thematic analysis, by identifying specific patterns based off of blockchain's implementation before and after use, based off of the companies and industries discussed above.

The AICPA has concluded that the use of blockchain by auditors contains the following benefits: Substantial decrease in time auditors spend on planning audit and designing audits. Auditors receive information used in audits such as trial balances, account reconciliations, journal entries, sub-ledger contracts, and supporting miscellaneous excel spreadsheets in a different format for each client. This is heavily time bearing to an auditor, as they spend a significant amount of time just simply formatting data before performing an audit. The implementation of blockchain would allow the auditor to have near real time data access via read-only nodes within the blockchain. This would then allow an auditor to obtain information required for the audit in a consistent, recurring format. Only after all clients have accepted, and implemented blockchain would it then be beneficial to the CPA firm (AICPA, 2017).

The potential benefits are seemingly endless, if clients were to hypothetically all implement blockchain technology as their data providing source to the CPA firm. Auditors could deploy more automation, analytics, and automatic alerts to be sent to clients for unusual transactions in real time. Additionally, auditors having access to unalterable audit evidence will increase the pace of financial reporting and audits in general (AICPA, 2017).

Test	De Beers Group	Food Production	Maritime Supply Chain	Abu Dhabi National Oil Company	FedEx	
Efficiency	Increase	Increase	Increase	Increase	Increase	100% Increase
Cost	N/A	Decrease	Decrease	N/A	Decrease	60% Decrease
Reliability	Yes	Yes	Yes	Yes	Yes	100% Yes
Acceptance	Yes	Yes	Yes	Yes	Yes	100% Yes

Table 3: Modern Day Companies Effects of Implementation of Blockchain Technology

As of April in 2022, nearly half of the countries in the world have provided some laws and regulations surrounding cryptocurrency / blockchain technology, but primarily for its use in cryptocurrency, considering investors of cryptocurrency are required to be taxed on gains from investment. Eight countries at this time have cryptocurrency banned, most important of those is China. The U.S has begun to develop a regulatory framework but is facing conflicting opinions between regulators (Hammond, Ehret 2022).

Governments have begun the use of blockchain technology for operations. These countries include Estonia, the UAE, Georgia, Singapore, Sweden, and Austria. The primary use of its government operations is for data integrity and information security (Brothwell, 2023).

Conclusions, Implications, and Future Research

The implementation of blockchain technology in various industries has yielded substantial benefits, and these implications extend significantly to management practices. One of the key advantages is the potential for decreased costs. Examples from diverse sectors, including the De Beers Group and Abu Dhabi National Oil Company, showcase how blockchain streamlines processes, eliminates intermediaries, and reduces administrative overhead, leading to significant cost savings (De Beers Group, 2022; ADIPEC, 2022). For management, this translates into enhanced financial efficiency, enabling better resource allocation and budget management.

Furthermore, blockchain's impact on fraud reduction is a critical implication for management. By providing a tamper-proof and transparent ledger, blockchain enhances the reliability of information. The case of De Beers Group utilizing blockchain in its supply chain demonstrates how consumers can have immutable records of a product's source, ensuring trust and authenticity (De Beers Group, 2022). For management, this implies a strengthened brand reputation and increased consumer trust, contributing to long-term sustainability.

Increased efficiency is another noteworthy implication. The use of blockchain in the food production supply chain has led to improved food movement management, reduced loss, and fewer recall incidents (Bosona & Gebresenbet, 2023). In management terms, this efficiency translates into streamlined operations, faster response to market demands, and overall agility in adapting to changes.

FedEx's implementation of a blockchain database showcases how the technology can enhance customer service efficiency by providing immediate responses and streamlined information access (Sirsty, 2021). For management, this suggests that incorporating blockchain in customer service operations can lead to a more responsive and customer-centric approach, ultimately improving customer satisfaction and loyalty.

The implications for management involve cost reduction, fraud prevention, increased operational efficiency, and improved customer service. Embracing blockchain technology can position businesses as innovators, fostering a competitive edge in an increasingly digital landscape.

Despite the promising potential of blockchain technology, this paper faces certain limitations. One major constraint is the relatively low adoption rate of blockchain across industries. While examples such as De Beers Group, Abu Dhabi National Oil Company, and FedEx highlight successful implementations, these instances remain relatively few in comparison to the broader business landscape. Additionally, the lack of comprehensive data on the long-term effects of blockchain implementation poses a limitation. Many companies are still in the early stages of utilizing blockchain technology, and detailed information regarding the sustained impact on their operations is scarce. Without robust empirical evidence, it becomes challenging to make definitive claims about the transformative nature of blockchain across diverse industries.

