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Digital Sustainability in the Organization: Scale Development and Validation

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Abstract: This study aims to develop a measurement scale for the digital sustainability practices in the organization. Considering that digital sustainability practices vary across industries and context, this study develops a scale of digital sustainability metrics, which is based on a comprehensive literature review. The proposed model was then tested with partial least squares-structural equation modelling (PLS-SEM). Several phases of qualitative and quantitative investigations of employees were conducted to propose and validate the construct of digital sustainability. The scale development process consists of initial item generation, item refinement, validity assessment and model testing. Four dimensions, namely, content, technology, preservation and promotion, were identified. A 16-item scale was proposed and validated. Theoretical and practical implications were discussed. Practitioners should focus on investing behind organisational resources and technologies that enhance the operationalisation of digital sustainability rather than seeking to promote the understanding of the concept and importance of digital sustainability. This study addresses the research gap, combining a focus group interview and literature review, followed by conceptualization and validation of a measurement scale of digital sustainability. Digital sustainability was validated as a manifestation of the availability, preservation, promotion and technological aspect of digital content in corporations.

Keywords: digital sustainability; organization; scale development

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1. Introduction

The world economy has been seriously affected by COVID-19, in particular, economic activities were badly affected by lockdowns and other mobility restrictions. It is expected to take substantial period of time for economic recovery from the pandemic. Different service sectors have been hardest hit by COVID, including the tourism and hospitality industry. However, the global pandemic has driven unusually strong demand in use of digital technologies; for example, people use virtual conferencing software like Google Meet, Zoom and Microsoft Teams to help meeting others virtually and facilitate professionals and employees working from home, students learning remotely, and so forth. Besides, customers can purchase goods and services through e-marketplace websites; and businesses run as usual via e-commerce operators. Digital technologies are important in helping people to fight against the pandemic and adjust to a new normal by maintaining a new momentum [1].

Under this global crisis, massive quantity of data are generated instantly from isolated sources, which calls for the need of data ecosystems that promote the integration and analysis of data at local, regional and national levels [1]. Challenges in information system management under COVID-19 include information behaviour, business models, cybersecurity and data privacy; together with the social and ethical consequences caused by the adoption of smart technologies should be mitigated through improved designs [1].

The rapid growth of digitalization of organizations using artificial intelligence and machine learning poses a great challenge on existing digital systems. Internet of things

connects many devices in webs and supports "smart" office, home, school, transportation. Changes happen everywhere and it is important to manage the changes well to ensure sustainable operations are observed.

Sustainability consists of three dimensions: environmental, social and economic. Environmental sustainability is defined as the 'ongoing preservation of ecosystem and their functions. Economic sustainability refers to ongoing ability of an economic system to fulfill all human needs. Social sustainability promotes well-being for all people; like access to food, medicines, education and recreation ([2], p. 4). The global economy affects our society and environment; and the three dimensions are interrelated.

Digital media are part of a convergence amongst interactive media, online networks and existing media forms, which support the existing forms of mass media distribution and tiny publics; and the collectivities of peer groups or specialised niche interests [3]. Sustainability is the ability of a system to maintain or renew itself perpetually [2]. Combining the two definitions, digital sustainability can be defined as the ability of a digital system to maintain or renew itself perpetually.

Records and record keeping have become increasingly intangible in nature under the growth of computerisation; different from physical items that are self-contained, the creation and access of digital artefacts should be processed using technical devices; hence, the availability of a data file depends on its storage media, and it is at risk of being lost as a result of data loss, hardware crashes or other accidents; for example, server systems may become dysfunctional when being hacked or disconnected due to technical problems [4]. Digital artefacts include data files of texts, pictures, audios and videos, as well as computer files of machine and source codes [5]. Whilst technologies rapidly develop, users need to be equipped with necessary skills and experience to operate, preserve and even repair different devices; to implement proper computer controls with on-going prevention, protection and monitoring procedures.

Digitalisation also lead to various challenges in sustainability, such as increased electricity consumption, cybersecurity threats and vulnerabilities and social discrepancies associated with the widening gap in access to information and communication technologies, commonly termed 'digital divide' [6]. A sustainable digital ecosystem requires flexible and adaptive governance approaches established based on the country culture, customs and economic needs; and the three main types of strategies are laissez-faire (industry-driven), precautionary and stewardship (active surveillance) approaches [6].

Open source software and open data are favoured by organizations in developing countries. Such preference contrasts with the traditional way of depending on suppliers' proprietary software. Open source applications and open data facilitate better services and encourage the concept of sharing, which enables organizations contributing to the wider community stakeholder [7].

This paper is organized in six sections. Literature review and methodology are presented in sections two and three respectively; and the results are presented in section four. Section 5 is the discussion of the results; and the last section is the conclusion and further research areas.

