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Article

Impact of Using Big Data Analytics as an Artificial Intelligence Tool on Achieving Effective Digital Transformation in Iraqi Ministry of Trade.

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Abstract: Research aimed to conduct a theoretical study on impact of using big data analytics as an artificial intelligence tool on effectiveness of digital transformation in Iraqi Ministry of Trade. To achieve this objective, researcher presented a theoretical framework for big data analytics as an AI tool and effectiveness of digital transformation in three chapters. Research indicated that managing and analyzing big data faces several fundamental obstacles, including: poor data quality, its enormous volume and rapid flow, diversity and multiplicity of data sources and formats, security risks and privacy issues, as well as high costs and a shortage of specialized human resources. Artificial intelligence technologies also face numerous challenges, including: data bias, privacy and security concerns, enormous energy consumption, its potential impact on labor market, and a lack of transparency in decision-making and strict regulations. Digital transformation also faces several challenges, including: employee resistance to change, a shortage of digital skills and human resources, complexity and weakness of technological infrastructure, security and cyber threats, in addition to high financial costs and lack of a clear strategic vision in some institutions. Research concluded that integration of big data, artificial intelligence, and digital transformation empowers organizations to make accurate and rapid decisions. This convergence transforms raw data into intelligent insights, accelerates modernization of processes and services, and enhances efficiency and innovation in digital work environment. Human and analytical skills are most influential and powerful factors in achieving high-quality digital public services; real-time communication and exchange are essential, and data technology infrastructure had a significant positive impact on increasing operational efficiency, reducing time, and streamlining supply chains.
Keywords: Big Data Analytics - Artificial Intelligence - Digital Transformation - Human Skills - Organizational Culture

1. Theoretical Framework of Research

1.1 Introduction:

Concept of Big Data Analytics as an artificial intelligence tool in literature of information systems and macroeconomics stems from integration of two revolutionary technologies. Big data represents "raw material and fuel," while artificial intelligence represents "engine and sophisticated cyber intelligence" that gives this material strategic value [Mikalef et al., 2020, p. 102].

Digital transformation in public sector is a fundamental pillar for reshaping administrative and service contract between state and its citizens, particularly in vital institutions such as Iraqi Ministry of Trade, which is responsible for food security and regulating market activity.

Big data analytics, as an advanced artificial intelligence tool, is a key driver of cybersecurity, enabling transformation of raw and dispersed government data into strategic assets and predictive knowledge to support administrative decision-making [Micalaeff et al., 2020, p. 110]. Public institutions in developing environments face complex challenges in transitioning from traditional bureaucratic systems to effective digital governance due to weak infrastructure resilience and cultural resistance to change. Therefore, this research proposes a theoretical framework to measure how adopting big data analytics contributes to enhancing "effectiveness of digital transformation," based on a dynamic resource and capability perspective, to explain how to generate strategic and institutional value from AI's technological and human assets [Wamba et al., 2017, p. 358].

1.2 Previous studies:

Recent foreign studies addressing study variables fall into two main categories:

- First category: Big Data Analytics Strategies.) Mikaliffe et al. , 2020: 115) showed that big data analytics strategies that include (technological infrastructure, human resources, and data culture) can directly improve organizational performance by leveraging human capital. This is achieved by developing "dynamic capabilities" that enable organization to anticipate and adapt to environmental changes.
- Second category: Determinants of Digital Governance Effectiveness. (Twizeyimana & Andersson , 2019, p. 170) explored dimensions of digital governance and emphasized that effectiveness of digital transformation in public sector extends beyond mere process automation to achieving public value, which includes transparency, accountability, combating corruption, and improving efficiency of service delivery to citizens.

Researcher can present some foreign studies closely related to current study, as shown in following table:

Table No. (1) Some foreign studies closely related to current study

Researcher's name and year of publication	Study Title	Study aims	Study Variables	Study Instrument/Methodology	Study Population and Sample	Study's key findings are:
(Mikalef et al.,2020)	Big data analytics capabilities and organizational performance.	Measure impact of big data analytics capabilities on organizational performance through mediating role of dynamic capabilities.	**Independent: Big data capabilities (technical, human, cultural).** **Dependent: Organizational performance.** **Mediator: Dynamic capabilities.**	Descriptive-analytical approach, using questionnaires and standard analysis via structural equation modeling (PLS-SEM).	Information Technology Managers in 175 Dutch and European companies adopting artificial intelligence.	Technological capabilities do not directly improve performance, but rather build dynamic capabilities that enable organizations to adapt to turbulent environments [Mikalef et

						al., 2020, p. 118].
(Twizeyimana & Andersson,2019)	public value of E-Government.	Review and develop a conceptual framework for measuring effectiveness of digital transformation through public value creation channels.	**Independent: Digital transformation and digital governance.** **Dependent: Overall value (operational efficiency, service quality, transparency, and integrity).**	Deductive approach, systematic literature review, and conceptual grounding.	**94 peer-reviewed scientific studies published in elite journals on government digital transformation.**.	effectiveness of government digital transformation is measured by its ability to create tangible public value, including combating corruption and rebuilding institutional trust [Twizeyimana & Andersson, 2019, p. 172].
(Wamba et al., 2017)	Big data analytics and firm performance.	Examine interaction between big data analytics and dynamic capabilities under influence of environmental disruption.	**Independent: Big data analytics.** **Dependent: Strategic and operational performance.** **Moderator: Environmental disruption.**	Quantitative-exploratory approach, using closed-ended questionnaires and confirmatory factor analysis via covariance-based SEM.	**356 executive leaders and digital strategists in organizations.**	impact of big data increases significantly in environments suffering from structural instability, as it provides predictive analytics to hedge against shocks [Wamba et al., 2017, p. 364].
(Vial, 2019)	Understanding digital transformation.	Deconstruct philosophical and organizatio	**Independent: Tangible and intangible**	Comparative-inductive approach, building oretical structural models based on resource-	A comprehensive critical review of 282 leading	Success of digital transformation requires a

		nal structure of digital transformation and identify resources and capabilities that govern its success.	**digital resources.** **Dependent: effectiveness of transformative digital transformation.**	based capability ory (RBV).	research papers in information systems and management.	fundamental re-engineering of processes, and failure is linked to employees' cultural resistance to absence of a data culture [Vial, 2019, p. 130].
(Hair et al.,2024)	Advanced issues in partial least squares structural equation modeling.	Establish rigorous and up-to-date criteria for evaluating predictive efficacy of out-of-sample management technology models.	**Independent: Underlying technological variables.** **Dependent: Predictive indicators observed outside sample.**	Mathematical-empirical approach, data simulation, and application of developed PLSpredict protocol.	Simulated random sampling of data from complex, multidimensional technological and administrative systems.	Study stipulated that R2 alone is insufficient and that Q2 {predict} should also be used to assess the predictive relevance of the models before generalizing their findings to governmental environments [Hair et al., 2024, p. 112].

Source: Prepared by researcher based on studies by o r researchers.

