Managing the Development of a Sustainable Digital Village

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Abstract: Area development is a critical issue that has a strong relation to economic, social, and environmental performances in an area. Boosting area development can be achieved using digitalization. However, digitalization is predominantly available for city life. Rural areas or villages are often left out, because of infrastructure deficits. With enough infrastructure support, rural areas in developed countries have also faced social problems such as population drops. Therefore, a comprehensive solution regarding the use of digitalization to boost rural area development is needed. This concept is often called the digital village. This paper proposes a concept for managing and evaluating the development of a sustainable digital village. The concept is developed based on the reviewed aims, expected deliverables, and existing concerns in previous digital village implementations. To justify the model, management theories, practices and available technologies are also reviewed. The proposed concept for digital village management is also compared to the concepts of enterprise architecture and project management, to evaluate its usability. Sustainability evaluations are performed regarding the three-bottom line of evaluation and the use of ICT resources in the integration of ICT into human resource management (HRM) and supply chain management (SCM). A development model and evaluation method are also proposed to make sure that digital village development and evaluation can be conducted efficiently.

Keywords: digital village; implementation review; enterprise architecture; project management; sustainability evaluation; development model; evaluation method

1. Introduction

Digitalization is now a widespread practice in our life. Commerce, education, and health sectors are all implementing information, communication, and technology (ICT) in their daily activities. E-commerce is one excellent concept that connects all types of stakeholders together, enabling them to communicate and conduct transactions [1]. The concept has brought several benefits, such as reducing the time and effort required to perform a task, promoting understanding between stakeholders, and helping to look into the future of the business, among others. This is made possible by incorporating ICT into the manual processes conducted.

ICT has been expanding its capabilities in providing services. Several advanced technologies have been developed. The concept of knowledge management enables one to put together existing knowledge into one platform [2]. Data that have been transformed into information to become knowledge increase easiness in performing communication, bring understanding, and provide possibilities to look into the future [2–4]. Automation is another concept that provides a substitute to the tasks commonly performed by humans [5]. The two technologies provide us with the ability to perform a variety of previously impossible tasks, such as predicting sales performance in a couple of years or monitoring soil conditions without really going to the field.

The availability of technologies leaves questions on whether those technologies have been used optimally in area. Countries have been divided into urban/city and rural area developments. Technologies have been implemented well in city areas, especially in developed countries. This is possible because of the availability of supporting resources...
such as internet infrastructure and human resources [6]. However, this is not easily the case for rural areas, especially in developing countries [7,8].

Rural areas have specific conditions that make it difficult for ICT to be implemented. One important problem is the availability of infrastructure, such as electricity and internet connection [8–10]. This condition means rural areas are easily left out from development. Rural areas in developed countries, on the other hand, have also faced problems in other aspects, such as decreasing population [11]. One reason for this is that living in rural areas does not match the expectation of how residents, especially the young ones, proceed with their lives [11]. This shows that the development of rural areas is not simply about the availability of resources, but also how the rural area residents develop their communities to live up to the expectations they set.

One solution is the digitalization of rural areas. The concept has been commonly named digital village [12–14]. The concept has been implemented in several countries with a different range of scopes [10,13,15–19]. However, developing a digital village is not simply just putting all the ICT available into a rural area. The concept should proceed hand in hand with the expectation that the residents have of how the communities should be built [11]. This also includes how to mold a community to the concept of the digital village without leaving out the social and cultural aspects of the community. Regarding previous implementations, the proposed models were found to lack evaluations and justifications of management, human resources development, and/or branding and community awareness aspects [8,15,19–22]. Previously proposed models [8,19–21] have also not provided enough justification for how the models contribute to sustainability management to result in sustainability capabilities.

This paper aims to propose a concept for developing and managing a sustainable digital village based on the reviewed aims, expected deliverables, and existing concerns in previous digital village implementations. The concept is also formed by reviewing management theories and practices, and the available technologies. The concepts of enterprise architecture and project management are also compared so that the proposed model is ready to be used for development as well as implementation. Evaluations of the proposed model regarding the three-bottom line of evaluation and the use of ICT resources in the integration of ICT into human resource management (HRM) and supply chain management (SCM) are also conducted. To make sure that the concept can be used properly, a new project development model based on the Scrum development model is designed. Moreover, an evaluation method is also proposed to make sure that the implementation is evaluated well to guarantee its sustainability.

