

Temporality foundations impacting the speed of change in digital transformation

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Abstract—Digital transformation (DT) refers to changes to organizational properties that are shaped by the application of digital technologies. Extant studies on DT have largely focused on which properties are changed and the extent of the changes. Not much attention has been paid to the temporality dimensions of DT. This paper suggests that the number of properties impacted, the level of an organization’s digital technology capability, and the order in which changes are implemented may influence the speed of DT. Additionally, this paper also points out that the strength of the interdependencies among organization properties can also affect the duration of DT. The implications of the study are also discussed.

Keywords—digital transformation, digital technology, temporality, existence interval

I. INTRODUCTION

There has been a growing interest in DT in the last decade. DT results in significant organizational changes through the application of digital technologies [1]–[3]. The changes to the organization reshape the value propositions and alter value creation mechanisms [4]. The length of time over which DT unfolds is regarded as its existence interval [5]. This existence interval is determined by how the changes to organizational properties occur. The way these changes transpire constitutes the temporality of DT. This study aims to explore the temporality foundations of DT. While DT has been around for a while now, exploring its temporality foundations can generate new insights into how the DT phenomenon changes over time.

The speed of change is one of the most important dimensions of any transformation. Yet, of the characterizing properties of DT [1], the speed of change has received little attention. Even though the speed and scope of change have been used to classify the type of change [6], there is little theorization on what affects the speed of that change. While digital technologies can be efficient antecedent mechanisms for bringing about change [2], how quickly the change is accomplished can affect an organization’s competitive advantage. The speed of change is measured by the existence interval of phenomena [5] which in turn is affected by the number of properties that are bracketed as part of that change [7]. Hence, the question we seek to address in this study is: *What are the temporality foundations of DT and how can these temporality foundations account for the speed of change?*

To explore the speed of change, it is important to first understand what ‘change’ entails. This study tackles DT from the two temporal dimensions of change as an accomplished event and change as distinguished by its indivisibility, fluidity

and open-endedness [8]. DT as an accomplished event focuses on the attainment of expected outcomes [9]. That is, unless the expected outcome is attained, then the DT process cannot be said to be complete. Open-endedness suggests that DT is a continuous process [10]. The fluidity of changes connotes that it can be difficult to point out the exact moment when the change occurred.

This paper makes the following contributions. We propose that DT has three temporality foundations. First, the speed of change is impacted by the number of organizational properties that are impacted by digital technologies. While DT strategies are often crafted to guide the DT process [11], the exact number of properties may not be known ex-ante. Second, the temporality of DT is controlled by the level to which an organization’s digital technology capabilities have been developed [12]. An organization with well-developed and matured digital technology capabilities may complete its DT process quicker compared to other organizations whose digital technology capabilities are nascent. Third, the order in which organizational properties are impacted by digital technologies affects the overall speed of DT. Loose coupling between organizational properties means changes to an organizational property may not be impeded by the relationship that it has to other properties. Strong coupling may negatively affect the speed of DT. As such, this paper contributes to the literature on DT [1]–[3] by highlighting aspects that may affect the speed of change [7], [8], [13].

The rest of this paper is structured as follows. In the next section, we discuss the concepts of DT and temporality. This is followed by a highlight of the temporality foundations of DT. After that, we discuss the implication of this study before concluding with an overview of the contributions of this study.

II. THEORETICAL BACKGROUND

A. Digital transformation

DT refers to changes to organizational properties that are triggered and determined by digital technologies [2]. Digital technologies include analytics, the Internet of Things (IoT), artificial intelligence and blockchain [9], [11], [14]. The organizational properties that are transformed include value proposition [3], [4], value creation [15] and structure [12]. The significant changes to organizational properties through digital technologies are denoted as the scope of change [1].

The scope of changes can be incremental or radical. Incremental changes denote minor yet significant improvements to organizational properties. The alternative terms evolutionary and transformative have been used to

characterize the nature of changes [6]. Evolutionary change indicates incremental improvements in all areas of an organization. Transformative change entails radical changes resulting in fundamentally different routines and structures for an organization. However, some studies contend that only radical changes should be characterized as DT [9]. This concurs with the view that DT changes the identity of an organization [3].

The alteration of processes and capabilities with digital technologies affects how an organization creates and delivers value [16]. Hence, DT is associated with major business improvements in three organizational activity areas: business model innovation, product development and changes in technology that shape DT [17]. Changes in strategy are required for the activity area of business model innovation, changes in structure are crucial for new product development, and changes in structure are required for bringing in digital technologies [18]. The creation of new business processes, services, processes and business models using digital technologies is referred to as digital innovation [19], [20]. Thus, digital innovation can be regarded as an essential part of DT.