Researcher can present some foreign studies that are closely related to current study, as shown in following table:

Table No. (2) Some Arabic studies closely related to current study

Researcher's name and year of publication	Study Title	Study aims	Study Variables	Study Instrument/Methodology	Study Population and Sample	Study's key findings are:

(Al-Ubaidi and Al-Jubouri, 2024)	Impact of big data technology on enhancing quality of strategic administrative decisions in public institutions.	Measuring extent to which big data analytics, as a digital engine, contributes to enhancing quality and clarity of operational and strategic decisions in public sector.	Independent: Dimensions of Big Data (volume, diversity, velocity). Dependent: Quality of Management Decisions (rationality, timeliness, accuracy).	Descriptive-analytical approach utilizes questionnaires and standard analysis through structural equation modeling (PLS-SEM).	Senior and middle management and technical staff in service ministries: A representative sample of (210) respondents was drawn.	Digital transformation based on modern big data structures enhances managers' ability to make evidence-based, predictive decisions (Al-Ubaidi & Al-Jubouri, 2024, p. 44).
(Al-Shammari and Al-Saadi, 2026)	Digital transformation in Iraqi public sector institutions and its impact on enhancing institutional performance.	Exploring reality of digital transformation applications in government environment and their impact on achieving efficiency and transparency, and reducing bureaucracy.	Independent: Digital Transformation (infrastructure, digital enablement). Dependent: Institutional Performance and Governance (operational efficiency, citizen satisfaction).	Applied quantitative approach (case study) employs questionnaires, advanced statistical analysis, and software such as SPSS and AMOS.	A stratified random sample of (168) employees and programmers in service departments and Bank of Baghdad.	Digital transformation faces challenges related to data governance, but AI-driven automation ensures greater resource efficiency (Al-Shammari & Al-Saadi, 2026, p. 92).
(Saleh and Al-Anzi, 2025)	role of artificial intelligence technologies in improving quality of e-government services.	Examining contribution of artificial intelligence algorithms and predictive analytics to improving reliability and speed of electronic services for citizens.	Independent: Artificial Intelligence Tools (machine learning, predictive analytics). Dependent: Quality of Digital Public Services (reliability, accessibility).	Deductive-analytical approach involves designing digital scales and testing their validity and statistical reliability.	Engineers and beneficiaries of government services: A random sample of (280) valid questionnaires.	Investing in analytical and technical human capital is most significant determinant of success of AI algorithms in achieving beneficiary well-being (Saleh & Al-Anzi,

						2025, p. 115).
(Al-Rashidi, 2024)	Determinants and success factors for adopting digital transformation in government service institutions.	Identifying cultural and organizational challenges facing radical transition towards effective digital governance.	Independent: Organizational and Cultural Challenges (resistance to change). Dependent: Effectiveness of Digital Transformation.	Inductive approach includes a systematic literature review and methodological matching.	A survey review of (45) applied studies published in post-conflict Arab contexts.	Failure to achieve digital effectiveness is not due to technical reasons, but rather to absence of a data culture and resistance of traditional employees to electronic systems (Al-Rashidi, 2024, p. 204).
(Al-Maliki and Hussein, 2025)	Big data governance and its impact on performance practices and reducing financial and administrative corruption.	Measuring effectiveness of integrating big data systems and digital audit processes in reducing avenues for administrative manipulation.	Independent: Big Data Governance (confidentiality, accuracy). Dependent: Governance of Procedures and Reduction of Corruption.	Exploratory descriptive approach utilizes closed-ended questionnaires and confirmatory factor analysis (CFA).	Accountants and internal auditors in banks and departments subject to oversight of Federal Board of Supreme Audit.	Replacement of human decision-making with cyber algorithms and big data eliminates subjective human element, thus significantly increasing transparency levels (Al-Maliki & Hussein, 2025, p. 138).

Source: Prepared by researcher based on studies by o r researchers.

Similarities and differences between previous studies and current study can also be presented as shown in following table.

Table No. (3) Systematic and critical comparison between current research and previous study

Researcher's name and year of publication	Systematic and critical comparison between current research and previous study
(Mikalef et al.,2020)	It agrees with current study in adopting dimensions of big data analytics capabilities (technological, human, and cultural) as a primary explanatory

	variable. It is identical in its use of descriptive-analytical approach and structural equation modeling (PLS-SEM) [Mikalef et al., 2020, p. 101]. First study was implemented in a private and commercial sector environment (175 Dutch and European companies) to maximize profits, while current study is being implemented in independent sovereign government sector. First study examined impact on overall organizational performance and dynamic capabilities, while current study examines effectiveness of digital transformation and public value creation channels [Mikalef et al., 2020, p. 124].
(Twizeyimana & Andersson , 2019)	It is similar in formulating dimensions of dependent variable, which are outputs of government digital transformation and channels for measuring public value (efficiency, quality, and governance) [Twizeyimana & Andersson, 2019, p. 167]. First study examined framework in stable international environments, while current study examines it in an unstable, rentier-based developing environment [Twizeyimana & Andersson, 2019, p. 178].
(Wamba et al.,2017)	It agrees in studying big data technology applications under dynamic capabilities hypothesis and surrounding environment disruption [Wamba et al., 2017, p. 356]. It was fully implemented in for-profit industrial and commercial business environments, unlike current environment [Wamba et al., 2017, p. 369].
(Vial ,2019)	It converges with current study in adopting resource-based theory (RBV) as an explanatory framework for how infrastructure interacts with human skills to achieve digital success [Vial, 2019, p. 118]. Study was an inductive, desk-based approach to building a general conceptual model, while current one is a structural, applied approach. It did not dedicate specific space to studying big data analytics as a separate tool for artificial intelligence, nor did it link outputs to a sovereign "Ministry of Trade" [Vial, 2019, p. 144].
(Al-Ubaidi and Al-Jubouri, 2024)	These studies similar in their handling of big data technology within Iraqi public sector, and in their reliance on PLS-SEM structural modeling to collect and analyze opinions (Al-Ubaidi & Al-Jubouri, 2024, p. 35). Previous study focused on the impact of "strategic administrative decisions" on quality and their implementation, while the current research focuses on the effectiveness of comprehensive digital transformation (process efficiency, e-service quality, and procedural governance).
(Al-Shammari and Al-Saadi,2026)	Current research agreed with the previous study in examining the reality and determinants of "digital transformation" in government service agencies in Iraq and their pursuit of governance of procedures (Al-Shammari and Al-Saadi, 2026, p. 75).
(Al-Maliki and Hussein,2025)	Current research shares with previous study role of data technology and electronic systems in reducing channels of financial and administrative corruption and implementing governance (Al-Maliki & Hussein, 2025, p. 120).

	It was implemented only in environment of commercial banks and departments subject to financial control, while current one studies commodity and food service sector.

Source: Prepared by researcher

1.3. Research gap :

Despite abundance of studies on artificial intelligence (AI) applications in business environments, there is a clear lack of research addressing impact of big data analytics as an AI tool, leveraging human capital, to drive comprehensive digital transformation within public service institutions in countries experiencing environmental and institutional instability, such as Iraq. This research addresses this gap by linking AI technology to operational efficiency and governance within Iraqi Ministry of Trade. Based on a critical analysis and comprehensive comparison of foreign and Arab studies, including this one, a research gap with specific dimensions identified, as follows:

- Contextual & Environmental Gap: Most leading foreign studies such as(Mikalef et al., 2020; Wamba et al., 2017) have focused on measuring competitive and financial returns of big data analytics in for-profit private sector environments and in institutionally stable and developed countries. In contrast, literature suffers from a clear scarcity of studies that address artificial intelligence technologies as a tool in sovereign services sector of developing and entrepreneurial countries (such as Iraq), which are characterized by environmental and institutional instability, and whose services are directed towards creating "societal value and public governance" rather than monetary returns. (Twizeyimana & Andersson, 2019) .
- Conceptual and Practical Gap: Review of local and Arab studies, such as study by Al-Shammari and Al-Saadi (2026), shows that studies that dealt with digital transformation focused on "superficial and simple automation" and traditional electronic transactions without linking them to cyber development represented by "big data analytics and predictive analytics of artificial intelligence"." Furthermore, studies examining big data have focused on "administrative decision-making" or "accounting and oversight performance" (Al-Maliki & Hussein, 2025), without developing an integrated structural model that links three dimensions of big data (technical, human, and cultural) to effectiveness of comprehensive digital transformation aimed at protecting food security, managing supply chains, and governing supply system in a sensitive institution like Iraqi Ministry of Trade.
- Methodological and Empirical Gap: Most Arab studies have been limited to using traditional and descriptive statistical analyses or in-sample variance-based modeling of strictly normal distribution data without verifying predictive power of proposed frameworks.