The paper is structured as follows. Section 2 elaborates on the methodology implemented in this research. Section 3 provides a review of the concept, aims, expected deliverables, and existing concerns of the concept implementation. It also includes a review of the relation between digitalization and sustainability management. Section 4 consists of an explanation of the model proposed for managing a sustainable digital village. Justifications of the proposed method in relation to the reviewed aims, deliverables, and concerns, and to enterprise architecture and project management, are provided. The sustainability evaluation of the proposed model is also elaborated here. Section 5 elaborates the proposed development model, which includes the concept of the Scrum development model. Several strategies in developing a digital village are provided, based on the reviews of previous implementations. Section 6 provides an evaluation method of the concept’s implementation to ensure its quality and sustainability. The paper ends with a discussion of the conclusions of the paper to be used further for future work.

2. Research Methodology

As illustrated in Figure 1, the research reported in this paper is conducted by following the several steps below:

1. Desk-based literature review, where previous digital village implementations are reviewed regarding the concept, objectives, and existing concerns;
2. Analysis of findings, where all the review results are analyzed and summarized into several aspects. The aspects are further used as a base to form a model that will be used to manage the development of a sustainable digital village;

3. Model development, where a model for managing the development of a sustainable digital village is proposed, answering the aspects derived from the analysis of the findings. Justification, comparison, and confirmation are provided following the points below:
   a. Justifications are provided based on related management theories and practices, and available technologies;
   b. The proposed model is also compared to other concepts, including enterprise architecture and project management concepts;
   c. Sustainability evaluations based on the three-bottom line of evaluation and the use of ICT resources in the integration of ICT in HRM and SCM are also conducted.

In addition to the management model, a development model is also analyzed to allow the development to be conducted efficiently. Evaluation criteria are also analyzed to make sure that the concept’s implementation can be evaluated. They are formed based on the necessary aspects and the availability of data sources.

3. Literature Reviews on Digital Village Implementations

3.1. Concept of Digital Village

Digital village is a social entity concept formed by community awareness, and a desire to think beyond and build a new form of cooperation and alliances using advanced digital technologies [12]. It is not only incorporating digitalization into the village, but also forming a social entity that can address the problems existing within the village. The concept must be based on community awareness and look for comprehensive solutions to all problems efficiently. The implementation could even end up producing a new form of cooperation among residents.

The concept is also considered as an ecosystem, where services are delivered digitally to provide local goods, social services, mobility and communication solutions, and
governance [12]. Residents in a village have a range of needs in the form of goods and services. Digital ecosystem could provide solutions to the needs. Digital solutions could also ease mobility and communication problems using integrated systems. This ends up with effective and efficient governance, which provides better services to the community.

The term is also interpreted as a concept whereby all components involved, including people, technology, and governance, can act smart in a highly effective and efficient way [13]. The concept integrates all components to work. Geared with the use of technology, residents will have the tools to think and act smartly, making decisions based on data. As in all integrated systems, governance could be conducted easily in a very efficient and effective way. All the unnecessary tasks and resources will be excluded.

From another perspective, it also exemplifies a new way of thinking for off-grid communities worldwide [14]. The concept provides solutions to the village residents. However, when each digitalized village is connected to the others, all villages’ needs and solutions become connected to one another. One village’s abundance will be a solution for the other villages that are lacking, and vice versa.

3.2. General Aims of Digital Village

Digital village is a complex concept that has a lot of aims. One aim of the digital village concept is to empower rural communities. This is conducted by implementing digital technologies through the act of innovation in developing cross-sectoral solutions that are sustainable, cost-effective, and affordable [12,17,19]. Digital village also aims to develop the concept of literacy culture. Culture stimulates new communication patterns, new information and decision practices, new actions and transactions model, and ends up achieving community culture prosperity [19,23].

Implementing the concept of digital village is also equivalent to creating a digital infrastructure that can be used as a utility for every rural resident [10,23]. The infrastructure provides services to rural residents digitally [24], and residents can conduct daily activities effectively and efficiently [12]. Furthermore, the concept ends up also establishing good governance [19,23], by using structured management systems [22] that can improve government performance and productivity [23].

Socially, the integrated concept of digital village reduces digital divides and develops a culture of collaboration and participation between residents, including immigrants, local authorities, and local industry [17,25]. The concept is also used to establish a network for attracting professionals and improving the digital skills of residents [12]. Several larger social outcomes, such as avoiding population drops, anticipating generational changes, and shifting the balance of opportunities and population distribution between villages and cities could also be answered by implementing the concept [11,12,24].

