DIGITAL TRANSFORMATION - KEY DEFINITIONS AND CONCEPTS

Reference: Umar, A., "Computer Aided Strategic Planning of Digital Enterprises – Concepts, Methodology and a Toolset for Digital Transformation", NGE Solutions Publication, July 30, 2020

1 Basic Definitions

Simply stated, an enterprise is a group of people with an overall and common goal or set of goals. An enterprise, also known as an organization or a firm, can be formed by at least two people but most enterprises consist of hundreds and even thousands of people. Our focus is on *digital enterprises* and *digital services* in public as well as private sectors.

- ***Digital Enterprise:*** An organization that heavily uses digital technology as a competitive advantage in its internal and external operations [Ruppa 2017, Streibich 2013]. Specifically, it is an "organization where nearly all significant business processes and relationships with customers, suppliers, and employees are digitally enabled and key corporate assets are managed through digital means" [Laudon & Laudon 2015].
- ***Digital Service:*** A business service that is delivered through digital technologies such as the Internet, world wide web, databases and mobile handsets. For example, online advertising and purchasing services over the web and mobile devices are digital services. Basically, a digital enterprise offers a set of digital services to its customers. The scope of digital services is being considerably expanded due to the advent of Internet of Things (IoTs) and Web of Things (WoTs); therefore, almost *everything* can be a digital service.
- ***Digital Technologies:*** These are the technologies that use digital information (0 and 1) only. The main power of the digital information is that it can be easily read, written and transferred by using computer programs. For example, a digital camera takes a picture where the images are represented in terms of bits (0 and 1). Thus, a program can make the picture bigger, smaller, change the colors, etc. Currently, the following technologies are of fundamental importance to digital enterprises and services:
    - Global digital networks
    - Web technologies
    - Mobile applications
    - Database and Big Data technologies
    - Artificial Intelligence (AI) based smart systems
    - Security technologies such as encryption techniques
    - Additional technologies such as 3D printing, nano technology, wireless mesh networks, biotechnology, and augmented/virtual reality (AR/VR), etc

2.2 Examples of Digital Enterprises: eBusiness, eCommerce and eGovernment

eBusiness, eCommerce, and eGovernment are legacy terms but still heavily used for digital enterprises. Let us start with a definition of *e-business*, also known as ebusiness and electronic business, and discuss how it is related to e-commerce, also known as ecommerce and electronic commerce. Simply stated, *e-commerce (EC)* is buying and selling over the network (mostly Internet) while *e-business (EB)* is conducting business, including buying/selling, over the network (mostly Internet). Thus EB subsumes EC (see Figure 1).

EB = EC + other activities such as conducting meetings, developing software and managing customer relationships.

eGovernment (also known as eGov, e-Government, electronic government, digital government, or online government) uses digital technologies between a government and its citizens, employees, other government agencies and related businesses. These digital interactions occur at all levels of government (city, state/province, national and international levels). As shown in Figure 1, there is some overlap between ebusiness, ecommerce and egovernment. This is mainly because many government operations (e.g., paying employees, advertising, and human resources) are similar to their counterparts in business. A good example egovernment is Smart Cities initiatives heavily use digital innovations to improve the lives of its citizens.

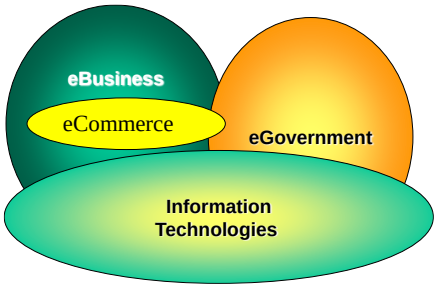

Figure 1: e-Business, e-Commerce and e-Government

2.3 Classification of Digital Enterprise Services: C2B, B2B, and B2E

Services in modern digital enterprises are used by the customers, employees, and the business partners, as shown in Figure2:

- **Business to Customer (B2C):** services that are used by the customers. Examples of these applications are online-purchasing and web advertising.
- **Inter-enterprise (B2B):** services that are used between businesses. These services are used to exchange orders, products, and payments between companies in B2B trade. Supply chain management and financial exchanges are examples of B2B services.
- **Internal (Business to Employee – B2E**): services that support the employees of the enterprise. Human resource applications such as payroll are good examples of B2E services.