1.4. Research problem:

Iraqi Ministry of Trade faces highly complex operational and strategic challenges, particularly in managing food rationing system (ration card system), tracking movement of essential goods, registering companies, and reducing bureaucracy and administrative corruption. Despite government's drive towards digital transformation, current initiatives are limited to superficial automation without leveraging daily influx of data. Research problem is defined by following main question: "What is impact of using big data analytics as an artificial intelligence tool on achieving effective digital transformation in Iraqi Ministry of Trade?" This leads to following sub-questions:

- What is level of availability of big data analytics capabilities (technological, human, and organizational) within Ministry under study?
- What is level of effectiveness achieved in digital transformation (operational efficiency, service quality, governance, and transparency)?

1.5. Research objective:

Research aims to determine impact of using Big Data Analytics as an artificial intelligence tool on effectiveness of digital transformation in Iraqi Ministry of Trade. It also aims to achieve following sub-objectives:

- To establish a conceptual framework for interactive relationship between Big Data Analytics (BDA) tools and digital governance in public sector.
- To diagnose current infrastructure and knowledge base for Big Data Analytics and Digital Transformation in Iraqi Ministry of Trade.
- To measure magnitude and nature of impact of Big Data technology on various dimensions of digital transformation effectiveness.
- To provide a strategic roadmap and practical recommendations for decision-makers in Ministry to maximize return on investment in artificial intelligence technology.

1.6. Research Propositions

Based on the theoretical framework and previous studies, the following research proposition is proposed: Big data analytics technology, through its dimensions of infrastructure, human skills, and organizational culture, is expected to contribute to the effectiveness of digital transformation through operational efficiency, service quality, transparency, and governance.

1.7. Significance of the Research:

The importance of this research can be divided into two main aspects:

- Theoretical Importance: Research contributes to enriching administrative thought and information technology library by providing a comprehensive theoretical framework that integrates "dynamic capability theory" with public administration environment in developing countries, thus addressing knowledge gap in literature on AI-driven government digital transformation.
- Practical Importance: Research is of great importance to Ministry of Trade and Iraqi government, as it offers recommendations for managing food resources and preventing manipulation and corruption in ration card system through "predictive analytics," in addition to improving Iraq's ranking in United Nations' e-governance indicators.

1.8. Research Methodology and Research Questions (RQs):

Research employed a systematic review methodology (Methodology Shift) using Systematic Literature Review (SLR). Researcher compiled previous studies by reviewing articles published in scientific journals that addressed both independent and dependent variables of research. Researcher also utilized several local and international databases related to big data and digital transformation.

Research problem formulated in the following main question:

- What is impact of using big data analytics as an artificial intelligence tool on achieving effective digital transformation in the Iraqi Ministry of Trade?

This main question includes several sub-questions, such as:

- What is conceptual development of big data analytics and artificial intelligence in public sector globall?
- Can a critical analysis of determinants of digital transformation (infrastructure, human skills, organizational culture) be provided based on findings of previous studies?
- How can results derived from literature be applied in Iraqi Ministry of Trade (e.g., the ration card system and company registration), and how can a proposed conceptual framework be developed specifically for Ministry based on identified best practices?

- How has previous literature addressed role of big data analytics in achieving efficiency in government operations?
- What are technological and human requirements for theoretically implementing these technologies in a sovereign institution like Iraqi Ministry of Trade?

1.9. Research variables:

Independent Variable: Big Data Analytics (BDA) : Measured through three main dimensions:

- Technology: This includes data processing software, cloud computing, and networking capabilities.
- Human Capital: This includes technical skills of programmers and strategic knowledge of managers in interpreting data.
- Organizational Culture: This extent to which management relies on data rather than personal intuition when making decisions.

Dependent Variable: Digital Transformation Effectiveness: Measured through three dimensions:

- Operational Efficiency: Reduction in time, cost, and errors in transaction processing.
- Service Quality: Ease of access to services for citizens and businesses through electronic platforms.
- Governance & Transparency: Ability to track resources and reduce avenues for administrative corruption.

1.10 Research limitations:

- Subjective Scope: Research focuses on presenting theoretical framework of big data analytics as an artificial intelligence tool. It will not address other tools such as robotics or simple mechanical automation, and will concentrate solely on service and governance outputs resulting from digital transformation.
- Spatial Scope: Iraqi Ministry of Trade (Ministry Headquarters, Companies Registration Department, General Company for Grain Trade, and General Company for Foodstuffs Trade) in Baghdad.

2. Big data analytics

2.1 Conceptual and philosophical framework for big data analytics:

Big data analytics helps to monitor and discover strengths and weaknesses, and provides officials with solutions to problems. Big data analytics also increases opportunities for competitiveness, achieving new advantages and results, and increases opportunities for development and growth. Big data analytics helps in making correct decisions and increasing opportunities for predicting future. Big data analytics tools consist of three main tools: mining tools, analysis tools, and results presentation tools. Big data analytics used in managing beneficiary databases, developing human resources, and rationalizing spending policies (Mohammad, 2022: 3) .

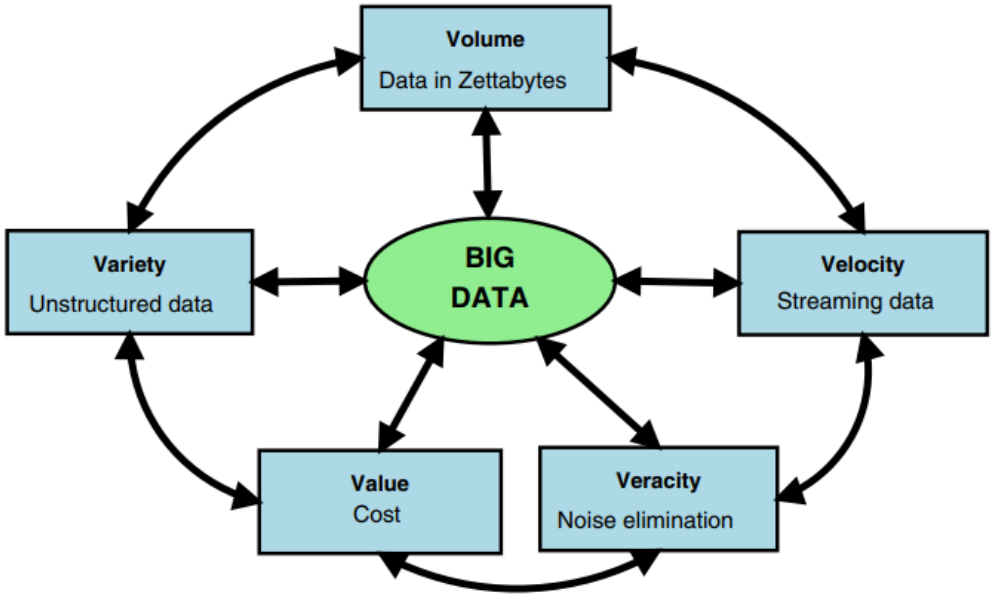
Big data is defined as a massive amount of data that requires new technologies and structures to enable value extraction through collection and analysis. Due to its enormous size, effective analysis using current traditional techniques becomes very difficult (Katal, A., et.al , 2016 :2) .

Big data also defined as data of a large size that cannot be processed by traditional methods and requires a degree of rapid processing and modern techniques to process it, while big data analytics defined as a complex process of examining large and diverse datasets or big data to uncover information including hidden patterns, unknown correlations, market trends, and customer preferences that help in making informed business decisions (Mohammed, 2022: 6).

Contemporary management thought has witnessed a radical shift in its view of "government data." It is no longer treated as a mere byproduct of bureaucratic processes, but rather as a sovereign strategic asset and a fundamental pillar for formulating evidence-based public policies. Big Data Analytics (BDA), defined as an artificial intelligence tool in public sector, is an integrated technological and knowledge system that relies on machine learning algorithms and predictive analytics to process government data characterized by well-known five attributes: massive volume, rapid flow, structural diversity, intrinsic value, and reliability [Mikalef et al., 2020, p. 102].

