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Digital Literacies and Sustainable Development: Narratives From A Tale of Two Cities.

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ABSTRACT

This article is a status report of the on-going efforts of the DiLiterati Group (funded by Singapore's Ministry of Education and led by Ravi Sharma) to investigate the role of digital literacies in fostering sustainable development. In this research, we are trying to investigate how the knowledge disparities could be bridged with digital literacy and whether the resultant "level playing field" will generate greater contributions of national wealth and a more equitable sharing of it. This culminated in the synthesis of a Digital Literacy Maturity Model. A quantitative approach to sense-making did not reveal much support for the model we had anticipated. Therefore a procedure to delve deeper into the qualitative and contextual was formulated to frame "narratives" that suggest "lessons learnt" and "best practices" from economies that have demonstrated successful sustainable growth and development. To test the efficacy of the procedure, Singapore and Hong Kong were selected as pilot subjects of interest.

Keywords: knowledge societies, digital economy, fourth industrial revolution.

INTRODUCTION & BACKGROUND

Building a Knowledge Society represents an aspiration that has been the thread of a voluminous body of work ranging from the classic treatise by Adam Smith (1776) to more contemporary projects by the World Bank [8]. It has been shown that knowledge and its diffusion become potent factors of innovation; and this creates a level of playing field of opportunities and hence reduces income and wealth disparities [3]. This paper is a status report of the on-going research of the DiLiterati Group, funded by Singapore's Ministry of Education, in addressing the following key questions. How can knowledge be diffused across a society so that it may be more effectively exploited to create national wealth? Can we bridge knowledge disparities with digital literacy? Will the resultant "level playing field" generate greater contributions of national wealth and a more equitable sharing of it?

There is considerable agreement across disciplines that knowledge is a key driver of sustainable development (cf [6] for a review). In this context, we adopt the view that sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. The challenge of sustainable development is that it should result in the ideal of equitable opportunities for value creation across the community at large. Equality of socio-economic participation and well-being is one of the key ideas of justice as espoused by the philosopher-economist Amartya Sen and echoed by Piketty [3]. The research described in this paper attempts to understand the rich linkages between access to knowledge, its diffusion through society, and society's ability to apply such knowledge towards sustainable development. In this era of the Internet-of-Things and the emergence of the so-called Fourth Industrial Revolution [4], a critical mass of such activities take place through digital exchanges of codified information shared across networks and applied in order to create value. Understandably, the United Nations has declared access to Internet services to be a basic human right. Inclusion and participation of a given population in such purposeful activities has hence attracted much scholarly interest. More specifically, digital participation has now become synonymous with active, engaged citizens – a public good referred to as digital entitlements [5]. The next section is a brief recap of prior research.

PREVIOUS WORK

Prior work by the DiLiterati Group highlight key characteristics of knowledge societies: i) they are necessary and sufficient conditions for growth in the knowledge economy, ii) they have high knowledge absorptive capacity and complex chains of creation, production and distribution, and iii) they consist of a sustainable learning community which emphasizes innovation. Four knowledge pillars actively used by the World Bank's Knowledge Assessment Methodology (information infrastructure, economic and institutional governance, education and human capital, and innovation system) have been effective in deriving a set of best practices in developing knowledge policies [5]. In a Structured Literature Review conducted by the DiLiterati Group [forthcoming], we note that prior research did not examine participation gaps arising from the uneven distribution of resources in developing skills and literacies throughout the world and in the lack of transparency in the way digital literacies shape perceptions of the world. At this juncture of the new participatory culture, the key question of "how we can guarantee that the rich opportunities afforded by the expanding digital landscape are made available to all," still remains unanswered.

Scholarly efforts to lay the conceptual foundations of economic, social, institutional and environmental indicators spanning ICT and knowledge domains have attracted long-standing interest. However, much of this work (including our own) was tentative and provisional. There is a need for: i) more accurate models, metaphors, and measures to describe human enterprise relative to society; ii) substantial improvements regarding digital citizenship and governance; iii) major enhancement in public awareness, along with provision of the education needed for the transition to sustainability; and, iv) tackling sustainability as a series of

divergent problems formed out of the tensions between competing disciplines. The research being undertaken by the DiLiterati Group is an attempt at fixing the above gaps. More specifically, we shall undertake four major phases that address the development of a theoretical basis as well as rigorous empirical investigation of a measurement scorecard for knowledge disparities.