2. Literature Review

2.1. Digital Sustainability and Its Definitions

The concept of digital sustainability originated in the 2000s, which was advocated by Bradley [8] as a way to achieve sustainable development from the perspective of digital artefacts and archives. As proposed by the United Nations ([9], p. 37), sustainable development refers to the 'development that meets the needs of the present witout compromising the ability of future generations to meet their own needs'. Scholars advocating digital sustainability have sought to advance the sustainable development goals to meet the needs of future generations through advocating the longevity of digital information [4,7,8,10,11]. Table 1 presents a summary of the conceptual works on digital sustainability. Bradley ([8], p. 151) defined digital sustainability as 'encompassing the wide range of issues and concerns that

contribute to the longevity of digital information' throughout the 'overall life cycle, technical, and socio-technical issues associated with the creation and management of the digital item.' Stüermer ([7], p. 1) riding on the idea of Bradley [1], posited that digital sustainability is the practice to 'create, use, and regulate digital resources in order to maximize their value for our society today and in the future.' Stuermer et al. [4] extended the concept of digital sustainability beyond the scope of digital artefacts into their ecosystem. Digital sustainability is achieved through the production, development, maintenance and access to digital artefacts that support the creation and usage of digital artefacts and archives [4]. Please refer to Table 1 for a summary of definitions on digital sustainability.

Digital sustainability has gained increasing attention in two major areas of research including the preservation of digital artifacts in (i) sociocultural context; and (ii) organizational context. In the sociocultural context, studies focused mainly on the preservation of culture, history, heritage and humanities to enhance the sustainability of non-material culture through digital technology [7,11]. Moreover, digital preservation of artifacts in library has also been explored to sustain the longevity of knowledge and information [8]. Meanwhile, research in the organizational context investigated how digital sustainability could contribute to the longevity of knowledge and information within organizations to enhance organizational productivity and performance [4,10]. As compared to the studies in sociocultural context, research in digital sustainability among organizations has not been receiving much attention despite its importance to entrepreneurial culture [8]. Although digital sustainability presents a great opportunity to advance the sustainable development of organizations, prior research on measuring digital sustainability and related empirical models is limited. The absence of a scale to measure digital sustainability has also limited the possibility to empirically examine digital sustainability and its associated antecedents and consequences in organizations. As no prior study was devoted to the scale development of digital sustainability from the organizational perspective, the current study proposes to address this identified gap in the literature and to develop and validate a digital sustainability scale in the organization.

2.2. Digital Sustainability in the Organization

The term 'digital sustainability' refers to an overarching view of an organization or a corporation on how it achieves enhanced sustainability through technologies.

Digital sustainability, in a broad sense, can be defined as 'organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data' ([8], p. 2). In a narrow sense, digital sustainability is the sustainable use of digital resources; as mentioned in previous research, the two directions are digital preservation in the context of conserving data and information and openness literature that extends to the legal context of accessing and modifying source code and data [7]. In terms of documentation, digital sustainability is an economic issue, an investment in the present, which serves the purpose of ensuring access in the future. As for open data, a sustainable repository should consider the barriers to participation and use because a collection of digital information without sufficient contributors or users to justify its existence is considered unsustainable; thus, measures should be taken to encourage and facilitate deposit and access [7,8].

Central to the idea of digital sustainability is digital preservation [8]. Digital preservation includes the production, storage and retrieval processes of digital artifacts. In the preservation process, we need to consider viability, understandability and authenticity [8]. To enhance the sustainability of digital artifacts in organization, the ability for organization to promote continuous production, storage, and retrieval of digital artifacts is also crucial to digital sustainability [10]. Hence, digital sustainability in the organization is postulated to encompass four major components including content production, enabling technology, content preservation, and promotion of digital sustainability within the organization [4,8,11,12].

Table 1. Definition on digital sustainability.

Author (Year)	Context	Perspective	Definition	Considerations
George et al. (2020) [10]	Organizational activities	Entrepreneurial	Digital sustainability as the organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data	Codifying Observations, Improving Liquidity, Facilitating Attention, Embedding Verification, Empowering People, Fortifying Infrastructure
Konstantelos and Hughes (2019) [11]	Community-generated content	Preservation of culture and history	"as encompassing the wide range of issues and concerns that contribute to the longevity of digital information [. . .] and provides the context for digital preservation by considering the overall life cycle, technical, and socio-technical issues associated with the creation and management of [a] digital item." [8]	Content, Technology, Preservation, Promotion
Stuermer et al. (2017) [4]	Digital artifacts and their ecosystem	Knowledge management	the sustainability of digital artifacts and their ecosystem is achieved by producing, developing, maintaining and ensuring access to digital artifacts in a way that ensures their creation and facilitates their use	Elaborateness, Transparent Structures, Semantic Information, Distributed location
Stüermer (2014) [7]	Technical longevity of digital information	Cultural heritage and digital humanities	How to create, use, and regulate digital resources in order to maximize their value for our society today and in the future	Intergenerational justice, regenerative capacity, economic use of resources, risk reduction, absorptive capacity, ecological and economic added value
Bradley (2007) [8]	Preservation and maintenance of digital content	Digital Repositories (library)	The concept of digital sustainability is defined as encompassing the wide range of issues and concerns that contribute to the longevity of digital information. Digital sustainability, it is demonstrated, provides the context for digital preservation by considering the overall life cycle, technical, and socio-technicalissues associated with the creation and management of the digital item.	Viability, renderability, understandability, authenticity, identity

The creation of digital content is the first step of digital sustainability. To enhance the longevity of information through digital sustainability, organization should turn organizational informational assets into digital content [4]. Thus, corporate documents, images, photographs, audio and video materials should be reproduced and stored in digital formats. The digital content created should also be actively updated, and made publicly available among relevant stakeholders [13]. Moreover, sustainable file formats should be used to maintain long-term accessibility of corporate digital content. Additionally, corporate websites/web pages should be actively updated, and available publicly.