Term "big data" is primarily used to describe massive and diverse digital content, often unstructured, that is difficult to process using traditional data management tools and techniques. Recently, businesses, academia, and governments have shown interest in enormous potential of big data. However, main challenge facing IT researchers and practitioners is that rate of growth of this data is rapidly outpacing their ability to: design appropriate systems to handle data effectively; and analyze it to extract relevant meaning for decision-making. Consequently, it is essential to use tools and frameworks to effectively organize, manage, and analyze these datasets. Big data described using 5V model, illustrated in Figure (1) (Rodríguez-Mazahua, L.,et.al , 2016 : 2):

Figure (1): The 5V model that currently defines Big Data

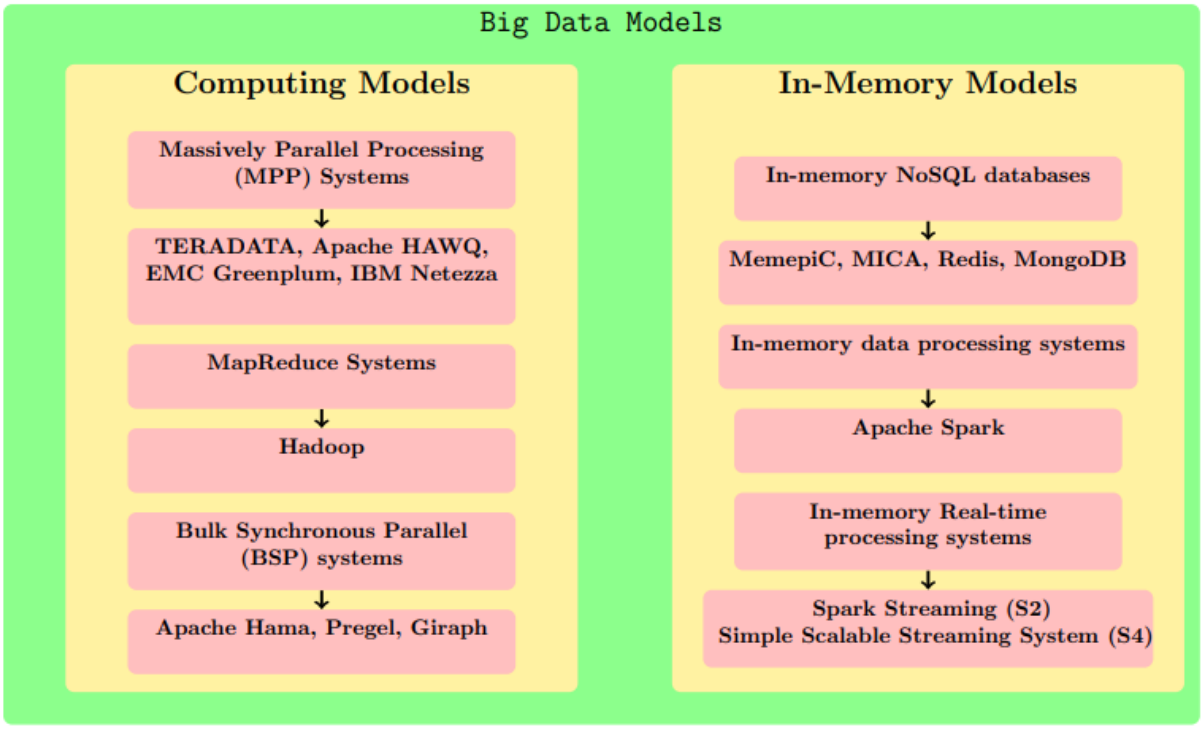


Source : (Rodríguez-Mazahua, L.,et.al , 2016 : 2)

2.2 Various types of big data models:

Big data models classified into four types: Massive Parallel Processing (MPP), MapReduce (MR) systems, Bundled Concurrent Parallel Processing (BSP) systems, and in-memory models. Figure)2(illustrates different types of big data models along with their frameworks. In these models, data is divided into partitions distributed across multiple servers, with each server having its own memory for local data processing (Rao, T. R.,et.al , 2019 : 5) .

Figure)2(: Various types of big data models



Source : Rao, T. R.,et.al , 2019 : 5

2.3 Importance of big data:

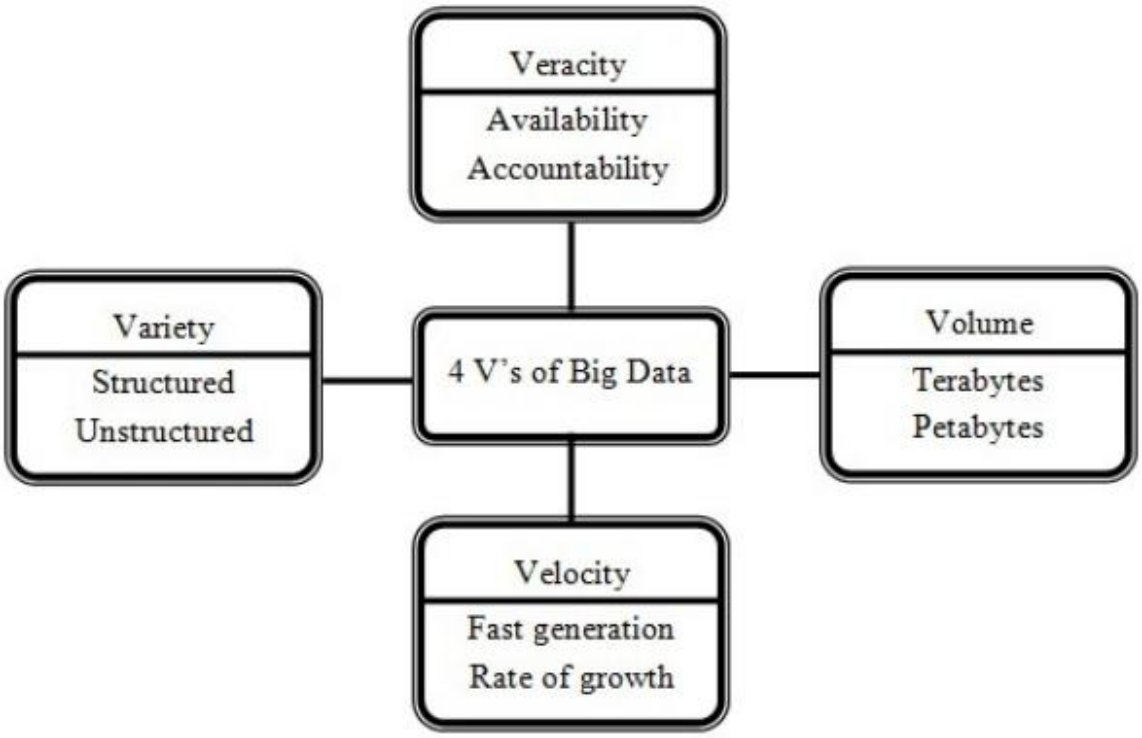
Big data gains its importance from its widespread use in various banking and government sectors. It also democratizes data work, providing numerous opportunities to generate value and new insights from massive amounts of data. The SAS Institute emphasizes that big data analyzed by organizations to identify new opportunities for providing smarter solutions, particularly in business sector, reducing costs, saving time, improving product development, making structural decisions, increasing profits, and helping companies identify root causes of failure (Mohammed, 2022: 24).

Importance of data science and big data analytics is rapidly increasing as organizations prepare to leverage their information assets to gain a competitive edge. Flexibility offered by big data analytics enhances both functional performance and overall organizational performance (Grover, P., & Kar, A. K. , 2017:2) .