The view presented in Figure 2 can be easily mapped to egovernment view by simply changing the "Business" to "Government" and "Customer" to "Citizen". Thus the eGovernment services can be briefly summed up as:

- G2C (Government to Citizens)
- G2E (Government to Employees)
- G2G (Government to Governments)
- G2B (Government to Businesses)

We can also introduce the following refinements to capture different models:

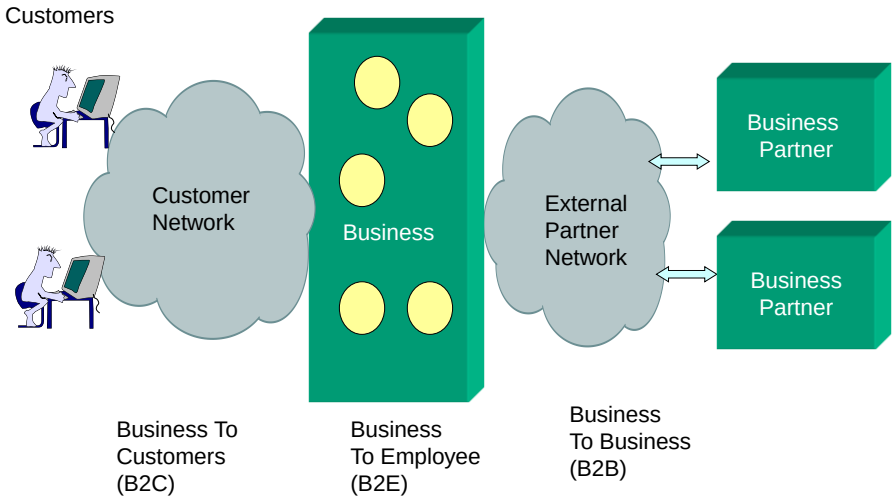

Figure 2: Digital Enterprise Services - High Level View

- Big "B" to small "b" to capture the differences between large and small businesses. Interactions between large businesses (B2B) versus large to small business (B2b) differ greatly. For example, interactions between Walmart to Sears (B2B) are quite different than the interactions between Walmart to a small clothing manufacturer in Malaysia (B2b).
- Big "G" to small "g" to capture the differences between large to small government agencies. For example, interactions between US Homeland Security and Immigration Department (G2G) are quite different than the interactions between the Homeland Security to a small city police department (G2g).

We can, of course, go crazy by considering g2g, b2b, g2B, G2b and other such variations. However, each variation can be used to model different types of interactions.

2.4: The Stage Model of Digital Transformation

Simply stated, the use of digital technologies in business and government has gone through several stages of evolution that have transformed brick and mortar companies to next generation of digital enterprises. **Error! Reference source not found.** 3 shows a view that casts this evolution into the following broad stages.

- **Stage 0: Brick and Mortar Enterprises.** Organizations in this stage practically use no digital technologies. Many organizations in the rural areas of developing countries fall into this category.
- **Stage 1: Simple Web sites for Advertising.** The basic idea is to use the Web sites to display /advertise company products. All other company operations are largely unaffected. For example, a restaurant can just display its menu on a website for advertisement.

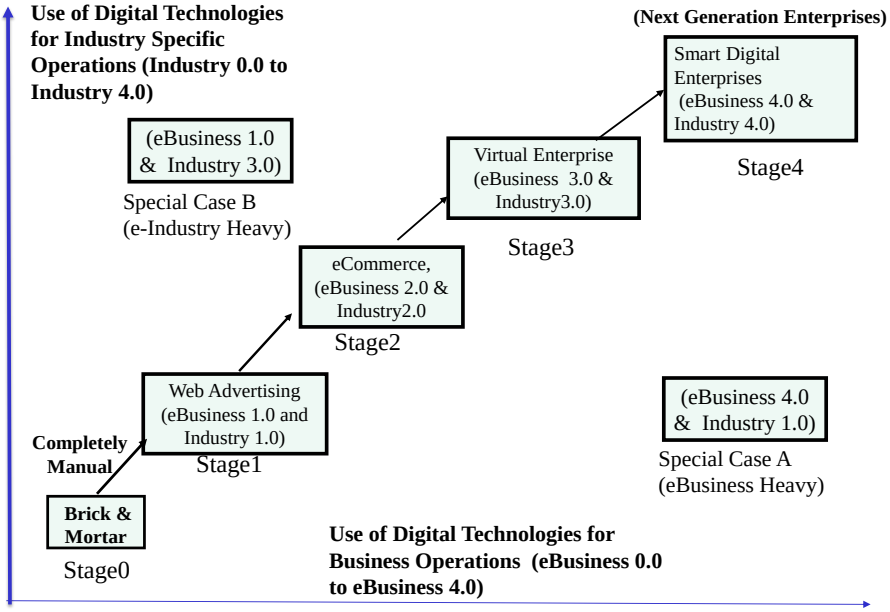

Figure 3: Stages of Digital Transformation: Brick and Mortar (Stage0) to Next Generation of Smart Digital Enterprises (Source Umar [15])