Moreover, the paper acknowledges that blockchain technology is still in its early stages in the audit industry. The limited adoption and the absence of

real-time auditing in current audit processes hinders a comprehensive understanding of how blockchain might significantly change audit operations. As a result, the research is largely exploratory and theoretical, providing insights into the potential rather than proven, widespread application.

The future of blockchain research is intricately tied to the evolving landscape of laws and regulations surrounding the technology. As more countries develop regulatory frameworks for blockchain and cryptocurrency, it is anticipated that more companies will start embracing blockchain technology (Hammond & Ehret, 2022). Future research should closely monitor these developments and assess their impact on the widespread adoption of blockchain in different industries. Moreover, the paper emphasizes the importance of consistent international laws and regulations for blockchain. Future research opportunities lie in exploring the challenges and opportunities associated with achieving global regulatory consistency. Understanding how harmonized regulations can facilitate or hinder blockchain adoption on a global scale will be crucial for businesses and policymakers alike. The ongoing evolution of blockchain technology also opens avenues for future research. As blockchain expands its capabilities and applications beyond its current uses, researchers can delve into novel use cases and their implications for various industries. Exploring the theoretical capabilities of blockchain, as highlighted in the paper, and conducting empirical studies on emerging trends will contribute to a more comprehensive understanding of blockchain's potential.

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Data Visualization Effects on Auditing Accuracy

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Abstract

Data visualization provides many tools to auditing companies and users of auditing information to make better-informed decisions. The increased use of Big Data in business operations and procedures makes data visualization an attractive tool in the auditing process but it is not without its drawbacks. Improper use of data visualization can cause misinterpretation of auditing data and conclusions and can cause individuals to make decisions based on inaccurate conclusions. This paper tests whether data visualization affects the auditing process. In its conclusion, after testing that it does have a noticeable impact on the auditing process, it details the extent of this problem. It is recommended that management and auditing firms counteract this gap in knowledge of the downfalls of improper data visualization to make sure audits remain of high quality.

Keywords: Auditing, Data Visualization, Judgements, Auditing Opinion

Introduction

When discussing how companies operate and make informed managerial decisions, it is hard to understate the role big data plays in this process. Big Data refers to the large quantity of data that a business collects through its normal business practices or what it acquires from a third party. This data can be anything from information about the spending habits of potential customers, data on different sales activities of regional stores, or even information about the many ongoing activities a business does during its normal operating cycle. While big data's purpose and benefit to large businesses have been made clear over the last few decades, it has also provided a new challenge to many auditors to properly review (Lam & Metaxa, 2022).

Big Data, because of its large size which could

sometimes be in the millions of data points, is by its nature a large and difficult tool. The data collected alone about business operations is massive itself and this poses a unique question to many auditors. How do you properly sample such data to do a proper audit test on it? How do you test data this large for potential problems or misstatements? These questions are not without merit and are intricately connected with not only the audit but also the degree of confidence with which an opinion can be issued. To provide an answer to this conundrum, many auditing firms have been turning to data visualization to help in this process (Li & Tohti, 2022).

Data visualization software, such as Salesforce's Tableau and Microsoft's Power BI, allows a company to process large amounts of data and to quickly create visuals such as charts and graphs that allow a person to analyze the data. They can discern patterns, find outliers or odd data points, organize data into categories, or identify matters of interest. Incredibly useful in management decision-making, data visualization software benefits auditors as well (Rose & Rotaru, 2022).

Auditors have used this software in their audit process to great benefit. With data visualization, they have been able to analyze the Big Data of a client and categorize it for testing, ensuring a more representative sample of the data. They have used its graphs to look for patterns in the data that may be difficult to distinguish when reviewing individual data points on their own. These patterns could lead to showing places where fraudulent or inappropriate behavior is occurring (Perkhofer & Hofer, 2020). They can also analyze the data to better measure the risk of the company and to direct focus to where internal controls must be strengthened or confirmed. The uses of data visualizations have been discerned by many firms, especially the Big Four, and have already been finding themselves in the toolboxes of auditors around the country (Cheng & Li, 2023).