2.4 Characteristics of big data:

Big data has numerous characteristics, some of which can be illustrated as shown in Figure (3).

Figure (3): Characteristics of big data



Source : Grover, P., & Kar, A. K. , 2017: 5.

2.4 Big data and technology:

Technological objective associated with big data in the public sector differs from that in the private sector; the goal is not to maximize profit, but to create "public value." The importance of adopting big data can be summarized in three strategic pillars. (Vial, 2019, p. 138; Twizeyimana & Andersson, 2019, p. 175):

- Resource optimization and predictive hedging: Protecting state's general budget from financial waste through accurate forecasting of actual consumption of essential commodities (such as wheat), and monitoring supply chains to prevent spoilage or monopolization.
- Eliminating sources of administrative corruption: Replacing need for algorithms and big data in auditing processes (such as automated review of company registration files or duplicate names in support networks) eliminates "subjective human element," which directly contributes to streamlining procedures and ensuring equitable distribution.
- Strengthening political and institutional trust: When citizens and businesses experience speed, accuracy, and transparency in their transactions, free from extortion and bureaucracy, "social contract" is rebuilt, and public confidence in efficiency and reliability of official state institutions increases.

Big data is closely linked to technology, which can be referred to within a conceptual synthesis that integrates two theories :

- Resource-Based View (RBV): This ory argues that Ministry of Commerce's possession of artificial intelligence tools and advanced software (tangible resources) is insufficient to achieve digital effectiveness, as technology is readily available and can be purchased. True value arises when this technology is combined with scarce and irreplaceable intangible resources, such as analytical skills of employees and an organizational culture that values digital evidence, creating a unique synergy that enhances efficiency of government performance [Vial, 2019, p. 125].
- Dynamic Capabilities Theory: Given that institutional environment in Iraq is characterized by turbulence and uncertainty (Environmental Dynamicism), this perspective explains how big data analytics contributes to building dynamic capabilities for ministry, which are represented in three dimensions: sensing market and household requirements, seizing import opportunities and combating corruption loopholes, and transforming administrative structures to become more flexible and digitally responsive (Vial, 2019, p. 125; Mikalef et al., 2020, p. 112).

2.5 Classification and requirements for big data:

United Nations Economic Commission for Europe classified big data sources to include: sources arising from management of a program – commercial or transaction-related sources arising from transactions between two entities – sensor network sources – tracking device sources – behavioral data sources – opinion-related data sources (Mohammed, 2022: 25).

Data characteristics include volume, velocity, variety, reliability, value, and variability, which explained as follows (Rao, T. R.,et.al , 2019 : 3) :

- Volume is amount of data collected in large datasets. Variability of large datasets depends on data structure and timing; that is, volume is size of different data types drawn from diverse data sources. Social media data (Facebook, LinkedIn, Twitter, etc.) is enormous.
- Velocity is rate at which data is received and processed for analysis. Data velocity is based on concept of data streams operating according to a sliding-window caching model. Social networks, such as Facebook and YouTube, generate continuous data streams through the sharing of photos and videos.
- Variety is a distinct type of data representation, such as structured, semi-structured, and unstructured data. Examples of structured data include relational data, tabular data, and electronic health record data.
- Credibility refers to biases, noise, and anomalies in data. Credibility issues arise from process uncertainty (randomness in process), data uncertainty (uncertainty in data inputs), and model uncertainty (approximate model).
- Value is another dimension of big data from a business perspective. Companies need to recognize value of big data to increase profits by reducing operating costs and providing better customer service.

Big data analytics requires a set of tools and software, divided into three categories (Mohammed, 2022: 30):

- Data mining tools: These tools deal with unstructured data such as text and user movements distributed across different devices via web.
- Analysis tools: These tools are used for comparison, classification, contrast, and correlation to obtain desired results.
- Results presentation tools: These tools are used to present final results of analysis in a visual and graphical format, according to previously defined analysis objectives.

2.6 Concept of Artificial Intelligence:

Artificial intelligence defined as the science that studies intelligent behaviors in living organisms and utilizes them through advanced computer software to perform intelligent tasks and functions that mimic those performed by humans, with aim of facilitating daily human life and for various other purposes (Ragee& Bouran,2024:5)

Artificial intelligence is also defined as a science that branched off from computer science, which undertook the task of simulating human intelligence, in its speed of understanding and skills in performing tasks, embodied in the development of programs and devices that perform tasks that replace human intelligence (Miftah, 2023 : 8) .

Researcher believes that artificial intelligence defined as (development of human use of technology that helps him accomplish his tasks since beginning of creation, relying on technology in all its stages of development, up to development of machine for its ability to think independently and to simulate mental thinking).

2.7 Characteristics of artificial intelligence:

Some of most important characteristics of artificial intelligence include (Ragee& Bouran,2024:5):

- Symbolic representation: AI programs use non-numerical symbols.
- Experimental research: AI programs focus on complex problems that can be solved using experimental research methods.
- Knowledge incubation and representation: AI programs must possess a large knowledge base that includes connections between cases and results.
- Uncertain or incomplete data: AI programs must provide acceptable solutions even when data is uncertain.
- Learning ability: AI programs must rely on machine learning strategies.

2.8 Types of Artificial Intelligence:

Artificial intelligence can be classified into three types (Ragee& Bouran,2024:6):

- Narrow (or limited) AI: This includes all contemporary AI applications and interactive machines with limited memory, without exception for systems that utilize machine learning and deep learning.
- General AI: This refers to ability of AI to learn, perceive, understand, and act like humans by imitating and mimicking human capabilities.
- Superintelligence: This is characterized by superior memory, speed in processing, analyzing, interpreting, and connecting data. Its development leads to technological singularity, surpassing human capabilities in guidance and control.

2.9 Challenges Facing Artificial Intelligence:

Artificial intelligence faces a number of challenges, including (Ragee& Bouran,2024:8) :

- Cost of innovation in this field.
- Lack of complete trust in artificial intelligence among many people.
- Poor data quality and the disappearance of some jobs.
- Occasional harm to human physical safety when interacting with robots.
- Limited privacy, especially when using data in health, security, and other sensitive areas.
- Sudden emergence of artificial intelligence and the need for its rapid adoption.

- Issues of data integrity and bias.
- Lack of transparency and potential for criminal and harmful use.
- Loss of individual freedom and independence due to constant machine surveillance.
- Conceptual evolution of big data analytics and artificial intelligence in public sector globally:

Based on preceding discussion, researcher observes that application of big data analytics and artificial intelligence in public sector undergone numerous intellectual and administrative transformations. It is no longer merely a tool to assist, but rather a driving force and catalyst for policy formulation and establishment of governmental digital sovereignty. This conceptual evolution, as reflected in recent literature, divided into three dimensions, as shown in following table:

Table (4) Conceptual evolution of big data analytics and artificial intelligence in the public sector globally

Third dimension	Second dimension	First dimension
Increasing ethical and moral dimension to include technical competence, ultimately leading to accountability of algorithms.	Transition from retrospective descriptive analysis to predictive and proactive analysis	Shift from e-government to AI-based government.
Global research in public administration has decisively shifted from studying service automation to examining ethical compliance, algorithmic fairness, and mitigating digital bias to ensure public trust in automated government decisions. This involves developing future strategies that balance reducing capital costs with respecting privacy and cybersecurity, recognizing big data as a sovereign strategic asset requiring flexible legislative frameworks.	Integration of artificial intelligence enabled governments to move towards "proactive policy analysis," such as predicting economic crises and targeting government support with high precision. Smart algorithms have been used to identify key variables and support the design of public policies to address major crises.	Integrating advanced statistical analysis tools with machine learning models to create flexible solutions for sovereign crises. This involves moving from processes based on fixed rules to adaptive systems that learn from data and predict user behavior.