Even though a distinguishing feature of DT is that changes must be organization-wide, such changes may not be instantaneous [18]. DT can begin with the transformation of business processes, followed by alterations to products and services, and culminating in the revamping of the business model [21]. This intimates that realizing DT is a process that takes time. There appears to be no clear approach to the order in which organizational properties are changed. DT can also begin with changes to the business model that eventually alter the culture of the organization [22].

A recent systematic literature review on DT discussed the phenomenon in terms of the content of change [2]. The content of change highlights how DT is associated with malleable organizational designs, that is, organizational designs that can be changed easily and are easily influenced. An additional focus of the content of change is how DT is associated with continuous adaptation. It is the continuous change that is associated with the improvements of processes and the creation of new business models that triggers the emergence of a new organizational form [23]. Hence, a distinguished characteristic of DT is the new organizational identity that emerges from the use of digital technologies [3].

B. Temporality

The notion of time is implicit in the conceptualization of change. This makes temporality a salient theoretical foundation of DT. By definition, DT captures changes to the properties of an organization [1]. These changes occur over time. Building on the definition of DT, this calls for exploring how the changes to organizational properties *change* over time. Additionally, the temporality of DT can refer to the change in the entire DT process. To unravel these notions, we need to understand the nature of change as it relates to the phenomena.

Phenomena can be explored through their existence interval [5]. The existence interval has three dimensions. First, the existence interval captures the time duration that is needed for one instance of the phenomenon to unfold. This begs the question of whether there can be several instances of DT within an organization and the length of time each instance takes to unravel. Second, the life span of a phenomenon is

depicted by this existence interval. The depiction of a life span requires clear boundaries to highlight when the phenomenon begins and when it ceases. Third, the phenomenon may exist only at a specific point or time which means the existence interval of the phenomenon is its cycle time. Cycle time means the period between the two points or times.

The aggregation interval represents another important dimension of temporality [5], [7]. Since phenomena occur over time, aggregation represents the bracketing of the occurrence into periods. DT can be understood as the aggregation of the changes to the properties of an organization that occur over some period. Changes to organizational properties that fall outside the boundary of the aggregation are excluded. Duration of change, rate of change, whether change is incremental or discontinuous, and intensity are paramount temporality dimensions that can be tied to DT [7]. These temporality facets exhibit the transformation that is associated with IS phenomena in the form of intensities and directionalities of change [13].

The dimensions of time that can be explored in research have a direct relationship with the nature of the phenomenon. The temporality of DT can be investigated in terms of duration, temporal location, sequence, and rhythm but not so much in connection with scheduling and punctuality [24]. Temporal location refers to the area where activities take place and this corresponds to the target entity [1]. Target identity indicates the object or thing that is changed or impacted by digital technology use. Sequence indicates the order in which activities take place. Rhythm shows the intensity of changes. Thus, rhythm connotes the scope of DT [9]. Scheduling relates to when an activity is supposed to take place. Punctuality expresses the extent of the rigidity of deadlines. While punctuality and scheduling may be important, their roles in explicating the trajectory of DT are potentially limited. Absolute temporal position and temporal deviation are other salient dimensions of time that can be related to DT [25]. Absolute temporal position measures the start time, end time and duration. We denote temporal deviation as the gap between the planned progression of DT and the actual position of the executed DT.

III. TEMPORALITY OF DIGITAL TRANSFORMATION

In this section, we highlight the three determinants of DT speed: number of impacted properties, level of digital technology capability and order of changes.

A. Number of impacted properties

The needs and objectives of DT differ from one organization to another. Some organizations may aim to transform their entire operations and structures with digital technologies. In other organizations, the transformation of a few properties can be sufficient to meet the objectives. The number of impacted properties can be understood from the DT pathway that an organization decides to follow.

DT can be geared towards transforming the value proposition [3], value creation [15] or the entire business model [4]. The transformation of a single organizational property should be simpler and less complex than the transformation of many different properties. The value proposition and value creation are components of the business model. Hence, when DT entails the transformation of the business model this makes the scope of that transformation

broader than just changes to one component of the business model.

There are four proposed pathways to DT [26]. The pathways are defined on the two dimensions of operation efficiency and customer experience. The first pathway involves addressing an organization’s operational complexity before a shift to customer experience. The second pathway focuses on changing the customer experience and offering before a shift is made to operational efficiency. The third pathway iteratively addresses both operational efficiency and customer experience. The fourth pathway focuses on establishing a new subsidiary or company that is not burdened by existing processes and systems. The number of properties involved in each of these pathways should determine how long the DT process takes.