The concept can be used to boost local development economically [10] and revitalize local economic potencies [10]. This in turn can increase the income of rural residents [24], provide a basis for economic self-reliance [25], and stimulate the financial independence of rural residents [16]. One specific area of the concept’s implementation is bridging the gap between the digital developer and actual service commercialization [26]. By bridging the two parties, it could result in a growth in the number of businesses [27].

Environmentally, the concept promotes sustainability in village development by setting up livable space ecologically [19]. The integrated concept of digital village avoids the inclusion of unnecessary tasks and uses of resources. By implementing this concept, access to sustainable energy is promoted, and more holistic and integrated approaches can be applied to enable access to energy in the rural contexts [14]. This in general improves the sustainability of the environment [12].

On a macro level, the implementation of digital village, with its economically and socially integrated community concept, pushes domestic product growth and increases income per capita [23] by generating more employment and improving labor productivity [23,27]. This in turn influences the effort in fighting against poverty, and enhances the quality of village life [24,28]. In more detail, the concept could also improve the quality of education,
healthcare, and banking access, including avoiding intermediacy, illiteracy, ignorance, a lack of funds, a lack of information, and a lack of investment knowledge [10,27].

3.3. Expected Deliverables of Digital Village

Digital village is a concept whereby services provided by all stakeholders are delivered digitally. As such, the output expected from the concept is used to stimulate the development of the service industry [20], improve local commerce [7], regenerate local industries [15], stimulate public–private partnerships, especially small–medium enterprises [29], and make it easier for ICT innovators to start a company [29]. By integrating all the related knowledge and means of communication, the concept also boosts the creation of domestic handicraft [30] and helps create more high-quality products [20].

As an integrated system, the concept has the ability to circulate and spread information and news about rural governance and rural services to all residents [17,20,31]. For this purpose, the standardization of broadcasting content is needed [29]. Residents could also contribute to provide content that can stimulate local content development [28]. This concept optimally uses technology and expands the availability of information [10]. With the concept of integrated information, an open data policy can be set [29] to provide easy access to information for residents [31]. Via this process, it provides a means of rapid information dissemination in the village [15]. The concept could also include applications of big data in any projects conducted [29] to encourage variety in information production.

Regarding local government conduct, the implementation of digital village initiates e-governance [29], and transforms manual work into a fully automation system within government [31]. One characteristic of an e-government is that it provides two-way communication between residents and the government [31], so that the government staff can quickly respond to, analyze, and resolve problems raised by residents [23,31]. Another characteristic of e-governance is its ability to stimulate public accountability [7,23], which lessens revenue leakage in government [10] and ends corruption systems [7]. The concept also reduces paperwork [7] and improves work quality in local administration [15]. This ensures good governance and services on demand [23], and all answers to villagers’ needs are provided effectively and efficiently [23].

Economically, through information provision, the concept also provides employment opportunities through job creation and job opportunities [28]. Information sharing and information generation through integration produce new employment opportunities that previously did not exist. Its implementation also provides a platform for developing a reliable and trustworthy service system [22], and it can act as an incubator for creating and developing socially responsible ideas that enhance the quality of life [30].

A social center could also be developed to provide a range of improved services [12]. The center could be used as a tool to stimulate a digitally active and healthy aging society [29], and to provide care for the elderly [10]. A combination of the center with the inclusion of digitalization in the village also helps establish an education center providing education for all [31], and improving education systems [7]. The facility will be a catalyst to improve knowledge for villagers [7], and develop villager capacities [23,28]. This also enhances the business skills and knowledge of villagers [28], and in turn develops emerging talents and digital industry entrepreneurship [20]. With villager capacity development, it eventually increases the abilities of villagers to manage village potential [23].

The concept itself cannot be separated from infrastructure development. Software and hardware infrastructures [28] are always part of the concept. It can accommodate so-called baked-in innovation, whereby the infrastructure is incorporated as part of the overall concept [11]. Because of the integration concept, the implementation uses energy efficiently [29] by reducing overall energy consumption [10] and lowering the carbon footprint, with a reduction in fuel consumption, and the promotion of better waste management, greener workplace management, and greener ecosystems [10,27].
3.4. Existing Concerns of Digital Village Implementation

3.4.1. Infrastructure Concerns

The most well-known issue in implementing digitalization to a rural area is connectivity. Connectivity is a prerequisite for digital village implementation [8,10,32,33]. The connection can extend as far as the provision of high-speed internet [33] or broadband connectivity [7,10,31,34,35]. However, providing massive broadband connection can cost a lot of money. In substitution, wi-fi hotspots with a wide range of capacities and types can be used instead [7,10,31,36].