Technology is important to create, store and access the data contemporaneously in the organization [4,8]. Over the history of storage technology development, data management has been constrained by the limited life expectancy of carriers. Research and debate on digital preservation in the archiving community began in the early 1980s, when tape was the only viable storage medium for audio and video data [8]. Whilst the notion of how to build a permanent carrier was never addressed, the migration of data from carrier to carrier was the solution to the problem of carrier failure, and permanence in access is the critical measure in the new digital preservation paradigm. Instead of depending on the reliability of the carrier, the focus shifted to the reliability of systems [8]. To advance digital sustainability, technology should be available for development, storage, and retrieval of digital content in the organization.

Preservation of digital content produced plays a pivotal role in digital sustainability in the organization [4]. Organizations are supposed to secure staff resources and financial support for ongoing support with digital content. Moreover, digital content should be well documented with descriptive information for easy and readily available access. Within the organization, users should be able to understand, interpret, and discover well documented digital content [8]. Thus, preservation of digital content goes beyond maintenance of content being digitalized but also associated with the measures to ensure the availability and handy usage of digital content within the organization.

In order to promote digital sustainability within the organization, organizations should hold activities that raise organizational engagement with digital content [10]. For entrepreneurial perspective, the promotion of digital sustainability should be organization-led and management-led initiatives so as to be efficacious. Therefore, to fully capitalize digital sustainability within the organization, it is inadequate to simply produce, maintain, and provide access to digital artefacts and archives. It is also detrimental for management to promote digital sustainability from a top-down approach in the organization.

2.3. The Responsibility of Organizations to Advance Digital Sustainability

Lock and Seele [13] identified 10 stakeholders of digital sustainability: governments, intergovernmental organisations, companies, media, NGOs, academia, charitable foundations, grassroots organisations, individual citizens and future generations. Among all stakeholders, business sector has indispensable responsibility for promoting digital sustainability. Being a major environmental pollution source and cause of social problems, most enterprises could cut down paper usage through digital sustainability in which corporate documents, images, photographs, and printed materials could be produced into digital content and disseminated to stakeholders in more environmentally friendly digital formats [13].

Under the evolution of the digital world, an increasing proportion of individual and communal activities are being recorded, digitised and analysed [6]. Seele [12] applied Foucault's panopticon theory to explain digital sustainability-related challenges under the trend of big data, transparency and surveillance in the age of AI. A paradox exists between privacy and freedom of choice, which raises the worry that it might open a Pandora's box of oppression and totalitarianism. Likewise, legal, ethical and practical constraints occur in the implementation of a digital workplace; companies need to achieve a balance between corporate security and employee privacy [14]. Thus, it presents challenges for organizations to move forward with digital sustainability and capitalize its associated opportunities to the

organization and society. Thus, to facilitate future empirical research in examining digital sustainability and its associated antecedents and consequences in organizations, this paper seeks to develop and validate a scale to measure digital sustainability in organization.

Limited literature is available on how to measure digital sustainability. Considering that digital sustainability practices vary across industries and context, this study addresses the research gap, and try to develop a scale of digital sustainability metrics. We propose the following two research questions:

Research question one: How can we measure digital sustainability?

Research question two: What is the construct validity and reliability of the scale?

3. Methodology

As discussed in the literature section, no scale is available for measuring digital sustainability in organization; as such, this study intends to develop a scale for measuring digital sustainability in organization based on Churchill [15]. The scale will then be validated through conducting an investigation on construct reliability and validity.

3.1. Research Design

Data triangulation with more than one sources were used. No assumption about the possible dimension was made and initial suggestions were obtained from focus group meeting. On the methodological side, this study uses exploratory factor analysis and confirmatory composite analysis (CCA) technique. CCA has several benefits; it is in both exploratory and confirmatory nature; and the number of items retained for measuring constructs are usually higher in CCA. Besides, the method analyses all variables together and confirms the measurement [16].

3.2. Methodological Steps

An overview of the steps in the study is presented in Figure 1. Scale development consists of five steps: initial item generation, content validity check, establishment of measurement model, item refinement and validity assessment. The partial least squares-structural equation modelling (PLS-SEM) approach was adopted to test the proposed model.