Building on the ongoing discussion, we propose that *the fewer the number of organizational properties targeted for change, the faster the speed of DT*. However, when the target of DT is a set number of properties that must be impacted, DT cannot be claimed to be complete until all those targeted properties have been altered. This number of impacted properties is an important determinant of the speed of DT if we consider the capability of digital technologies as invariant. However, this may not always be true since organisations tend to use digital technologies in different ways to achieve transformation. In Fig. 1 below we project the impact on transformation duration that the number of transformed properties may have.

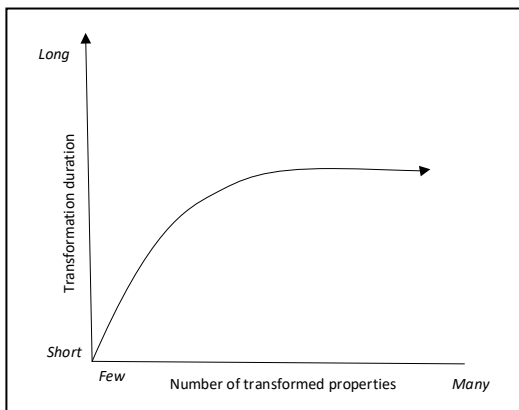


Fig. 1. Transformation duration

We conceptualize in Fig. 1 above that the fewer the number of properties, the shorter the transformation duration. Transformation duration is the existence interval of DT. However, even though the transformation duration should increase with the number of organizational properties, we anticipate it does not exponentially do so. At some point, increasing the number of organizational properties should result in only marginal changes in the transformation duration.

B. Level of digital technology capability

The introduction of digital technologies within an organization occurs through internal development or outsourcing. Prior studies have highlighted the existence of digital networking capability and big data analytics capability which are two crucial capabilities that may impact the speed of DT. Digital networking capability refers to “the firm’s ability to bring together and match distinct users to address their mutual needs via digital means, which becomes more important in digital settings” [27, p. 893]. Big data analytics

capability means “a firm’s ability to assemble, integrate, and deploy its big data-based resources” [28, p. 1054]. Each of the primary digital technologies may have its level of capability within an organization [9]. As such, we use the term digital technology capability (DTC) to refer to an organization’s *ability to acquire or develop and implement digital technology towards specific business goals*. An organization can implement several digital technologies to achieve transformation goals. Thus, we use DTC as an umbrella term that covers the use of various digital resources.

Capability development goes through a lifecycle. The lifecycle has four stages: development, maturity, transformation and decline [29]. A capability refers to a reliable capacity to do something [30]. Notwithstanding, the fact that “a capability may have reached a threshold level of reliability, however, does not imply that the capability has attained the highest possible level of functionality” [29, p. 999]. This is where the aspect of the capability lifecycle emanates from. The development stage involves the building up of the capability. When the building-up stops, the capability has reached the maturity stage. The development stage can stop because of limits related to what can be done with the existing technology, people and other resources. When a capability has reached maturity, it can be transformed through retirement (death), retrenchment, renewal, replication, redeployment, and recombination. Eventually, the capability goes into decline.

The level or stage of an organization’s DTC determines how many of the organization’s properties can be changed during any given period. DTC may not be measured using scales such as low or high but possibly as a relative term indicating how much of the intended change can be achieved during any period with the available capacity of digital technologies. DTC affects the duration and existence interval of DT [5]. Understanding what fraction of the total change has been accomplished means the total intended change is known. This form of change is grounded on the understanding that the organization being transformed can have distinct states at different points in time [8].

We propose that *the speed of DT is relative to an organization’s DTC such that the more developed the DTC the greater the potential speed of DT*. The pressure to undertake DT may force organizations to use a DTC that may not be fully developed. However, DTC may mature during the process of DT. A DTC that is at the stage of decline may not be able to meet the technological needs of DT. This can negatively affect the speed of the DT process. In Fig. 2 below we depict how the DTC can have an impact on transformative potential.

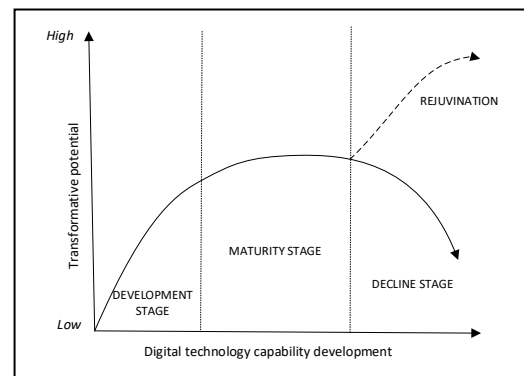


Fig. 2. Transformative potential of digital technology capability

In Fig. 2, transformative potential indicates the power of digital technologies to effect changes. In the development stage of DTC, the transformative power will be low. This can be because the existing DTC is still unable to meet organizational needs or simply because the DTC lacks the requisite needed capacity. The maturity stage is where the greatest impact from DTC can be achieved. In other words, the transformative power has peaked. After the maturity stage, the transformative power starts to decline. This means the existing DTC may no longer fully meet the needs of DT. Notwithstanding, digital technologies are malleable and dynamic [31], [32], hence there can be a rejuvenation of the DTC beyond the maturity stage.