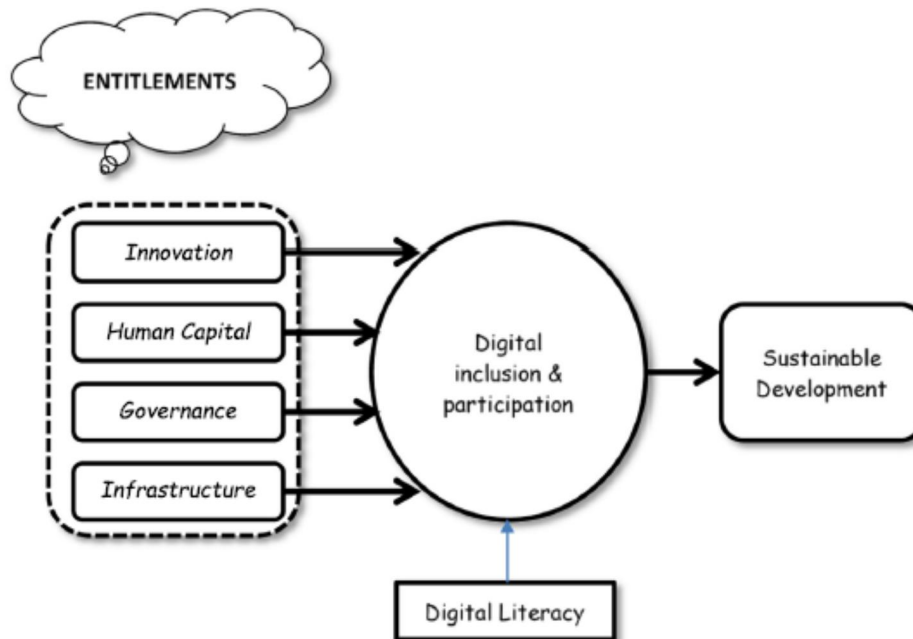


Figure 1: Digital Transformations and Sustainable Development [6, p 641]

Figure 1 above conceptualizes what we propose as a general theory of digital literacies, knowledge societies and sustainable development. Specifically, ICT infrastructure, governance in terms of policy implementation, human capital development, and the creation and endorsement of a culture of innovation are a set of digital entitlements that would promote inclusiveness as well as participation in opportunities for growth and development. Digital literacy skills are “contingency factors”, i.e. they are acquired and applied by citizens when there is a value proposition. The notions of digital inclusion and participation are deeply entwined. Inclusion is an effort by the state to reach out to its citizens, be it through a physical or virtual public sphere. Participation is when this outreach (presumably in the form of access, content and applications) is useful and usable. Even so, inclusion and participation must embrace economic, technical, and socio-political feasibility. Such an interaction, we had theorized in [6], ultimately leads to sustainable growth and development for the evolution into knowledge societies.

Our framework for digital inclusion moderated by digital literacy, is also consistent with four knowledge pillars actively used by the World Bank’s Knowledge Assessment Methodology [8]: information infrastructure, economic & institutional governance, education & human capital, and innovation system. This has been effective in deriving a set of measures and investigating knowledge policies in several field studies [8]. However, these studies did not examine participation gaps arising from the uneven distribution of resources in developing skills and literacies throughout the world and in the lack of transparency in the way digital media shapes perceptions of the world. At this juncture of the new participatory culture, the key question of “how we can guarantee that the rich opportunities afforded by the expanding digital landscape are made available to all,” still remains unanswered. In the next section, a quantitative approach to probing this is explored.

DATA MINING AND SENSE-MAKING

Given the voluminous, public domain datasets available, we first performed data mining in order to ascertain the linkages between our theory and reality. Drawing from secondary data sources such as the World Bank’s World Economic Indicators, United Nations’ Databases, and the World Economic Forum; panel data from 100+ countries covering as many key indicators were mined for a 10-year period. The variables were categorized (1) under the 4 sets of entitlements shown in Figure 1 (information infrastructure, economic & institutional governance, education & human capital, and innovation system); and (2) as indicators, a moderator and their effect on the outcome (ie sustainability). This two-step categorisation allowed for deeper data analysis on the impact of each factor in the development of sustainable knowledge societies as shown in Table 1.

The choice of datasets was based on a timeline. Data for countries were required for the years between 2005 and 2015 so as to allow a lag of 10 years. Another requirement was that the data had to be recent and up-to-date. The ICT Development Index, which indicates the development of ICT in countries under three themes: access, use and skills, was considered the sole moderator in our model. The association among the indicators, and the outcome, as well as the effect of the moderator were determined. Countries with missing values were eliminated based on a threshold and linear regression was used to obtain the values for the remaining missing values for the respective years. Once pre-processing of the data was completed, data for 102 countries was available across all nine indicators shown in Table 1.