- **Stage 2: eCommerce sites.** In this stage, the enterprises use digital technologies for online purchasing and other business operations. The company does use some digital technologies in manufacturing operations (e.g., logistics and supply chains).
- **Stage 3: Virtual Enterprises.** In this stage, the enterprises use digital technologies heavily for most business operations and perform B2B operations over the Web (virtual enterprises). The company does use digital technologies in manufacturing operations (e.g., CAD, CAM, some

robotics, logistics and supply chains). In this stage, digital technologies take a central role in gluing services across almost all organizational units spanning multiple organizations.

- **Stage 4: Next Generation Enterprises** (Smart Enterprises and Manufacturing 4.0). This stage goes beyond stage 3 and fully exploits the latest digital technologies to quickly detect, adjust & learn in a highly competitive marketplace. The digital infrastructure *drives* all the company business and manufacturing operations in this model. NGEs are the ultimate in digital transformation and they push the limits of digital technologies in their sectors. M4.0 is NGE in the manufacturing sector.

How to Use the Stage Model to Guide a Transformation Strategy

Figure 3 shows how companies *should* ideally evolve from Stage0 to Stage4 by keeping the X and Y dimensions in balance, i.e., automate business and industry specific operations in-step. This is an important rule of thumb that can be used to guide organizations on the desired evolution path. Consider, for example, the following "undesirable" instances that are overemphasizing business or industry automation, respectively:

- CaseA (eBusiness Heavy): A textile mill, for instance, that heavily utilizes web portals and digital marketing in business processes but still relies on purely mechanical machines (Industry1.0) in manufacturing operations. Such a company could greatly benefit from inkjet and other digital printing technologies that quickly produce the colors and shapes that are much more sophisticated than the old textile mills. This could be highly beneficial in a competitive marketplace.
- CaseB (e-Industry Heavy): A defense contractor in UK or Germany may heavily utilize Industry4.0 on the factory floor to build advanced weapon systems but may use legacy systems in their business operations. Such a company could greatly benefit from cutting edge digital technologies to support Smart Customer Relationship Management (CRM) systems for marketing its products and services to potentially new customers. Smart CRM systems support features such as contact management, opportunity management, sales analytics and sales forecasting

Important: This model can be used to determine what stage an organization is in and what is next. It can be used in almost any enterprise in the eCommerce, eBusiness and eGovernment space.

2.5: Eight Dimensional Model of Digital Technologies

We have selected certain basic dimensions of digital technologies that define our reference multidimensional space shown in Figure 4. This analysis proceeds by mapping various configurations of enterprises to regions in this space. With each attribute, we associate a set of discrete values, {Low, Medium, High}, based on an informal estimation. In this model, enterprises conduct business by exploiting the following eight major trends displayed in Figure 4 (starting from Web and going clockwise):