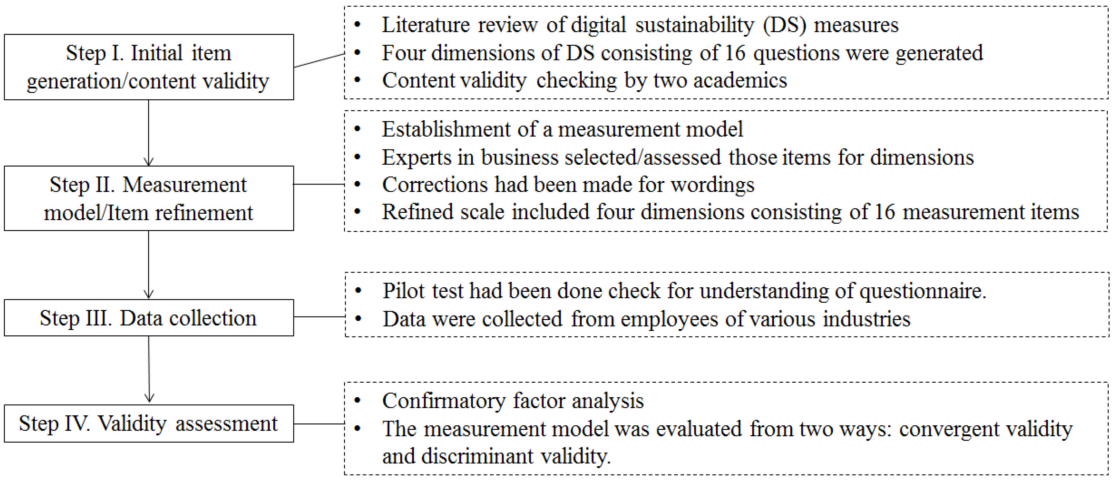

Figure 1. Methodological steps (Source: authors).

3.2.1. Item Generation

We conducted a focus group meeting of employees from various industries including financial, retail, engineering and professional services in September 2020; with brainstorming activities held. Measurement items as shown on Table 2 were derived from the literature and appropriate sources were disclosed. Members of focus group were provided with

the items; and they were asked to give opinion as to whether the item categorization is reasonable. Based on the literature review in Section 2 and our focus group results, 16 measurement items of digital sustainability were identified. Exploratory factor analysis (EFA) was then conducted in the pilot test in September 2020 and four-factor structure of digital sustainability was identified. It accounts for 78.10% variance. No item was deleted due to low or cross loading.

Table 2. Initial generation of digital sustainability dimensions and items.

Dimension/Item	Adapted/Defined Item Description	Source
	Content	
DS_C1	Corporate documents should be produced into digital content, actively updated, and publicly available.	Kallinikos (2013) [5]
DS_C2	Corporate images and photographs should be produced into digital content, actively updated, and publicly available.	Kallinikos (2013) [5]
DS_C3	Corporate audio and video materials should be produced into digital content, actively updated, and publicly available.	Kallinikos (2013) [5]
DS_C4	Corporate websites/web pages should be actively updated, and publicly available.	Kallinikos (2013) [5]
DS_C5	Sustainable file formats should be used to maintain long-term accessibility of corporate digital content.	Bradley (2007) [8]
	Technology	
DS_T1	Technology should be available for development of digital content.	Seele (2016) [12]
DS_T2	Technology should be available for storage of digital content.	Bradley (2007) [8]
DS_T3	Ongoing maintenance for technology used to develop and store digital content should exist.	Bradley (2007) [8]
DS_T4	Technology should be available for staff to share and access digital content.	Seele (2016), Stuermer et al. (2017) [4,12]
	Preservation	
DS_PE1	Staff resources should be secured for ongoing support with digital content.	Seele (2016) [12]
DS_PE2	Financial support should be secured for ongoing maintenance of digital content.	Bradley (2007), Stuermer et al. (2017) [4,8]
DS_PE3	Digital content should be well documented with descriptive information.	Bradley (2007) [8]
DS_PE4	As users, we can understand, interpret, and discover well documented digital content.	Bradley (2007) [8]
	Promotion	
DS_PA1	Organizations should hold activities that raise the engagement with digital content.	George (2020) [10]
DS_PA2	Digital content should be promoted through organization-led initiatives.	George (2020) [10]
DS_PA3	Digital content should be promoted through management-led initiatives.	George (2020) [10]

3.2.2. Content Validity

Two academics were invited to allocate the presented items to various dimensions independently and ensure that the items represent the latent variable. Minor amendments were made to the wordings of the items, and all the items were corrected and placed under the four dimensions finally.

These constructs covered four major dimensions of digital sustainability: content, technology, preservation and promotion [8,10,17]. The four dimensions consist of 16 measurement items, as shown in Table 2. The first dimension, content, assesses whether information within the organisation is produced, updated and provided in the form of dig-

ital content. The second dimension, technology, measures the availability of technology in the organisation to support the creation, storage, maintenance and dissemination of digital content. The third dimension, preservation, assesses whether resources are present in the organisation for the preservation of digital content and that the preserved digital content is accessible through clear documentation. The last dimension, promotion, measures whether management and organisational initiatives are presented to promote the engagement with digital content in the organisation.