Even though data visualization is a great tool for firms to use in their auditing process, there exist risks that must be discussed to ensure the quality and reliability of audits do not suffer from using data visualization. The main concern around data visualization and the focus of this paper is on the dangers of visuals, when used inappropriately or improperly, affecting its users. Not every visual and graph is appropriate when used in certain contexts and can sometimes even misrepresent the data it is trying to show. This can cause incorrect conclusions to be drawn from the data. If this data is used by the auditor to determine a sampling method for testing or is used to test internal controls, it may cause the audit itself to suffer in quality and precision (Weirich & Kozlowski, 2018).

Visualizations have been used in the past by many different industries to convey a certain message to their audience. Sometimes these visuals can cause emotional responses or attract more attention to them based solely on their appearance and sometimes the shocking nature of the quality of the presentation or data behind it. This has appeared in society many times and it is because of this potential for misuse that this paper is designed to research the effect improper data visualization usage can have on the audit process.

This paper's focus is to study what potential psychological pitfalls exist when it comes to data visualization and what dangers firms must know about when designing auditing plans and procedures that incorporate data visualization into their arsenal. This research paper will fill a role in the literature by helping the audience to understand the research into data visualization in auditing with industry examples of visualization potentially negatively impacting the auditing process. This is to help management make a more effective decision about how they would like to best train employees in these technique and the procedures used to make sure high-quality audits are maintained (Rose & Rotaru, 2022).

The research questions that this paper will answer are the following. How can data visualization negatively impact the auditing process? How are accuracy and quality affected? How are audiences and users of auditing reports misled by faulty data visualization

practices? Are there ways to address these failures in the industry to ensure that auditing remains of high quality?

Literature Review

In the process of conducting research for this paper, a thorough review of the literature on this topic was done to not only provide an answer to the research questions posed by this paper but also to serve as the foundation for the conclusions drawn. In this section, this paper will explore the current literature available on this topic and how it pertains to answering the research questions that this paper sets out to answer.

To find the individual articles, the following keywords were used when narrowing down possible related articles. Sources were narrowed down with the keywords: *Auditing, Data Visualization, and Accounting*. This helped to find articles that tended to speak about how Data Visualization can be used in the auditing process. All articles were also chosen from English sources as that is the primary language spoken and understood by the author. The last reason was that articles were chosen that focused on the United States to keep some consistency when it came to similar political, legal, and economic conditions the data and articles were affected by.

The articles chosen can be broken down into a couple of broad categories to help get a more accurate picture of Data Visualization's role in auditing. The first of these categories are articles that talk about Data Visualization's possible impacts on auditing from a purely academic and theoretical standpoint. These types of articles were chosen to help understand what some of our academics feel are the best frameworks, roles, strategies, and possible outcomes of using Data Visualization in the auditing process. The first of the sources that fall under this umbrella would be *Internet Technologies in the auditing profession: A WOS bibliometric review of the past three decades and conceptual structure mapping*. This article describes conceptual frameworks and mapping for Data Visualization and explains different schools of thought on the matter. The author also talks about its evolving role over the last three decades. The second article would be, *does design matter when visualizing*

Big Data? An empirical study to investigate the effect of visualization type and interaction use. This article talks about the different formats that Data Visualization can take and its effects on the auditing process, for both the auditor and the client. The third and final article is *Teaching Data Analytics Skills in Auditing Classes Using Tableau.* This article, while it may be focused on teaching a specific Data Visualization style, talks about the best theories and frameworks for discussing Data Visualization for auditing purposes, providing valuable insight into tools taught to young professionals entering this field. These three articles make up the academic-focused articles used in this report.

The second main category of articles that were chosen for this paper focuses on data visualization from a more practical standpoint. These articles discuss how Data Visualization is being implemented and used in different industries across the United States. They go into not only how they were implemented, but also describe the impact, shortfalls, a potential found in Data Visualization backed with real-world data and experience. These types of articles make up the remaining seven articles chosen but focus on various industries. This was done to make sure conclusions for this paper were not hyper-focused on a specific industry that may apply to other fields.

The first of these articles is *Data Visualization in Local Accounting Firms: Is Slow Technology Adoption Rational?* This article focuses on whether it makes sense for smaller auditing firms to try to include Data Visualization as one primary tools for their auditing process. It recommends following the lead of other firms before deciding.