Table 1: Data Dictionary of the Sense-Making Model.

Category	Sources (with classification as per knowledge pillars)
Indicators	Global Innovation Index (GII): innovation system [11]
	Government Effectiveness (GOVe): economic and institutional governance [12]
	Human Development Index (HDI): education and human capital [13]
	Network Readiness Index (NRI): economic and institutional governance [14]
	Political Stability (PoIS): economic and institutional governance [12]
	Regulatory Quality (RegQ): economic and institutional governance [12]
	Rule Of Law (RuIL): economic and institutional governance [12]
Moderator	ICT Development Index (ICTD): information infrastructure [15]
Outcome	Sustainable Society Index (SSI) [16]

Values for different variables were in different scales. Therefore, z-score standardization was used to convert all indicators to a common scale with an average of zero and standard deviation of one. Standard data mining techniques such as Visualisation of Descriptive Statistics, Principal Components Analysis, and Structured Equation Modeling. The next section delves into some preliminary results and observations.

PRELIMINARY RESULTS

In the first pass of data mining, visualization techniques such as scatter-plots did not show any clear relationships (positive or negative) among the indicators. However, using ADANCO 2.0 for 2005 to 2015 data, we found consistently high cross correlations among the indicators. This may suggest multi-collinearity.

Table 2: Heterotrait Monotrait Ratio of Correlations (HMRT).

Construct	SSI	GII	GOVe	HDI	NRI	PoIS	RegQ	RuIL	ICTD
SSI									
GII	0.5411								
GOVe	0.4737	0.8902							
HDI	0.4711	0.8236	0.8546						
NRI	0.4734	0.9218	0.9216	0.8834					
PoIS	0.4777	0.7214	0.7758	0.6956	0.7367				
RegQ	0.5197	0.8543	0.9122	0.7902	0.8694	0.7589			
RuIL	0.4519	0.8705	0.9427	0.7859	0.8843	0.8169	0.9025		
ICTD	0.4892	0.8900	0.8749	0.9519	0.9224	0.7295	0.8236	0.8289	

Table 2 shows the ratio of cross correlations for 2015 data. From Table 2, we evince higher correlations among the indicators than with the outcome. This is interesting because it also suggests that the indicators seem to be measuring similar phenomena (SSI?) but at the same time do not sufficiently capture the nuances of SSI individually.

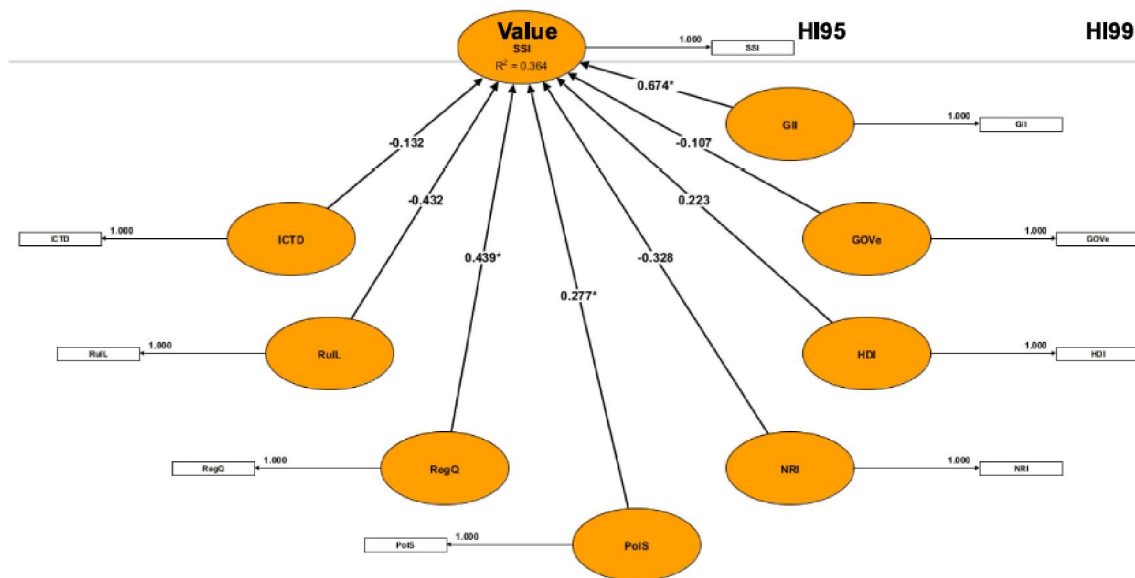


Figure 2: Graphical Representation of the Model (ADANCO 2.0 Output).