Source : Kushmar et al., 2022, p. 294 - Fredriksson & Mubarak, 2026, p. 12-Al-Amri, 2024, p. 45 - Kouis et al., 2020, p. 641 - CiteSpace Analysis, 2026, p. 203 - Hamed & Ali, 2025, p. 88.

- Relationship between big data and artificial intelligence (AI):

Relationship between big data and artificial intelligence (AI) is complementary and symbiotic. Big data represents "raw material" and fuel upon which AI learns and develops, while AI represents "brain" and intelligent tool that analyzes this data and extracts valuable insights and knowledge . AI and machine learning algorithms would remain very limited without the intervention or exploitation of big data. There is a complementary or symbiotic relationship between them, and one cannot be studied in isolation. Big data becomes useless without intervention of AI programs and algorithms. There is also unstructured data, randomly generated from emails and social media, which cannot be analyzed or used to extract knowledge without AI and machine learning programs and algorithms (Abu Karaa, 2024:3) .

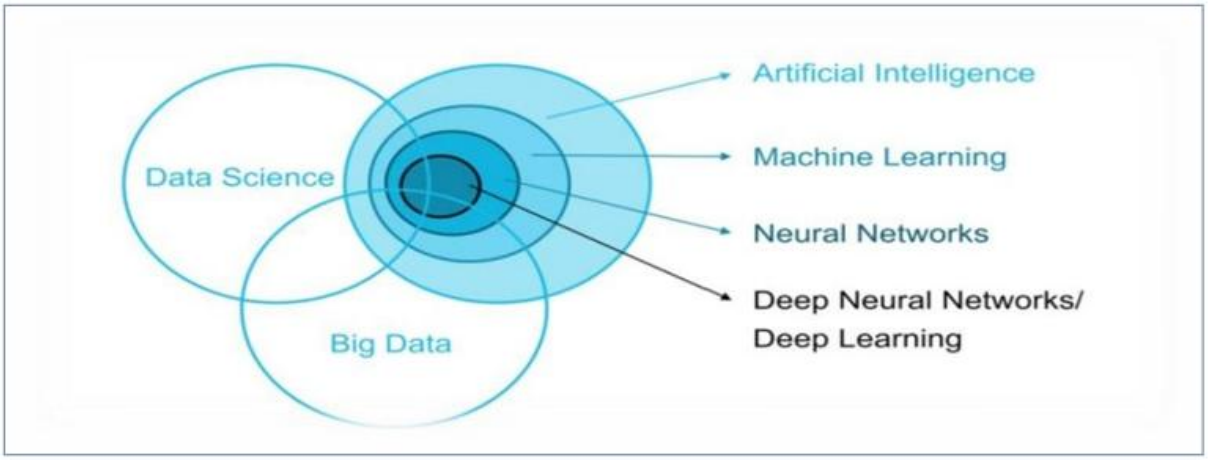
In accordance with sound global standards big data as a tool for artificial intelligence are divided into three complementary dimensions:

- Structural dimension of technology infrastructure: Infrastructure here is not limited to computer hardware, but also includes "cyber architecture of data." Effective digital transformation requires secure cloud computing platforms and software capable of handling unstructured data (such as text, barcodes, and X-ray images of shipments). Efficiency of infrastructure in public sector is measured by its "interoperability"; that is, ability of Ministry of Trade's systems to communicate in real-time and securely with databases of Ministry of Planning (employee ID number), Ministry of Interior (national ID card), and Central Bank (financial transfer platform) (Henseler, 2021, p. 145).
- Structural and analytical dimension of competencies and human capital: human element represents weakest or strongest link in government's artificial intelligence system. skills required in modern management journals are divided into two parts: hard skills, which involve Iraqi data scientists and programmers capable of building and developing customized predictive algorithms, and soft skills, which involve ministry's administrative leaders (directors general and decision-makers) possessing "active digital literacy" that enables them to read and interpret dynamic dashboards and translate statistical indicators into rapid supply and organizational decisions (Twizeyimana & Andersson, 2019, p. 172).
- Structural dimension of a data-driven organizational culture: Organizational culture is invisible engine of technology. In traditional bureaucratic environments, artificial intelligence tools face strong user resistance due to fear of losing power or exposing vulnerabilities. literature indicates that success of digital transformation requires replacing culture of "personal initiative and political patronage" with a culture of "digital institutionalization." When culture becomes data-driven, compliance with digital evidence extracted from AI algorithms becomes mandatory in determining eligible households for support, and authority matrix grants executives flexibility to innovate digitally without fear of rigid bureaucratic constraints (Podsakoff et al., 2024, p. 215).

(Ragee & Bouran , 2024:11) argue, relationship between artificial intelligence (AI) and big data is directly reciprocal; AI cannot exist without big data. AI requires data to build its intelligence and feed into its processing capabilities. The greater input to AI systems in form of big data, the more accurate results they achieve. This falls under two important elements for future of technology and business:

- Machine Learning: The vast amount of data allows machines to learn. The larger data volume, the more intelligent algorithms learn by classifying and analyzing data, identifying similarities, and making decisions quickly and accurately based on similar past experiences.
- Deep Learning: Data scientists realized that massive datasets can serve as a huge training set. Deep learning is a branch of machine learning, and following figure illustrates the relationship between AI and big data.

Figure (4) shows the relationship between artificial intelligence and big data.



Source : (Ragee& Bouran,2024:12)

3. Digital Transformation

- Conceptual framework for effectiveness of digital transformation:

Modern concept of "digital transformation effectiveness" in contemporary management thought transcends narrow view of "automation" or replacing paper transactions with electronic ones. Effective digital transformation in government institutions represents a "radical strategic re-engineering" of processes, human capabilities, and organizational culture, aiming to change how public services are generated and delivered to beneficiaries [Vial, 2019, p. 119].

Digital transformation refers to process of using digital technology to redesign traditional processes and services in a way that enables the delivery of flexible and rapid services to users. Its applications are not limited to digitizing content, but also include reconsidering organizational structures, modernizing infrastructure, and adopting predictive analytics and artificial intelligence (Jilani & Bouchta, 2026: 5).

Digital transformation also encompasses radical changes occurring in society, economy, and governments through modernization of governance and administration and use of digital technologies. This is particularly true regarding innovation, technology, digitization, transparency, order, and e-government(Avila, T. J. T., et.al , 2023: 4) .

- Factors and variables associated with digital transformation:

Research and studies included many factors and variables related to digital transformation, some of which can be illustrated as follows:

Figure (5) illustrates some of factors and variables associated with digital transformation.

Source: Prepared by the researcher based on the study: (Zaoui, F., & Souissi, N. , 2020: 4-5)

- Digital Transformation of Business:

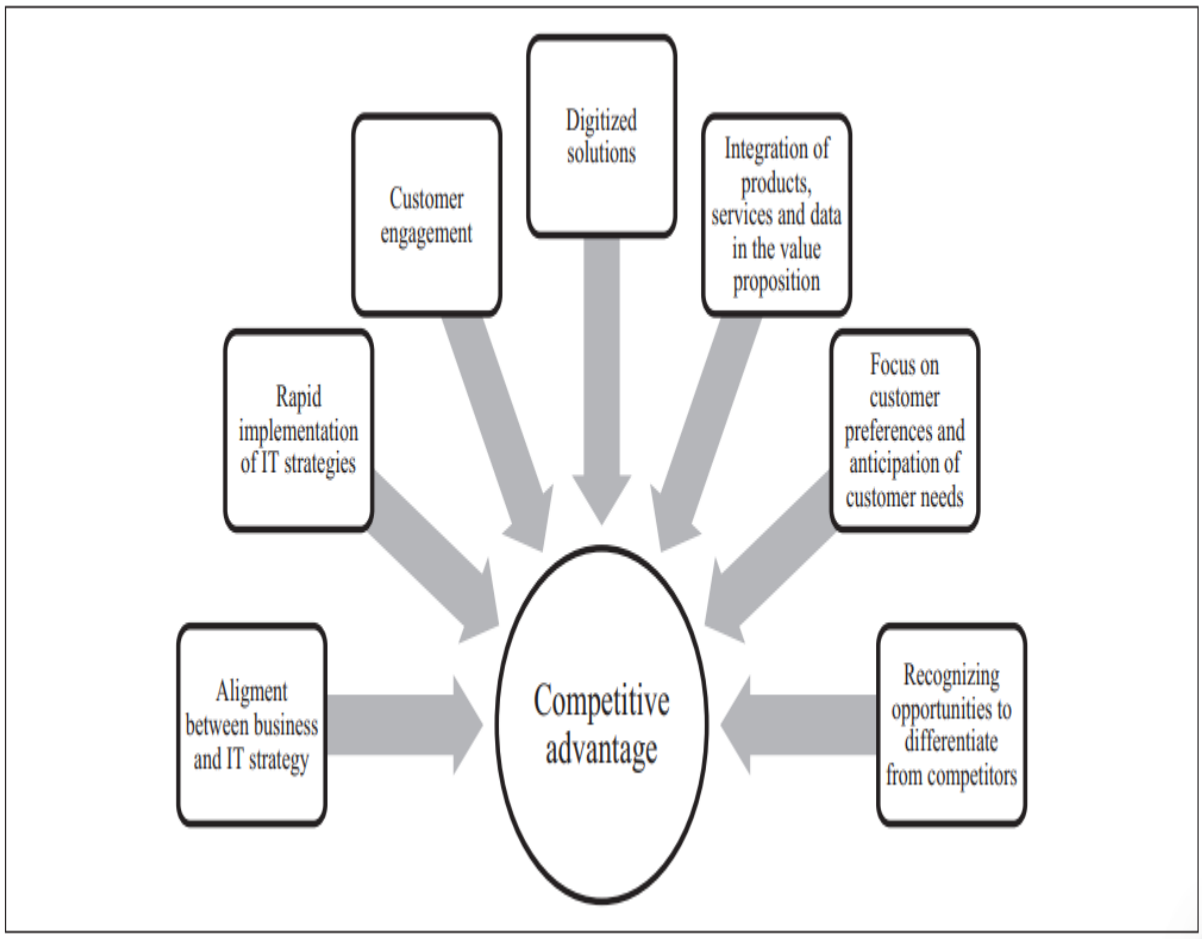
Digital transformation of business can be divided into two research areas(Kraus, S., et.al : 2021 : 7):

- Business Processes and Organizational Implications. This focus examines how business environment is affected by digital transformation. Digital technologies impact not only transformation of products, business processes, or sales, but also entire business models.
- Digital Interactions, Digital Distribution, and Digital Diffusion are trends that companies must prepare for as they face ongoing digital transformation. Increased digital interaction is essential given consumers' growing ability to create and interact with content at any time. Furthermore, increasing availability of open content

production technologies reduces barriers to content distribution. Therefore, controlling digital distribution is crucial, as content distributed across open-access digital communication channels. Similarly, leveraging digital diffusion means building networks based on communities of shared interests rather than geographical location.

following figure illustrates a combination of business strategies that can achieve a competitive advantage :

Figure (6) Combinations of business strategies that can yield a competitive advantage



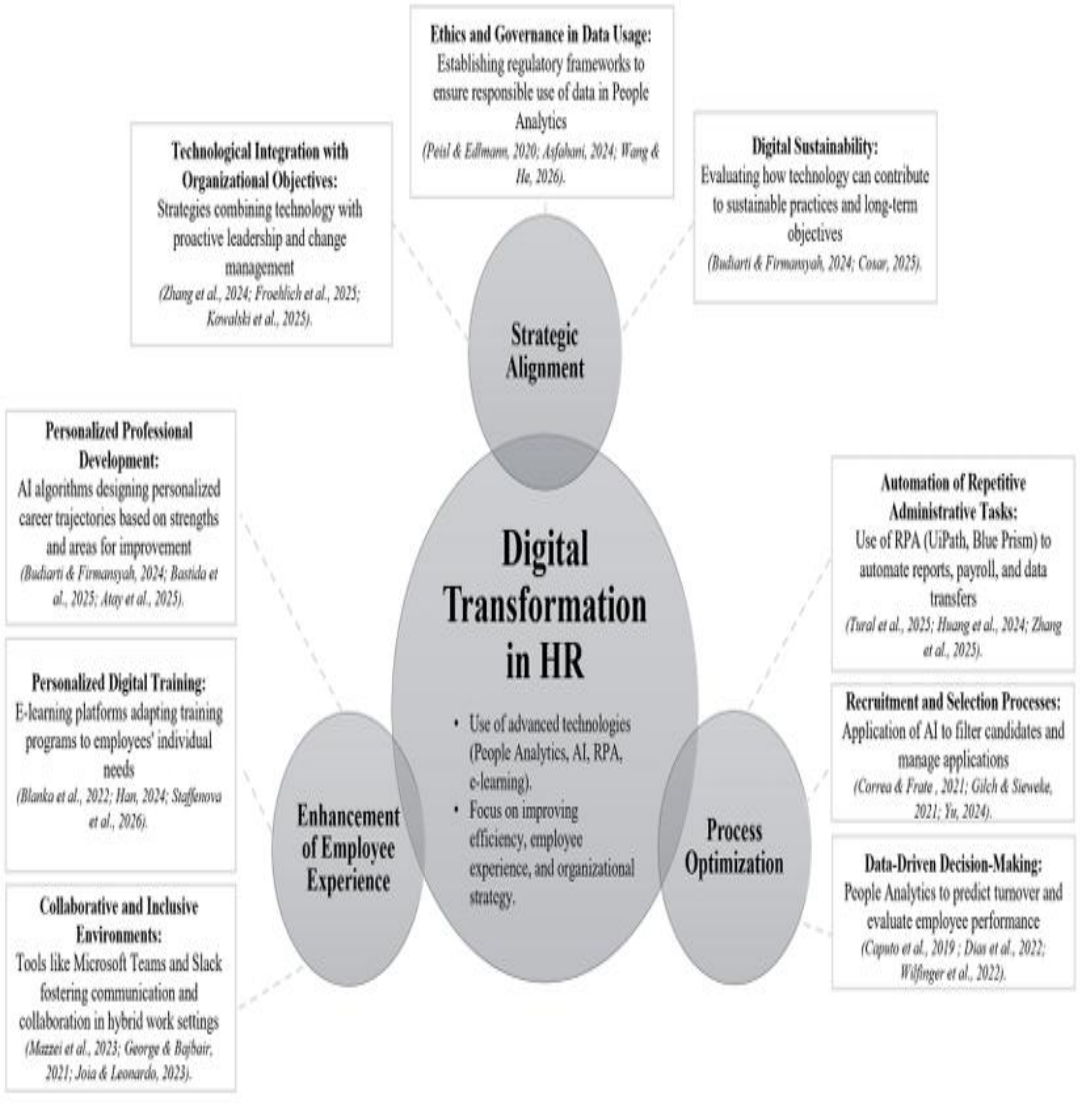
Source : Kraus, S., et.al : 2021 : 7

- Importance of Digital Transformation:

Among benefits of digital transformation (Al-Nasr, 2023:8):

- It helps in responding quickly to the needs of society and providing the best quality goods and services at the lowest possible cost via the internet. - It facilitates easy access to digitized data, including retrieval, searching, rapid access, and real-time availability for multiple people simultaneously, anywhere.
- Importance of using digital transformation is multifaceted, including in the field of human resources, as illustrated in following figure:

Figure (7) Cultural framework for digital transformation in human resources.