The second article chosen was *A Case Study Using Data Analytics to Detect Hail Damage Insurance Claim Fraud.* This article focuses on how Data Visualization can be used to help in detecting fraudulent activities, something important for the modern auditor. The third article, *Effects of Data Visualizations on Jurors' Judgments,* focuses on how Data Visualization helps people in management, the jury, or in other professions to understand data that may be fraudulent and to make better-informed decisions on important criminal matters.

The fourth article, *End-User Audits: A System Empowering Communities to Lead LargeScale Investigations of Harmful Algorithmic Behavior* focuses on the effect of Data Visualization from a purely end-user perspective, and how auditors can leverage this technology for different purposes. The fifth article, *Fake Plate Vehicle Auditing Based on Composite Constraints in the Internet of Things Environment* focuses on some constraints visible in Data Visualization and what impacts this has on different audits.

The sixth article, *Effects of Uncertainty Visualization on Attention, Arousal, and Judgment,* helps to articulate how Data Visualization is useful for the auditor to help deal with uncertainty and come to more accurate conclusions for their clients. The final article *When Should Audit Firms Introduce Analyses of Big Data into the Audit Process* deals with how Data Visualization can help analyze Big Data more effectively, something that is crucial in today's industry. These are the articles chosen for this report that give real-life data for the research undertaken in this paper.

Methodology

This paper will test two hypotheses to determine which of the two conclusions is more likely to be true from the data collected. The baseline, or null hypothesis (H_0), for this paper is the following. Data visualization has little impact on an audit's outcome and interpretations. This paper will test it against an alternative hypothesis (H_a) that stands for the opposite viewpoint. This would be data visualization does have a noticeable impact on an audit's outcome and interpretation. These two hypotheses will help to answer the research questions posed based on the resulting conclusion of the research.

Before discussing how the hypothesis will be judged, this paper will first lay out the procedure and tests used in conducting its research. This paper will collect data from the various studies on data visualization and measure when data visualization affected interpreting auditing data and the conclusion drawn from said data. For example, if one study measured end-users of the data and concluded that participants came to

a differing conclusion than the professional auditing opinion based solely on the effectiveness of the data visualization of an opposing viewpoint, then said participants will be counted towards letting data visualization affect their viewpoint in the context of this research. Since there is a wide range of specific research on different effects of data visualization, this research will help to measure the overall effect that data visualization has on the auditing process from a more generalist perspective.

Also, to measure the conclusions drawn, this research will divide the participants into three distinct categories. These categories are auditors, end-users, and clients. Auditors refer to any individual or firm conducting the audits. Clients refer to the different industries and businesses where the audit is being performed. End-users are those outside these two groups that may use the auditing opinion after it has been published. Examples of end-users include investors, stakeholders, jurors, legal practitioners, the United States government, or any other users of an auditor's opinions.

This distinction was made to help determine which groups are most affected by data visualization and if some groups have a greater resistance to misinterpreting an audit based on data visualization. It will also help to identify if applicable what areas of the audit process need to be addressed if the alternate hypothesis proves to be correct.

After the data is collected, statistical analysis will be applied to the collected material to determine how many of the individuals or entities were affected by data visualization. To test if the alternative hypothesis is correct, a set of conditions will need to be met to draw such a conclusion. The first is that enough data points will need to be collected to give an accurate result. For this research, overall, it was set that at least one hundred participants, not necessarily from each category, must be measured. The second condition was that at least 70% of all participants must express that data visualization affected their judgment in some manner. This will be measured on a per-category basis to determine a conclusion for each of the three groups. Overall, if two of the three groups show an impact from data visualization, then the alternative hypothesis

will be considered proven in the context of this paper and conclusions will be drawn from it. If otherwise, the null hypothesis will stand, and it will be concluded that data visualization does not have a noticeable impact on the auditing process.

Findings

When looking for data for this project, all ten sources mentioned above were examined for their research into this topic. Of all the research available, about six of the articles had research that could be used for this research project. When viewing these six articles, their research was scrutinized by participants in this research. Not all participants in their research were chosen as some of them could not be sorted by the categories set in the methodology of this paper. When unclear, these data points were discarded from the overall sampling. This was done to make sure the results were as accurate as possible and the hypothesis chosen would be the most accurate to the data made available to this paper.

After the participants were chosen for this research, they were then sorted into four categories. These categories are affected, moderately affected, barely affected, and not affected. These categories were left open to interpretation as many different authors used different scales and measurements when coming to their conclusions. For affected or moderately affected, it was looked at if the author made note that these participants were the most affected by the tests they ran.