Again for 2015 data, path analysis showed that GII, PolS, and RegQ (innovation, political stability and regulatory regime) are significant contributors to SSI. It was surprising that neither HDI nor ICTD-NRI were significant. Such anomalous characteristics did not make sense and could not be explained. There was also difficulty in relating our provisional results to existing theory. For example, it is generally accepted by political economists that the soundness of political and economic institutions underlie economic success, yet the “governance” indicators were not significant contributors to sustainability outcomes.

To probe further, we next attempted random effect regression and pooled regression (with / without time dummies, with / without interaction terms). This set of fixed effect regression seemed to be relatively reasonable (although the results were still not completely within our expectation). More specifically: i) on average, GII has a negative impact and HDI has a positive impact. In terms of magnitude, HDI is far more important than any other variables in affecting SSI. Other variables NRI, INSG and ICTD do not significantly affect SSI; ii) the impacts of GII, HDI, NRI and IG on SSI are enhanced by ICTD. In countries with large ICTD, GII has an even larger negative impact on SSI; and HDI has a more positive impact on SSI. Thus, our preliminary data mining seems to suggest that human capital is the sole significant source of growth and development. Digitisation (ICTD or NRI) is a moderating variable at best. As an explanation, it could be conjectured that population densities, levels of HDI, and proportion of the middle class may also be moderators as the link between the indicators and outcomes are complex and nuanced.

Our empirical model suggests that human capital is the sole significant source of growth and development. At this point, it appears that the digital transformation of society through mass digital literacies is a moderating variable at best. It was further conjectured that population densities, levels of HDI, and proportion of the middle class may also be moderators as the link between the indicators and outcomes are complex and nuanced. This is at odds with the theory we had formulated after an extensive SLR [forthcoming] and Grounded Theory validation [6]. We concluded at this time that quantitative analyses were insufficient to explain the linkages between policy indicators and socio-economic outcomes.

ON-GOING RESEARCH AGENDA

Given the ambiguity of the sense-making phase of the research, a “narrative” using the Digital Literacies Maturity Model [7] was developed whose efficacy was to be tested with Singapore and Hong Kong SAR as observation points. At this point, we gratefully acknowledge the contributions of Fang Zhang (UniSIM) in the time-series data modelling, and Carol Soon (NUS) and Marko Skoric (CUHK) for the expert inputs on SGP and HK respectively. For our purpose, a narrative encapsulates best practices and lessons learnt as a means of explicitly capturing the qualitative associations between indicators, moderators and outcomes. Consistent with the approach of the Constructivist Grounded Theory, narratives combine the richness of case studies with the structure of theory building using inductive techniques of observation, insights and hypothesis. Our development of narratives proceeded as follows. First we selected 20 knowledge societies as subjects based on size, geography, and performance. We then applied a maturity model as framework for the elicitation of how these economies / societies were able to develop sustainably over the past decade. Finally, using a standard, off-the-shelf, information mining tool, we tracked official websites of our subjects, policy pronouncements by their leaders, and other published reports, we considered the question of whether these characteristics made the society more ready for the Fourth Industrial Revolution. The litmus test is whether “leaders and citizens together shape a future that works for all by putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people” [4]. This may be considered the industrial perspective to digital literacies and sustainable development.

The relationship between knowledge societies, digital inclusion and digital literacies may hence be examined through the lens of a Digital Literacies Maturity Model (DLMM) that was proposed in [7]. A maturity model is an assessment tool used to evaluate an entity (e.g., an organization, industry, economy etc.) or a process. The term "maturity" relates to the degree of optimization of practices. Typically, a maturity model formally defines steps and resultant metrics which are applied to the management of best practices and active optimization of processes [7]. Our proposed DLMM combines the World Bank's four knowledge policy pillars with the four levels of digital development (please refer to the work of Armenta et al., 2012 listed in Further Readings) and provides a framework on how to promote sustainable development and socio-economic well-being.

The matrix shown in Table 3, with its cells populated with generic descriptors, is proposed as a template for the pilot run of developing narratives which could potentially answer why certain patterns of correlations, causations and moderation were not observed from the data. Each cell in the matrix has a focus theme that characterizes knowledge policy for a given pillar and level of development.