3.2.3. Measurement Model

No single dimension of digital sustainability can explain the entire construct. Thus, this study regarded digital sustainability as a second-order, reflective–reflective construct. Sixteen indicators enabled the measurement of the four dimensions of digital sustainability. The respondents were asked to rate the individual question on a seven-point Likert scale, from 1 'strongly disagree' to 4 'neutral' and 7 'strongly agree'. In reflective measurement model, the standardized loadings will be larger than 0.708. The loadings' squares give us the variance shared between an indicator and the construct [18].

3.2.4. Item Refinement

A pilot test of about 10 employees was conducted to check for the understanding of the questions in the survey questionnaire; the result of this pre-test was used to fine-tune the items. Besides, several experts in the business management area were also invited to make an independent assessment on the 16 items. The pre-test and expert validation allow the researchers to further improve the questionnaire and assure that the questions are well-formulated relating to the objectives of the study and be well understood by the respondents. The feedback from the pilot test participants together with the opinions from the experts on unclear terms and incomplete items were taken into account for refinement of the items; and corrections were then made on the items relating to wording of questions, comprehension and clarity. All the questionnaire items were originally written in English and were then translated into Chinese by using the back translation method [19]. A cover letter indicating the aim of the research and a short paragraph on the definition of digital sustainability was attached to the questionnaire to ensure that the respondents understood the key concepts of digital sustainability.

3.2.5. Sample and Data Collection

Data were collected from employees working in various industries in Hong Kong using a convenience sampling method which requires much less time and resources [20]. We sent out 200 questionnaires by electronic mail in October 2020 due to the COVID-19 pandemic; and received completed questionnaires from 150 respondents (response rate 75%). However, five of the respondents were found out being full time students, and thus their replies were discarded. In order to reduce self-selection bias, we compare our sample characteristics to the whole population. The final sample consisted of 145 respondents, and the distribution of the respondents were analysed by gender, age and occupational information. They were about the same distribution of working population in the city [21]. The gender distribution was rather balanced, with 53.8% were male and 46.2% were female. 37.9% of the respondents were with age group of 41–50; while the proportion for other age groups of 18-30 and 31-40 was 29% and 22.1% respectively. For the occupational distribution statistics, 38.6% were professionals, 19.3% were from the technology and engineering fields, 11% hold clerical or administrative positions and 10.3% were from the financial services industry. Doctors, nurses, health care supporters, teachers, lawyers and psychologists belonged to the category of professionals. Over half of the respondents (58.6%) were from large companies with more than a hundred employees, and 14.5% were from middle-sized companies that employed between 51 and 100 people. Approximately 31% of the respondents had been working in the same company for more than 10 years, and the rest of the 69% were evenly distributed among other groups of 5–10 years, 2–5 years,

and 6 months to less than 2 years. In terms of positions in the company, 33.1% of the respondents were at the entry level, 27.6% were at the supervisory management level and 20.7% were at the middle management level (Table 3). In summary, many of the respondents were experienced workforce from large organisations.

Table 3. Demographic data of respondents.

Category		Frequency	Percentage %
Gender	Male	78	53.8
	Female	67	46.2
Age	18–30	42	29.0
	31–40	32	22.1
	41–50	55	37.9
	51–60	12	8.3
	61 or above	4	2.8
Company size	Less than 5 people	12	8.3
	5–20 persons	14	9.7
	21–50 persons	13	9.0
	51–100 persons	21	14.5
	101 or above	85	58.6
Industry	Tourism	4	2.8
	Financial services	15	10.3
	Civil servant	9	6.2
	Engineering and technology	28	19.3
	Trading & Logistics	4	2.8
	Clerical/Admin	16	11.0
	Retailing and customer services	6	4.1
	Professionals	56	38.6
	Cultural and creative	3	2.1
	Self-employed	2	1.4
	Career break	0	0
	Others	2	1.4
Tenure	Less than 6 months	10	6.9
	6 months to less than 2 years	30	20.7
	2–5 years	30	20.7
	5–10 years	30	20.7
	10 years or above	45	31
Job level	Entry level	48	33.1
	Supervisory level	40	27.6
	Middle management level	30	20.7
	Senior management level	15	10.3
	Director level	12	8.3
	Total	145	100

4. Data Analysis

Confirmatory Composite Analysis (CCA)

CCA, being a systematic methodological process, is used in measuring model assessment in PLS-SEM. Under our reflective measurement model, the items or indicators are affected by latent variable—digital sustainability (Figure 2).