Under DTC, we also note the speed at which digital technologies are applied. The rate and duration of DT may be determined by how quickly digital technologies are applied to alter organizational properties. In the case of business analytics, the impact on organizational properties is determined by the speed at which insights are generated [33], [34].

While the introduction of digital technologies requires a change in organizational structures and culture, these digital technologies are often depicted as being distinct from the change they give rise to [12]. However, the embedded nature of these digital technologies means that they are often part of the changes to organizational properties [35]. Paradoxically, digital technologies are a property of the organization, and thus a change in these digital technologies may also be classified as DT.

Organizational properties such as culture do not become embedded into digital technologies but the change to such properties occurs through an interaction process [35]. The rate and duration of the change to an organizational property can be determined by the intensity of the interactivity of such properties and digital technologies. Changes such as alterations to business processes involve digital technologies becoming embedded into the organizational property [36]. When digital technologies become embedded into organizational properties, the changes to the properties are contingent on the effect that the embeddedness has. The first change is of course that of the digital technology becoming part of the organizational property. The second change is a consequence of such an integration. Management research has shown that the integration of firm resources produces capabilities [37]. When digital technologies and other firm resources are integrated, they produce capabilities. Hence, DT can be regarded as a capability-creation process. The level of DTC controls how quickly the capabilities are created.

C. Order of changes

The change to organizational properties driven by digital technology use can occur from the relationships among the different organizational properties. Systems theory has been used to explore the relationships and interdependencies among components of a system and the emergence of new properties [38], [39]. A key aspect of the systems theory is interdependence among its components where the functioning of one component requires the support of the other components [39]. The interdependences are classified as either tight coupling or loose coupling. Specifically, “components of a system can be tightly coupled, where the components are closely interdependent, or loosely coupled, where the smaller subsets of tightly connected components are loosely connected to one another” [39, p. 3]. In Fig. 3 below,

we depict the systems perspective of organizational properties. The emergent property is produced by the interactions among the system properties.

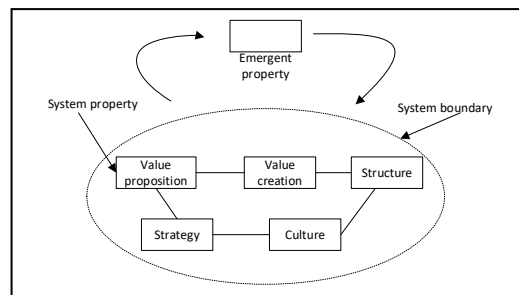


Fig. 3. Systems' perspective (modified from [38])

The tight coupling between organizational properties means that changes to one such property are likely to affect other properties. In other words, the changes to such tightly coupled properties may not be independently completed. We propose that *the tighter the coupling among organizational properties the more extensive but slower the speed of change to those connected properties*. Loose coupling means that an organizational property may be changed without such a property strongly impacting or being impacted by other properties. Hence, DT involving loosely coupled properties may be quicker than when the properties are tightly coupled.

When discussing the transformation of organizational properties, it is vital to also consider the directionalities of the relationship among the properties. For instance, the question that can arise is whether we need to define a digital business strategy first before the value proposition. The digital business strategy is an “organizational strategy formulated and executed by leveraging digital resource to create differential value” [40, p. 472]. The digital business strategy controls how the value proposition is redefined and how value creation transpires. This implicates a sequential application of digital technologies within an organization. Feedback loops in which a downstream application of digital technologies impacts an upstream application of those technologies cannot be ignored. Digital technologies may also be simultaneously applied to different organizational properties. This creates the possibility of decentralized functional or unital changes within the organization that eventually merge to reflect an organization-wide transformation process. Organization-wide changes have been highlighted as a salient aspect of DT [18].