Table 3: Developing Narratives with the Digital Literacy Maturity Model

	GOVERNANCE	INFRASTRUC TURE	EDUCATION & HUMAN CAPITAL	INNOVATION
HUMAN VALUES	<i>Sustainable Growth & Development</i>	<i>Community Involvement & Socio-economic Returns</i>	<i>Civic Responsibility</i>	<i>Collective Intelligence</i>
PARTICI PATION	<i>Grassroots Participation</i>	<i>Network Effects</i>	<i>Community Participation & Community Leadership</i>	<i>Knowledge Exchange & Co-Creation</i>
USAGE	<i>Training</i>	<i>Applications</i>	<i>Skills Experience</i>	<i>Information Economy</i>
ACCESS	<i>Universal Service Obligation</i>	<i>Devices & Networks</i>	<i>Utility</i>	<i>Seeking Value</i>

For example, at the most basic level of digital development (the access level), governance policies mainly focus on universal service obligations extracted by the regulator from licensed service providers so that no segment of society is excluded from access to basic digital services including mobile apps. The infrastructure dimension focuses on improving access to devices and network and the training is geared towards utilitarian functions. Most innovative efforts are engaged in seeking value through efficiency and effectiveness. Assuming ubiquitous penetration of Internet services is achieved, the next level focuses on the usage. Government policies promoting skill-based training and applications are essential to the development of an information economy. When both Internet usage and access "cross the chasm", the next policy imperative is how best accelerate digital participation, such as grassroots take-up, community leadership and knowledge exchange. Similarly, at the highest level of digital development (the human values level), innovation policies would seek to capture the collective intelligence of the community (sometimes known as the wisdom of the crowds) to provide an avenue for problem-solving and having a stake in making the solution work.

As a pilot test of the narrative construction method, we picked Singapore and Hong Kong SAR as convenient observation points. For each, we considered the 4 levels of digital literacies (access-usage-participation-values) across the 4 pillars of our framework referred to in Figure 1. For each cell, the key question addressed was – which indicators within that pillar were most effective (best practices) and least effective (lessons learnt) in transforming the corresponding level of digital literacy. Another way of looking at this is to consider, in terms of velocity, scope, and systems impact, how ready is each facet of a society for the Fourth Industrial of digital transformation. [4] prescribes some guidelines for such a readiness check. For the purpose of bench-marking and bench-learning, we limited our observations to domains of government, education and health. These 3 domains are generally considered the pace-setters in digital policies among OECD nations.

The comparison of Singapore and Hong Kong SAR is intended to provide provisional findings for the tale of two cities. While focus group workshops were initially considered, Design Thinking (Steve Eppinger, MIT, personal communication, 2016) suggests that in-depth interviews with key stakeholders (citizens, policy makers, academics, industry players, etc) could be just as effective. The entire exercise will serve as a pilot to validate the efficacy of the DLMM as a template for our narratives. It is anticipated that the construction of narratives results in a procedure whereby feasible and useful best practices and lessons learnt may be placed in context. Hence, to complete the research objectives, we shall undertake a total of 20 narratives in order to support inductive reasoning as the basis of substantiating our general theory of digital transformations, knowledge disparities and sustainable development. The quantitative techniques we used in the sense-making process did not address the research

questions but left much answered. As Caffo, Leek & Peng “view it as a success if we can show that the data can't answer the questions being asked.” Hence we may justify the mixed methods.

The intended contributions of the DiLiterati research programme are four-fold. First, whereas economic measures of wealth and income disparities are historical, we undertake to investigate knowledge disparities and their impact on future growth and development. In an era of disruptive innovation and rapid change, this research proposal and its findings would be relevant and timely to document best practices and lessons learnt. Second, whilst the World Bank, OECD and the UNDP have longstanding programmes on knowledge for development, they do not specifically address the challenge facing the more compact “smart cities” such as Singapore with an overwhelming dependence on intellectual capital (mostly human, leveraged by structural and relational) with the ambition of keeping ahead of the growth and innovation curve. Third, there is a lack of detailed narratives that address the dilemma of disparities in advanced economies and policy solutions. Fourth, the creation of a body of theoretically- sound tools and methods for bridging knowledge disparities (such as a generic scorecard for knowledge disparities and applying it to benchmark and drive policy initiatives. We believe that our efforts would be a small but purposeful contribution to the World Bank’s gargantuan mission of eliminating poverty by 2030 (cf <http://live.worldbank.org/within-our-grasp-world-free-poverty>).

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