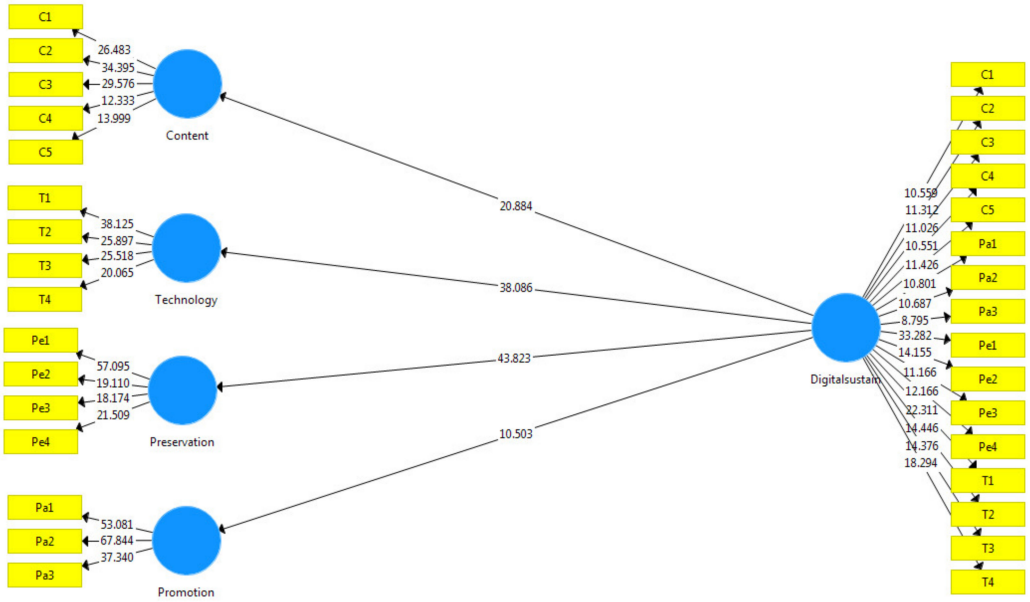

Figure 2. Partial Least Squares Model (Source: authors).

Reliability of the construct could be assessed by Cronbach's alpha and composite reliability. Composite reliability was considered as a better option and usually more accurate than Cronbach's alpha; as it was weighted and opposed to Cronbach's alpha as unweighted [18]. The data were input into SmartPLS (Version 3.2.9) software (Germany) for analysis. The measurement model was evaluated in two ways: convergent and discriminant validity assessment. Average variance extracted (AVE) is used to assess convergent validity. The indicator loadings, composite reliability and average variance extracted (AVE) were summarized in Table 4 [22].

Table 4. Convergent validity and reliability of the constructs.

Construct	Item	Loading	Cronbach's Alpha	Composite Reliability	AVE
Content	C1	0.838	0.866	0.904	0.655
	C2	0.873			
	C3	0.866			
	C4	0.697			
	C5	0.758			
Technology	T1	0.896	0.868	0.911	0.718
	T2	0.867			
	T3	0.848			
	T4	0.773			
Preservation	Pe1	0.895	0.838	0.892	0.674
	Pe2	0.8			
	Pe3	0.797			
	Pe4	0.788			
Promotion	Pa1	0.911	0.911	0.944	0.849
	Pa2	0.939			
	Pa3	0.914			

As shown in Table 4, the loadings of all items have met the minimum requirement of 0.708, except C4 (Corporate websites/web pages should be actively updated, and publicly available) with 0.697, which was only marginally lower than the threshold. Thus, C4 indicator was retained. Cronbach's alpha and composite reliability were also adopted to assess the internal consistency reliability following the recommended threshold 0.70 [18]. Cronbach's alpha and composite reliability of all the constructs were found higher than

0.70. Also, Cronbach's alpha and composite reliability cannot be higher than 0.95, which indicators were measuring the same concept. Some indicators are redundant. As shown in Table 4, all the values in Cronbach's alpha and composite reliability are less than 0.95. That means the required diversity within each construct are fulfilled. Lastly, AVE was measured following a minimum threshold of 0.50 to test the convergent validity [18]. All four constructs' AVE values are larger than 0.50 which confirm the convergent validity.

The measurement model was investigated for discriminant validity. As presented in Table 5, discriminant validity was examined. The square root of the AVE of each construct was greater than the related inter-construct correlations in the construct correlation matrix. The values in diagonal were greater than the other values in the same column. In the content column, 0.809 is the largest number (Table 5).

Table 5. Assessing Discriminant Validity.

Construct	Mean	Standard Deviation	Content	Preservation	Promotion	Technology
Content	5.8966	0.93930	0.809			
Preservation	5.9690	0.74354	0.628	**0.821**		
Promotion	5.6897	1.02036	0.483	0.574	**0.921**	
Technology	6.0517	0.76654	0.586	0.755	0.529	**0.848**

Note: Bold means that the square root of the AVE of each construct is greater than the construct's highest correlation with any other construct.

The weights of first-order constructs on the designated second-order construct are shown in Table 6. All the path coefficients are significant, and p values are less than 0.001.

Table 6. Second order construct.

Second Order Construct	First Order Constructs	Path Coefficients	t-Value	*p*-Value
Digital sustainability	Content	0.825	20.884	0.000 ***
	Preservation	0.891	43.823	0.000 ***
	Promotion	0.746	10.503	0.000 ***
	Technology	0.868	38.086	0.000 ***

*** $p < 0.001$.

The results indicated that digital sustainability is a second-order factor with four dimensions: content, technology, preservation and promotion (Figure 2).