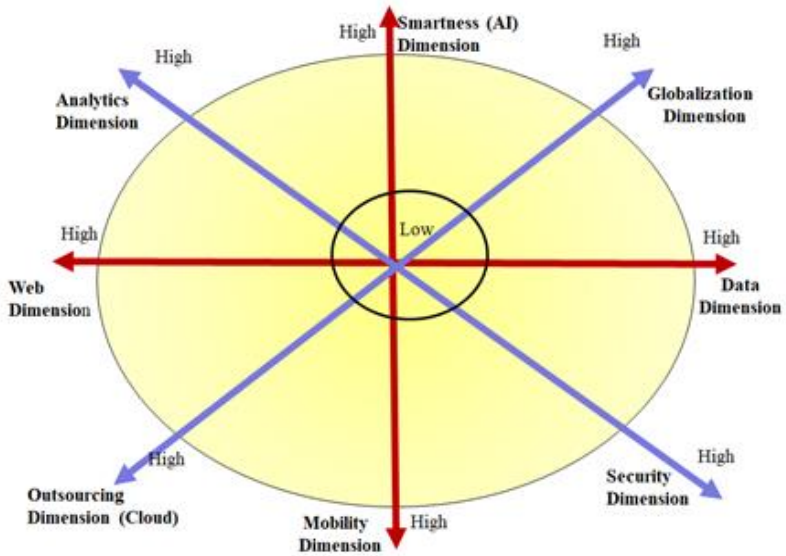

Figure 4: Eight-Dimensional View of Digital Technologies

- **Web (W)** dimension that indicates the use of Web technologies at three levels: Low (Basic Web usage for advertising), Medium (eCommerce for buying and selling), and High (Social Media, Internet of Things and Web of Things).

- **Analytics (A)** dimension represents the use of analytical techniques at three levels: Low (Descriptive Analytics for visualization), Medium (Predictive Analytics for forecasting), and High (Prescriptive Analytics for optimal investments and decision support).

- **Smartness (S)** dimension represents the use of AI techniques at three levels: Low (quickly detect events and trends), Medium (agility to respond to changing business conditions), and High (learn from the past experiences to do a better job in the next round by using Machine Learning and Deep Learning).

- **Globalization (G)** dimension deals with widely dispersed sites that are interconnected through the broadband global digital networks. Use of digital networks could be at three levels: Low for local businesses and small shops, Medium for regional businesses, and High for large global enterprises such as IBM and GE. Global businesses that operate in multiple countries deal with many regulatory issues.

- **Data (D)** dimension represents the use data technologies at three levels for internal as well as external business decisions: Low (Excel spreadsheets), Medium (Database Management Systems such as Oracle) and Large (Big Data Warehouses for business decisions).

- **Security (S)** dimension, that also includes blockchains, represents the use of security technologies at three levels: Low (Basic Security with ID-PW), Medium (Enterprise Security packages from Microsoft, Norton and others), and High (Security Solutions with extremely high levels of security and accountability measures needed for financial institutions, government agencies and defense organizations). Blockchains could be used in such organizations.

- **Mobility (M)** dimension represents the use of mobile devices and apps at three levels: Low (2G supported networks and mobile apps), Medium (3G supported networks and mobile apps that include short range

wireless sensor networks and IoT (Internet of Thing) devices), and High (5G supported networks and mobile apps that include augmented and virtual reality (AR/VR)).

- **Outsourcing (O)** dimension represents the use of cloud services for outsourcing at three levels: Low (only a few business operations are outsourced to the cloud), Medium (cloud providers are used extensively for outsourcing many business assets) and High (all business assets are outsourced to clouds and the enterprise exists in the cloud).

These eight technologies (Web, Analytics, Smartness, Global Networks, Data, Security, Mobility, and Outsourcing) faithfully capture a very large number of digital enterprise models. For example, Figure 5 displays how a company has transitioned from Stage1 to Stage3 and now is entering Stage4 (high use of analytics and mobile access). Figure 5 could also roughly represent the evolution of Ahmed's Tailoring shop, introduced in Exhibit1, from 1980s to early 2000s.

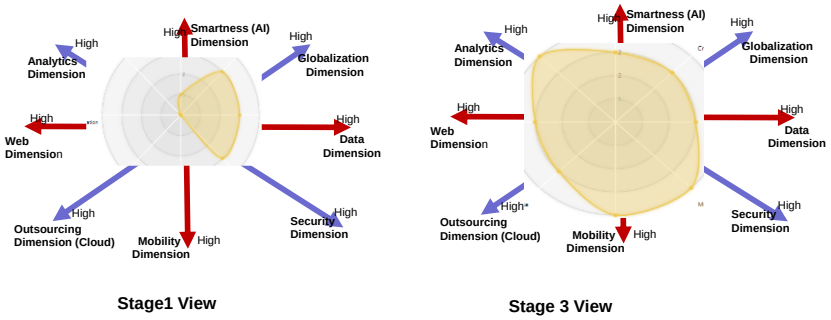

Figure 5: Dimensional View of an Evolving Company

These eight dimensions also capture the essence of large number of smart cities and communities' initiatives that rely heavily on security (with blockchains), analytics and outsourcing. While more dimensions can be always added, it seems that these 8 dimensions are good enough for our purpose: to represent the essence of most digital enterprises in a simple yet elegant manner. The main idea is that NGEs lie at the outer edges of this model and thus represent M4.0 enterprises. As M4.0 push simultaneously towards these dimensions, they dramatically increase their reliance on a complex array of digital technology services. In fact, the digital infrastructure starts driving the business strategies. As displayed in Figure 5, this simple model can be used to characterize an overall profile of a M4.0 enterprise and can also display how a given enterprise can evolve over time from an initial inner circle (M1.0) to the outermost (M4.0) over the years.