The other two categories, barely affected and not affected represent those that may have been affected by the data visualization in some ways during their experiment, but in the context of their research question, the findings did not show that it affected them strongly enough to warrant accepting their form of alternative hypothesis.

After doing said research, the totals for each were counted. After all the research was conducted, it was determined that this paper had a sample size of 136 participants, which meets the 100 participants requirement set out in the methodology. While no one category alone reached 100 participants, it is the

author’s opinion that enough was collected to reach a reasonable conclusion on this topic. The findings are listed below.

	Auditors	Clients	End-Users
Highly Affected	5	7	74
Moderately Affected	18	3	8
Barely Affected	4	2	5
Not Affected	6	2	2
Total	33	14	89

Table 1: Data Visualization Effect on Judgment

After the results were collected and displayed, it was time to apply statistical reasoning to the results. Highly affected and moderately affected counted towards a positive result for the alternate hypothesis while barely affected and not affected were counted in favor of the null hypothesis. The results are presented below.

	Auditors	Clients	End-Users
Alternative Hypothesis	69.7%	71.4%	92.1%
Null Hypothesis	30.3%	28.6%	7.9%

Table 2: Overall Results of the Test

In conclusion, it was found that clients and end-users are affected enough to justify saying that data visualization affects the auditing process. They both have exceeded the 70% threshold and while auditors just barely missed the mark by 0.3%, the ending result is that two of the categories satisfy the alternative hypothesis so it will be the one that is accepted.

Conclusion

Through the research conducted, it can be concluded the alternative hypothesis is that data visualization can affect the auditing process. As such this means that steps must be taken to lower the risk of such an event happening in future auditing processes.

While technically auditors themselves did not reach the threshold of 70%, being so close to this number makes it quite clear that they too are heavily affected by data visualization. An interesting point to make is

that the group that is most at risk for data visualization misinterpretation is the end-users. This is significant in that these users tend to be the investors and other important users of an auditor’s opinion. As such, steps must be taken to ensure better communication and better visualization to make sure that judgment is not affected by these groups. The least affected groups, auditors, and clients are still affected but tend to have more professional skepticism to help counteract this trend to some degree.

It is important to discuss the limitations of this research and what implications this may have for possible users of this information. The first is that this research was built upon the data collected and presented by other peer-reviewed sources studying the field of data visualization in auditing practices. This means the data collected was heavily influenced by what previous authors chose for their research. This can skew the data used in drawing this paper’s conclusion towards certain industries or parties but leave other organizations underrepresented. This research should be treated as an overall trend of how data visualization affects the auditing process and not a case study of a specific industry.

The second important limitation of this research is that it only measures those individuals or entities affected by data visualization in the auditing process and that it can cause changes in judgment. It does not however measure the degree to which this judgment is impaired. The four response results measured in the research do not quantify the degree to which the participant’s judgment was affected, just they were to a certain extent. This judgment on which category an individual falls into relied heavily on the conclusions drawn by the original authors of said research and their opinions on the emotional response of their test takers. The scale and personal judgment of each researcher can and most likely did have an impact on the findings of this paper. The summary findings of this paper therefore should be treated as the consensus of the academic and professional community on this topic.

The findings of this paper and research should be carefully considered by managing both firms and

clients going forward when designing, implementing, and auditing procedures. As stated before, data visualization does have a noticeable impact on a person's judgment which can affect not only how an opinion is arrived at, but also how said opinion is communicated to others. Training therefore of both management and auditors is recommended in recognition of how to use data visualization appropriately, how to make sure that conclusions are not emotionally driven and remain objective, and best practices to incorporate it into current day practices.

Possible sources of training models for this can take inspiration from data analyzers as they are used to dealing with Big Data and how to best present said findings to management for decision-making. Possible models have also been put forward by other researchers and should be referenced for further information on this topic, but they are outside the scope of this paper to list.

These findings however should not be ignored because as shown data visualization can affect the summary judgement and perception of an auditor's opinion. As these opinions can affect how outside investors view a company and their attractiveness to invest in, an incorrect opinion can have large consequences on the stock price. Therefore, education on this issue is important for both management and auditors to avoid such an example and to make sure auditing is of a high quality so it may still be relied upon.