The scale development research on digital sustainability yielded positive results. Systematic literature review and analysis showed that the power of the posited model was significant and supported that digital sustainability in a corporation is a second-order reflective construct consisting of four dimensions: content, preservation, promotion and technology. The content dimension includes five items: the production, update and availability of digital content for (i) documents; (ii) images and photographs; (iii) audio and video; (iv) corporate websites; and (v) the use of sustainable file formats for long-term accessibility of corporate digital content. The preservation dimension has four items: (i) staff resources; (ii) financial support in relation to securing the ongoing support with digital content; (iii) the documentation of digital content and (iv) the facilitation of understanding, interpretation and discovery of digital content through good documentation within the corporation. The promotion dimension comprises three items: (i) organisational activities that raise the engagement with digital content; (ii) organisation-led initiatives that promote the usage of digital content and (iii) management-led initiatives that promote the usage of digital content. The technology dimension consists of four items: (i) the availability of technology for the development of digital content; (ii) the availability of technology for the storage of digital content; (iii) the ongoing maintenance for the technology used to develop and store digital content and (iv) the availability of technology for staff to share and access digital content. The concept centred on the longevity of data and information within the organisation through digitalisation. Our empirical exploration confirmed that

all the four dimensions collectively define digital sustainability as a second-order reflective construct, implying that all dimensions must be present for effective digital sustainability in the organization.

The two research questions were answered; and we will discuss the theoretical and practical contributions of this study to digital sustainability in the context of organization in the following subsections.

5. Discussion

This study is among the first to conceptualize and operationalize an important concept of sustainability research: digital sustainability. We critiqued and extended existing research by proposing a four dimensions model.

5.1. Theoretical Contributions

The review of extant literature revealed the absence of a scale measuring digital sustainability since its ideation advocated by Bradley [8]. This study developed and validated a scale measuring digital sustainability in the context of organization from the perspective of employees. Prior digital sustainability studies focused primarily on the context of cultural and historical artefacts [4,7,8,11] but seldom on the context of organization. For the first time, the current study examined digital sustainability from the theoretical perspective of organization through the eyes of employees in corporations. This study was the first attempt to investigate digital sustainability in corporations and explore how digital sustainability is perceived by employees in the organization.

The result of this research confirmed that digital sustainability in the organization is an integral of four dimensions, reflectively operationalised by 16 indicators, as shown in Figure 2. This conceptual development advanced the understanding and measurement of digital sustainability and validated that digital sustainability cannot be measured using one-dimensional or single-item measures. This paper distinctively contributes to the sustainability literature and scale development efforts. Extant literature has emphasised the conceptualisation and importance of digital sustainability, while this study expanded the empirical conceptualisation into scale development. Digital sustainability in the organization was validated as a manifestation of the availability, preservation, promotion and technological aspect of digital content in corporations.

In summary, this study made significant contributions to operationalising digital sustainability in the context of organization. This paper presents a scale development research that adopted confirmatory composite analyses which represent a distinctive scale development in the organization for digital sustainability.

5.2. Practical Implications

Whilst extant studies of digital sustainability focused primarily on the preservation of cultural and historical artefacts in digital content, corporations are also in need of digital sustainability. The production, preservation and ongoing accessibility of digital content in the organization are inevitable processes of knowledge management and entrepreneurship in the digital era [10]. Digital sustainability, as advocated by George et al. [10], seeks to advance the sustainable development goals through the creative deployment of technologies that create, use, transmit or source electronic data in organisations. The digital sustainability scale developed in the present research provides a tool for corporate management to sense the acceptance and hurdles towards digital sustainability amongst employees in an organisation in the areas of content production, preservation, promotion and technological enablers. Amongst all dimensions comprising digital sustainability, technological enablers and resources in relation to the preservation of digital content are rated as the topmost important factors contributing to digital sustainability. Low mean ratings for promotion indicates that employees consider digital sustainability an important practice in the organization; and not because of any incentive from the management or organisational activities. Employees, as the major producers, users and beneficiaries of digital sustainability in the

organization, appear to praise highly the longevity of documents, images, web information and corporate knowledge in digital formats. Thus, management should focus on investing behind organisational resources and technologies that enhance the operationalisation of digital sustainability rather than seeking to promote the understanding of the concept and importance of digital sustainability.

5.3. Limitations

This study has two limitations. Firstly, the data collected were mainly come from the employees of organizations in Hong Kong. Additional studies in other geographical locations might help broaden the understanding of whether there are differences in the perception of digital sustainability in the organization exist amongst cultures or subcultures. A wider coverage of different sectors including engineering, technology, medical services and financial services makes the study more representative. Secondly, this survey study relied on the self-report of employees [23]. The questionnaire did not ask for any personal information of the respondents; so as to preserve their confidentiality and to avoid social desirability problem.

6. Conclusion and Future Research Areas

This research conducted a systematic literature search to conceptualise and identify the dimensions of digital sustainability. A quantitative survey of digital sustainability amongst employees (n = 145) was performed to understand the perception of digital sustainability. In accordance with the established guidelines on scale development, useful data were analysed via PLS-SEM. The result of this research confirmed that digital sustainability, as a second-order construct, consists of four dimensions: content, preservation, promotion and technology. Future research may conduct a comparative analysis across hierarchical levels in organisations in terms of the operationalisation of digital sustainability. In this digital world, digital sustainability plays a crucial role in enabling the longevity of information availability and knowledge transfer in the organization. It constitutes one of the important components of entrepreneurship embracing the power of business digitalisation [10]. To be digitally sustainable, a corporate should invest in resources and technologies that enable the production and preservation of digital content in the organization. The predictive validity of our digital sustainability construct should also be tested. Possible outcome latent variables include knowledge retention and information sharing.