From Digital to Smart Enterprises: As the enterprises push towards these four dimensions, they not only dramatically increase their reliance on digital services but also change the situation where the digital infrastructure starts driving the business strategies. In addition, new issues in planning, integration, security and administration arise. In particular, NGEs need to plan and integrate their digital services quickly and correctly to compete and survive. This simple model can be used to characterize an overall profile of a digital enterprise and can also display how a given enterprise can evolve over time from an initial inner circle to the outermost "smart" circle over time.

Exhibit1: Smart Systems, Cities and Enterprises – Pushing Digital Technologies to Their Limit

The basic idea is that smart systems (smart people, smart cars, smart cities, smart enterprises, etc) must exhibit four key features of human intelligence shown in Figure 5 (this concept is roughly based on the IBM Smarter Planet Initiative):

- Knowledge (K): familiarity and awareness or understanding of someone or something
- Detection (D): ability to discover, sense or feel a situation such as problem or opportunity
- Adjustment (A): ability to change accordingly, e.g., stop and choose a different strategy

- Learn (L): the capability to gain more knowledge and to use the knowledge to do a better job in the future

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Let us use the example of an autonomous vehicle (smart car) to illustrate this concept. Specifically, a smart car must have the following capabilities:

- *Know* about driving, i.e. possess the knowledge and familiarity, awareness and understanding of driving a car at the level of a licensed driver.
- *Detect* a situation, i.e., an event, an opportunity, or a threat. For example, the car must be able to detect rain, snow, a pedestrian, a downhill slope, or a blocked road.
- *Adjust* according to the situation, i.e., stop on a red light and for a crossing pedestrian. Adjustment involves developing plans of action based on alternative analysis and requires reasoning (i.e., inferences) based on rules. For example, if it is raining and the car is on a downhill slope, then slow down.

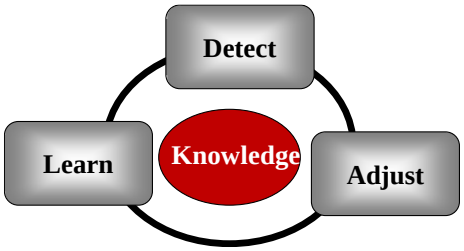

Figure 5: KDAL -- Key Metrics of a Smart System

- *Learn* to do it better in the next round when a similar situation arises. Basically, the smart car should be able to *automatically* acquire knowledge (new things, new relationships between things, and new rules), retain knowledge and remember (through short term memory, long term memory, persistent memory), and update knowledge (revise things, revise relationships between things, and revise rules).

Although additional capabilities can be added, we will use this Know-Detect-Adjust-Learn cycle to characterize smart services and enterprises. For example, a Smart Environmental Protection Service will have the following KDAL capabilities:

- Know about the pollution levels that are dangerous to human beings
- Detect pollution concentration in city streets when the pollution rises to a dangerous level
- Adjust the system to trigger alarms and even shut down some sources
- Learn what caused the pollution to prevent it in future

In the same vein, Smart Enterprises and Smart Cities should know about the needs of their populations, detect when the needs are not being met, adjust to meet the needs and also learn to do it better in the next round. An interesting example is how machine learning and data-driven smart marketing is revolutionizing the travel industry.

Thus *Smart Global Enterprises* have the needed KDAL capabilities: knowledge (K) about their enterprise at global level and also have the ability to quickly detect (D) problems as well as opportunities in globally distributed operations, adjust (A) quickly to handle the detected situation, and learn (L) how to do it better in the next round by using the latest developments in AI, big data, and IoTs. The core systems that support smart global enterprises are in fact a network of interconnected systems that operate at global levels. For a global enterprise such as Walmart, inventory shortages of blue jeans in Hong Kong impact blue jeans sales in Chicago, supply chain delays of brown sweaters from Singapore directly impact inventory levels of stores in Detroit; and problems in shipping of items purchased in Egypt result in customer complaints living in California who expected the items before Christmas.