This research provides many interesting questions about the proper and ethical use of data visualization going forward. With the continued growth of Big Data use in companies and clients, data visualization will always be a powerful tool for auditors to not only review said data, but to also conduct the audit to a higher degree of completeness and precision. Even though data visualization can have negative consequences if used incorrectly, it is still a powerful tool if used correctly. Further research should be conducted by first quantifying and analyzing the exact degree to which people's judgments are affected by data visualization. This will provide directions to the most at-risk segments of the audit process. More research should continue to build proper models

and training guides to instruct how to best use data visualization appropriately and ethically. These models and templates can be used by many different industries and firms to better educate and train auditors or management on best practices when it comes to data visualization in auditing. These procedures can also be used by internal auditors when testing internal controls and presenting said data to management.

The last concern of research this paper can recommend is research into how to stop data visualization from hiding fraudulent activities. As discussed earlier, data visualization has the potential, through evoking emotional reactions, to misrepresent data for an audience. An individual can, in theory, use this to visualization to mask or hide patterns that can expose fraudulent activities. Research should be done into how to best protect businesses from such practices and how best to educate management about such potential dangers.

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Metalsmithing Works

Artist: Rebecca Batdorf

Artist Statement

My love of nature has been a source of meditation and a way to express emotions. I have spent time thinking and reflecting while walking in the country to inspire my art. I am inspired by all of nature but find amphibians and dragonflies most interesting for my work. During my youth I would spend hours every day outside. Now as an adult I find the natural world calming and a source of comfort for mental stress and the horrific events in life. Sketching in my hammock during spring and summer is one of my favorite activities. When I am not sketching, I take walks on my property and even travel to local state parks to sketch or do photography. While nature scenes help me by providing inspiration for my art, I hope to give back by providing people with a small glimpse of why the natural world is important for us all to protect.

Dragonflies and frogs are important not just to me but also to the entire ecosystem to keep other species under control. Knowing this vital information inspires my creative process and helps heal my inner child. Now I put that inspiration into the metal boxes, cups, pitchers, and any other item I create. I transfer the peace I find in nature into the creative process of making each item. Every stage of metalsmithing is relaxing and a source of meditation for me. The process helps me through my emotional states from depression and PTSD. The pitcher allowed me to process my grief through my working the metal. With natural images depicted in metals I am finally starting to feel like myself again. I put all my love, strength, and courage into each item for people to enjoy and be inspired by as well.





Pumpkin, Ice Cream Set of Four

Artist: Louise E. Haynes

Artist Statement

Ice cream socials became popular in the United States in the 1800's as technology allowed for the freezing processes and equipment to evolve. The ice cream social was a way to gather with friends and enjoy the cold treat.

I have been working with a series of leaf designs and when I was asked to create a metal piece for an ice cream social, I wanted to continue that thought. I felt that a pumpkin was the perfect shape from nature to fit my need. The ice cream bowls are raised pewter, in the shape of a pie pumpkin cut in half, the bottom half being the bowl. Each bowl is nestled on a copper-

-chased pumpkin leaf plate, with a copper tendril as part of its handle. A cast pewter spoon in the shape of a male pumpkin flower, showing both the inside and the outside of the flower, finishes the set.

Pewter and Copper

Bowls: 1 3/4 x 4 6/8 x 4 6/8 inches

Plates: 3 1/4 x 11 1/8 x 7 1/4 inches

Spoons: 3/4 x 6 1/2 x 1 5/8 inches



Golden Straw

Artist: Nicole Pitcher

Artist Statement

I am captivated by the profound sensory experience of touch that comes from working with clay. The feeling of the clay gracefully spinning through my hands on the potter's wheel, its coolness and pliability intertwining with the rhythmic movements of my hands, creating a dance of a tactile connection. As an Autistic the experience of touch is a profound part of my experience. Through my creations, I strive to evoke a sensory experience of touch in others, inviting them to engage with my pieces instinctively.

One key aspect that defines my artistic practice is incorporating elements that celebrate the touch and feel of the finished pottery. I intentionally integrate raw clay portions, often leaving texture on the foot of my pieces and incorporating surface textures that beckon the viewer's hand to explore the contours and ripples of my work. By doing so, I aim to establish a direct connection to foster a tangible and intimate experience. Soft curves and the interplay of texture are fundamental elements in my creative process. The gentle arcs and flowing lines, inspired by my experience on the wheel, convey a dynamic quality as if my pieces possess movement frozen in time.