The next further research area of the digital sustainability construct is to assess its nomological validity in predicting other constructs in a structural model [23]. Possible constructs are stakeholder engagement, and employee engagement. This echo to solve the digital divide problem by organizations and enable the organizations to contribute to the society for becoming good corporate citizens.

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References

1. Pan, S.L.; Zhang, S. From fighting COVID-19 pandemic to tackling sustainable development goals: An opportunity for responsible information systems research. *Int. J. Inf. Manag.* **2020**, *55*, 102196. [CrossRef] [PubMed]
2. Martin, D.; Schouten, J. *Sustainable Marketing*; Pearson: New York, NY, USA, 2012.
3. Buckingham, D. *Youth, Identity, and Digital Media*; MIT Press: Cambridge, MA, USA, 2007.
4. Stuermer, M.; Abu-Tayeh, G.; Myrach, T. Digital sustainability: Basic conditions for sustainable digital artifacts and their ecosystems. *Sustain. Sci.* **2017**, *12*, 247–262. [CrossRef] [PubMed]
5. Kallinikos, J.; Aaltonen, A.; Marton, A. The ambivalent ontology of digital artifacts. *MIS Q.* **2013**, *37*, 357–370. [CrossRef]
6. Linkov, I.; Trump, B.D.; Poinsatte-Jones, K.; Florin, M.-V. Governance strategies for a sustainable digital world. *Sustain. J. Rec.* **2018**, *10*, 440. [CrossRef]
7. Stüermer, M. Characteristics of digital sustainability. In Proceedings of the 8th International Conference on Theory and Practice of Electronic Governance, Guimaraes, Portugal, 27–30 October 2014; ACM: New York, NY, USA, 2014; pp. 494–495.
8. Bradley, K. Defining digital sustainability. *Libr. Trends* **2007**, *56*, 148–163. [CrossRef]
9. United Nations. *Report of the World Commission on Environment and Development: Our Common Future. UN Documents: Gathering a Body of Global Agreement*; United Nations: New York, NY, USA, 1987; Available online: http://www.ask-force.org/web/Sustainability/Brundtland-Our-Common-Future-1987-2008.pdf (accessed on 26 January 2021).
10. George, G.; Merrill, R.K.; Schillebeeckx, S.J.D. Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development. *Entrep. Theory Pract.* **2020**. [CrossRef]
11. Konstantelos, L.; Hughes, L. *Digital Sustainability Review of HLF-Funded Projects*; Heritage Lottery Fund: London, UK, 2019; Available online: https://core.ac.uk/download/pdf/305111869.pdf (accessed on 26 January 2021).
12. Seele, P. Envisioning the digital sustainability panopticon: A thought experiment of how big data may help advancing sustainability in the digital age. *Sustain. Sci.* **2016**, *11*, 845–854. [CrossRef]
13. Lock, I.; Seele, P. Theorizing stakeholders of sustainability in the digital age. *Sustain. Sci.* **2016**, *12*, 235–245. [CrossRef]
14. Miller, C.; Wells, F.S. Balancing Security and privacy in the digital workplace. *J. Chang. Manag.* **2007**, *7*, 315–328. [CrossRef]
15. Churchill, G.A. A paradigm for developing better measures of marketing constructs. *J. Mark. Res.* **1979**, *16*, 64–73. [CrossRef]
16. Hair, J.F.; Howard, M.C.; Nitzl, C. Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *J. Bus. Res.* **2020**, *109*, 101–110. [CrossRef]
17. Stuermer, M.; Abu-Tayeh, G. Digital preservation through digital sustainability. In Proceedings of the iPRES, 13th International Conference on Digital Preservation, Bern, Switzerland, 3–6 October 2016.
18. Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to use and how to report the results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24. [CrossRef]
19. Karatepe, G.M.; Choubtarash, H. The effects of perceived crowding, emotional dissonance, and emotional exhaustion on critical job outcome: A study of ground staff in the airline industry. *J. Air Transp. Manag.* **2014**, *40*, 182–191. [CrossRef]
20. Chauhan, S.; Gupta, P.; Jaiswal, M. Factors inhibiting the internet adoption by base of the pyramid in India. *Digit. Policy Regul. Gov.* **2018**, *20*, 323–336. [CrossRef]
21. Census and Statistics Department. Snap Shot of Hong Kong Population. 2016. Available online: https://www.bycensus2016.gov.hk/en/Snapshot-03.html (accessed on 2 February 2021).
22. Hair, J.F.; Hult, G.T.M.; Ringle, C.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*; Sage Publications: New York, NY, USA, 2017.
23. Motamarri, S.; Akter, S.; Yanamandram, V. Frontline employee empowerment: Scale development and validation using Confirmatory Composite Analysis. *Int. J. Inf. Manag.* **2020**, *54*, 102177. [CrossRef]