Source :Marchena-Sekli, G., & Godo, A. , 2026:13

- Elements and components of Digital Transformation Process:

Elements and components of digital transformation process include (Al-Nasr, 2023: 9):

- User Experience: Providing goods or services that align with users' digital lifestyles.
- Product Innovation: Using digital technologies to offer innovative goods or services.
- Strategy: The organization's strategy is based on leveraging the resources and capabilities of digital technologies.
- Organization: Organization aligns all processes with digital structures.
- Collaboration: Organization uses digital technologies internally to support and enhance communication, coordination, and collaboration.
- Information and Communication Technology (ICT): The organization utilizes ICT infrastructure to enable users to purchase, use, and benefit from goods and services electronically.
- Culture: The organization's openness to and understanding of digital technologies and the acquisition of related skills.
- Transformation: From traditional, paper-based management to paperless, remote, or electronic management.

- Challenges of Digital Transformation:

Digital transformation in various institutions and sectors faces several key obstacles that hinder its rapid implementation. These include employee resistance to change, a shortage of specialized digital skills and personnel, weak technological infrastructure, cybersecurity and data protection challenges, high financial costs, and the absence of a clear management strategy.

Systematic use of data, statistical models, and algorithmic tools to support human resource decision-making is one of the most important, and simultaneously, one of the most questionable, applications of digital data in HR. Tracking evolution of HR information systems through real-world analytics platforms reveals that, despite growing technological capacity for data-driven HR decisions, professional skepticism and cultural resistance within HR departments continue to slow adoption of these technologies. Integrating big data and advanced analytics into HR control processes delivers tangible improvements in efficiency and cost, although it requires significant investment in both technological infrastructure and change management. Design, development, and testing of HR analytics to support people-centric transformation demonstrate how structured data visualization tools translate complex workforce data into actionable management insights. Documenting the application of decision tree-based data mining systems for analyzing employee data and integrating machine learning techniques into HR management systems enables more accurate and scientifically informed workforce decisions (Marchena-Sekli, G., & Godo, A. , 2026:5) .

- Critical analysis of determinants of digital transformation (infrastructure, human skills, organizational culture) based on findings of studies:

From foregoing researcher concludes that contemporary management thought shifted its focus from determinants of digital transformation to "discrete or linear" elements, treating them instead as complex, interactive units. Contemporary critical analysis demonstrates that simply providing technology does not guarantee success unless underlying human and cultural behaviors within organization are deciphered. Traditional management has long viewed infrastructure as sole cornerstone; however, recent scientific reviews have proven otherwise.

(Khatir & Madani, 2026, p. 301) argue that digital administrative performance demonstrates that infrastructure is a “deceptive” partner; it is a prerequisite for starting but does not possess any single explanatory power to achieve a real transformation unless standardized professional practices intervene to turn those devices into added value.

literature also confirms that skills barrier does not lie in “inability to learn,” but rather in “flexibility to adapt to continuous change.” Organizations fall into trap of providing dry and temporary technical training courses, forgetting “cognitive agility” that enables employee to lead self-change (Plekhanov et al., 2025, p. 55).

Organizational culture also represents most critical and stubborn determinant. A literature review (Al-Malki, 2026, p. 5) shows that "resistance to change" stemming from bureaucratic culture and fear of losing power or job (due to automation) is rock on which latest digital infrastructures are shattered.

- Integrating Big Data, Artificial Intelligence Technologies, and Digital Transformation in the Iraqi Ministry of Trade :

Integration of big data, artificial intelligence technologies and digital transformation in the Iraqi Ministry of Trade, along with recommendations and implementation mechanisms to serve decision-makers in the Iraqi Ministry of Trade, can be illustrated in the following table :

Proposed goals	**Proposed recommendation**	**Mechanisms for implementing recommendation in Iraqi Ministry of Trade**
Superior impact of human capital: Human and analytical skills can help influence the quality and reliability of digital public services for the public.	Intensive and targeted investment in building digital competencies and analytical human capital is far less about an exclusive focus on physical purchase of technology [Twizeyimana & Andersson, 2019].	Establishing a Data Science Unit directly under Minister's office. Establishing academic partnerships with leading Iraqi universities to offer intensive professional diplomas for Ministry staff in fields of predictive analytics and machine learning. Creating special financial and career incentives to attract qualified data programmers and engineers and prevent their departure to the private sector.
Need for real-time connectivity and exchange: technological infrastructure for data has had a significant positive impact on increasing efficiency of operations, shortening time, and streamlining supply chains.	Migrating infrastructure from isolated data silos to a unified cyber platform environment to enhance interoperability and connectivity [Henseler, 2021]. Activating common application programming interfaces (APIs) for real-time integration with Ministry of Interior's databases (Unified Card) and Planning Authority's databases (Employee Number and Poverty Surveys) for continuous automatic purging of ration card databases and removal of fictitious names.	Building and activating a secure, instant, cloud-based network linking platform between the Ministry's headquarters and its affiliated companies, such as Grains Trading company, Foodstuffs Trading Company, and Companies Registration Department.
Digitalizing anti-corruption efforts: A data-driven organizational culture contributes significantly to enhancing governance and integrity and reducing channels for administrative manipulation.	Institutionalizing administrative procedures and eliminating discretionary and capricious power of human element through introduction of algorithmic auditing [Vial, 2019].	Develop and build intelligent predictive dashboards for senior management to accurately monitor strategic food stock levels and real-time company registration activity. Make outputs of digital algorithms legally and procedurally binding in determining families eligible for

		financial and in-kind support, thus preventing any misappropriation or appropriation of resources by special interest groups. Build immutable, cyber-based electronic audit trails to track transaction activity and hold accountable any technological breaches.

Based on foregoing, researcher concludes that research findings summarized in three main axes:

First axis: Conceptual development of big data analytics and artificial intelligence in public sector globally:

Conceptual development of big data analytics and artificial intelligence in public sector globally witnessed a gradual shift from traditional bureaucratic management to evidence-based, smart digital governance. Initially focused on electronic archiving, concept evolved to encompass policy forecasting and real-time improvement of public services.

Second axis: Critical analysis of determinants of digital transformation (infrastructure, human skills, organizational culture) based on the findings of previous studies:

Digital transformation is not merely about acquiring new technologies; it is a comprehensive change process based on three key, integrated pillars: technological infrastructure, human skills, and organizational culture. Studies have shown that deficiencies in any one of these pillars can hinder transformation efforts.

Third axis (contextualization): Critical application of findings from literature to context of challenges facing Iraqi Ministry of Trade (such as the ration card system and company registration), and presentation of a proposed conceptual framework tailored to Ministry based on identified best practices:

In contemporary management thought, digital transformation is no longer simply about replacing paper transactions with technology. Its concept has undergone a radical shift thanks to integration of big data analytics and artificial intelligence. Recent studies indicate that " true strategic value of these technologies only emerges when they are integrated into core of strategic planning and good governance systems, rather than being treated as isolated operational tools." This conceptual development demonstrates that digital transformation requires a comprehensive re-engineering of the public service delivery model to achieve efficiency, transparency, and accountability. Practical reality of Iraqi Ministry of Trade's ration card system reveals that it involves a database of millions of people and complex distribution processes. This system faces structural challenges related to bureaucratic resistance to change, weak institutional coordination, and a lack of software integration between ministries. Integration of data analytics and artificial intelligence can help provide predictive data and utilize machine learning algorithms to automatically detect duplicate entries, deaths, and travel-related cases, thus directing support to its rightful beneficiaries. It can also facilitate smart supply chain management. Predicting food demand and monitoring inventory to reduce waste and ensure smooth distribution, in addition to necessity of automating legal and financial due diligence using artificial intelligence to process massive amounts of documents, contracts, and paperwork with unprecedented speed, thus shortening company formation time. Furthermore, combating money laundering and shell companies by linking big data analytics to investor files to automatically detect suspicious financial patterns and shell companies is crucial for protecting national economic security.

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