The natural world and its relationship with my community play a vital role in shaping my artistic practice. I draw inspiration from the softness and harmony that can be found in the environment surrounding me, particularly the greenways and rivers that weave through our community. The graceful contours and winding bends of these landscapes, along with the delicate ripples on the water's surface, serve as endless sources of inspiration. Infusing my pottery with the essence of these organic elements, I aim to create pieces that bring about a sense of tranquility and foster a deeper connection to nature. I hope those who engage with my work will experience a moment of respite and a renewed appreciation for the beauty surrounding us.



Medium: Stoneware

Size: 15" x 7" x 7"

Year: 2023

Want to see more of this artwork?

Check out the interactive 3D Scan at this link: <https://sites.pfw.edu/wehl/sites/3d/golden-straw-np/golden-straw-np.html>

In Memory

Artist: Alexa Ross

Artist Statement

The remembrance of memories lost through the symbolism of death influences my art. Death extends to our memories of people, places, and things, as time moves forward our memories get left behind, and forgotten. The addition of the music box allows the audience to interact with death as symbolized through the form of the vessel, the short tune that plays acts as a sensory stimulus that elicits a lost memory within the viewer.

The loss of my pet cockatiel, Mia, sparked my interest in creating vessels referencing the typical form of ceramic urns commonly sold. My art became a way to honor her loss since she was integral to my first year as a college student. In her memory, my vessels evolved to house music boxes to invite the audience to interact and listen to the short tune that plays. Inserting music boxes into my vessel adds a sensory stimulus that may bring up lost memories in some of the audience, either the familiar sound of a music box playing or a tune previously forgotten to the past.

The knob of the lid isn't the typical shape and is instead a bird in an animated pose, their outstretched wings captured in animation, giving a more active and powerful look. They were inspired by my love for birds, their elegance, freedom, and can be seen as either a protector of lost memories or a guide for those memories back to the viewer.

Want to see more of this artwork?

Check out the interactive 3D Scan at this link: <https://sites.pfw.edu/wehl/sites/3d/in-memory-ar/in-memory-ar.html>



Medium: Ceramic, Music Box

Size: 13" x 5.5" x 5.5"

Year: 2022

Faculty Spotlight: Works by Seth Green

Artist: Professor Seth Green

Artist Statement

Capturing clean lines and continuous curves that produce striking silhouettes, strong negative spaces, and distinct profiles around architecture primarily drives my creative decision making in the studio. Symbolic details used in the creation of religious and royal architecture also influence my wheel-thrown and assembled ceramic vessels. Specific forms of inspiration are Baroque and Romanesque cathedrals, palaces, and other architectural references of the Czech Republic and Islamic mosques, that are topped with domes, spires and finials that pierce the sky and reach heavenward.

Luxury or ceremonial wares that were used in a palace to celebrate a momentous occasion or in a place of worship to enhance the sacredness of a ceremony also influence my work. Such examples include scalloped rims and the elaborate joinery of necks, spouts, and handles of metalwork and pottery crafted during the Persian and Ottoman Empires. Rather than the specifics of rituals or ceremonies that these objects were used for, I am intrigued with the sense of importance and sacredness that my pouring, drinking, and lidded vessels convey.

The metalsmithing technique of inlaying metals, such as silver and gold into brass, is reminiscent of the silver and gold crystals that emerge through the glazed surfaces of my vessels as they cool in the kiln. Glaze applied to these ceramic forms accentuate, yet soften, their details and silhouettes. Precious metal lusters are applied to spout tips and finials to communicate the same degree of beauty and luxury as the referenced historical objects and emphasize the most important aspects of the work. Sharply detailed edges and patinated metallic surfaces are also achieved through the use of high-iron clay slips applied to my wood-fired vessels that are cooled in a reduction atmosphere.

Ultimately, the ascendant gesture of my work is meant

to elevate. It symbolizes strength in purpose and the potential for transcendence toward something higher and greater.



Title: Vase

Medium: Reduction-Fired Stoneware

Size: 15" x 8" x 8"

Year: 2023

Want to see more of this artwork?

Check out the interactive 3D Scan at this link: <https://sites.pfw.edu/wehl/sites/3d/vase-sg/vase-sg.html>



Tankard: Reduction-Fired Stoneware, Gold Luster, 7" x 5" x 3"



Bottle w/Rattling Stopper: Wood-Fired Stoneware, 16" x 5" x 5", Reduction Cooled

This bottle was fired in my train-style wood kiln built in 2017 with the assistance of Ted Neal, my good friend and kiln extraordinaire, who is a Professor of Ceramics at Ball State University.