The decentralized application of digital technologies in transforming organizational properties can make it difficult to pinpoint exactly when DT has been completed. The following arguments can be made. First, if at least one property of an organization has been changed by digital technology use, we can contend that DT has taken place. This argument suggests that changes do not need to occur across the entire organization to achieve DT. Second, if the ripple effect of digital technology use has changed all organizational properties through interdependencies between them, DT can be said to have successfully taken place. Minimally, direct changes to only one property of the organization through digital technology use may be sufficient to cause indirect changes throughout the organization.

IV. DISCUSSION

Understanding the speed of organizational property changes only as a factor of the number of properties impacted, DTC level or order of changes may not be enough to explain the speed of DT. It is important to recognize the interdependencies between these three factors. The complexity concepts of nonlinearity [41] and transformational emergence [42] can help to explicate how the different factors interact to influence the speed of change. Nonlinearity means that “a change in one element creates larger or lesser changes in other elements, which can sometimes result in a significant change in the outcomes” [41, p. 89]. A change to one organizational property may trigger large or small changes in other properties. Where a change in one property triggers larger changes in the other properties, this may slow the entire DT process. Conversely, when smaller changes are triggered by a change in an organizational property, this can suggest that the entire DT process may transpire quickly.

Therefore, the overall DT duration may be determined by whether the changes already done have triggered smaller or larger changes in other organizational properties. Even though the number of properties to be changed can be fixed, the magnitude of changes required in them may vary. Hence, the number of properties alone may not be a good indicator of the entire DT speed. Larger changes also do not imply a slow change process. An organization can have a well-established and matured DTC that can help to quickly achieve the large-scale transformation of organizational properties. Notwithstanding, an under-developed DTC may result in more time being taken to achieve DT.

Another challenging aspect in measuring the speed of change is that such changes are often emergent. Emergence means that “a structure has properties and capacities that only exist because of the composition and interactions of its parts” [42, p. 5]. Emergence also means that a system can be analyzed from the level of its sub-systems and their relations [43]. Each organizational property can be analyzed as a sub-system that is made of other components that affect the speed at which the property can be changed. Emergence can be taken to mean that the entire speed of DT can only be known ex-post when all the changes have been completed.

V. IMPLICATIONS

The level of DTC is an important determinant of DT. Efforts to improve DTC can have a profound impact on the speed at which DT is achieved. Prior research has underscored the development of DTC as an initial step towards DT [12]. However, the exact DTC needs of an organization can be difficult to know ex-ante. Thus, there is always the possibility that the exact DTC needs of an organization may never be known until the effects are observed in how quickly (or slowly) DT occurs.

This paper has posited that the speed at which the expected outcomes of DT are achieved can be affected by the order in which changes are implemented within the organization. Even though changing the organization’s culture is important, an organization may prioritize changing the value proposition and value creation first. The logic for this can be grounded in why DT was initiated in the first place. When an organization’s existence or profitability is under threat, the most pressing need may be changing the value proposition before all the other organizational properties are changed. [3]. Nonetheless, organizations must understand that the order in

which properties are changed may speed up or delay the expected outcomes of the DT process. An organization must also have a clear DT strategy in which choices are made on whether digital technologies are going to be simultaneously applied to organizational properties or changes will commence with specific organizational properties.

The discussion on temporality can help to improve the understanding of DT by showing how it may change over time. Temporality can enable the forward-tracking of the empirical unfolding of DT, and the backwards-tracking of how DT can be conceptualized from how changes to organizational properties transpired. The literature on DT has largely focused on *what* has changed ignoring the temporality dimensions that explicate *how* the changes have occurred or will occur. As such, temporality can be important in the development of theories on DT.

VI. CONCLUSION

This paper set out to answer the question: “*What are the temporality foundations of DT and how can those temporality foundations account for the speed of change?*”. We have outlined the number of properties impacted, the level of DTC, and the order of changes as the temporality foundations of DT. These aspects affect the speed of DT. The discussion of temporality is on *how* quickly change has occurred or will occur and not simply *what* has changed. How quickly DT is achieved can have an impact on an organization’s competitive advantage.

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MATCH & CONTRIBUTION

This paper relates to the conference themes of “R&D, Innovation, Technology, and Entrepreneurship” and “Industry 4.0: Managing Digital Design and Manufacturing, Artificial Intelligence, Machine-learning, Big-data, and Concurrent/Distributed Computing”. The study relates to managing and implementing engineering and technology. In particular, the study aligns with the IEEE focus area of integrating technology for capability and development. The paper highlights how the speed of DT is impacted by three temporality dimensions: the number of impacted properties, the level of digital technology capability and the order of changes. We introduced the concept of digital technology capability to highlight how digital transformation is impacted by how well-established an organization’s digital technologies are. Thus, the study relates to the use of digital technologies in the broader context of Industry 4.0, of which DT is an integral part.

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