To make sure that it is implemented well, the scaling up of connectivity infrastructure is always required [29]. Some infrastructures are aging and need to be revitalized [11]. In this case, fundraising can always target investments in broadband infrastructure [34]. Another infrastructure problem is that the adoption rate of internet in rural areas can be diverse and terribly slow [10]. Collaboration between internet providers in providing towers is also limited [9]. For some that are ready to be used, the bills are too high, and they are not affordable for rural villagers [15,28]. In relation to connectivity, one other principal issue in implementing the concept is the availability of a reliable electricity supply [8].

Related to digital infrastructure, deficits always emerge in rural areas [31]. Several prerequisites for implementing the concept exist, including the needs of updated computers [36], the digital information environment, the application environment [8,17,19,35–38], infrastructure support [38], and domain-specific services [17]. Such infrastructures need to be well-equipped [36], and their provision by locals is recommended for cheaper price and easier maintenance [39].

Digital village includes the concept of integrating services using applications, so that application infrastructure is an important part of the concept. However, along with implementation, problems arise such as service apps that have not been well developed [31,35]. Demands for comfort in using technology, especially regarding user interface (UI) and user experience (UX), also become a problem [11]. Already-existent digital villages use legacy business systems that lack current technologies [11], and they are often too complex [6,11].

Integrating information also introduces some problems. The first problem regards whether the information required is readily available or not [8,28]. This can be due to the problem of the standardization of information and content creation [32]. Some types of sectoral informatization, such as administrative and educational informatization, are often conducted without considering the convenience of residents [16].

In providing information to all users, access to information and digital knowledge needs to be set up properly [40]. In this regard, information, in particular personal data, need to be provided securely [29] and guaranteed with the highest safety [32]. Authentication can be implemented for security [7]. Security regarding cyber connections should also be incorporated to make sure that no intrusions occur [11].

3.4.2. Awareness and Branding Concerns

A digital village is formed based on community awareness. A lack of community awareness [8,9], solidity [9], contributions [8], and commitment [41] will result in an unsuccessful digitalization project. A key resource of a successful digital village project is its residents [35]. Residents can act as drivers to generate demand, values, and motivations [37]. The implementation structure needs to include a platform to collect the support of the community and civil society’s participation [17]. Since the concept is developed based on innovation, the implementation should also consider including a facility to improve the awareness of villagers regarding innovation.

Awareness problems could also arise from the existence of poverty and illiteracy [7]. One example of a lack of response problem is that residents are not used to using online systems of purchasing. There are also elderly residents. Encouraging involvement is also a challenging task [15]. Companies involved also often compete with one another, making it hard for them to make a full contribution [6]. There is also an issue of inflexibility within public and private sectors [6]. In solving the problem of awareness, we also need to analyze
the community background and surrounding environment [28]. Resistance to changes and unwillingness to disturb business partner networks are among the backgrounds that need to be taken into consideration [11]. In relation to project awareness, project branding is also an important part of the development [8].

As a digital village connects all existing stakeholders in the village, the types of stakeholders can include residents and businesses, government administration, researchers [17], labor and financial institutions, universities, and intermediaries [19]. Strong coordination and collaboration among stakeholders is always needed [7,15,24]. However, the real-life condones are often opposed to this, with poor private participation [10] and a lack of coordination among departments [10].

3.4.3. Human Resources Concerns

As skills are fundamental when implementing the digital village [8,32,35–37], capacity-building will always be part of the project. Residents need to scale up the rate of adoption [29], improve their digital literacy [29,34], and upgrade their information literacy [8,34]. Strategies to build digital skills need to be developed and implemented [34]. In particular, a capacity for problem solving needs to be developed in residents [32].

Some specific problems regarding human resources include the lack of suitable human resources [28], the inability to coordinate with foreign human resource or outsourcing firms, and the lack of necessary anthropological and ethnographic skills to understand users [11]. Residents also often find it difficult to keep up with advanced technology [15]. The gap between users and non-users remains large [15].

Regarding culture, a digital village is often considered to depersonalize the construct of a rural area and its human resources [42]. The balance between the value added by ICT use and the expected structure of rural communities and residents needs to be maintained [42]. Cultures are also different from one community to another [7]. It is necessary to consider the residents and local/regional specifics in the analysis of digital village implementation [14].

3.4.4. Management Concerns

To ensure that the digital village is running well, regulations must be put in place. A policy environment [38] needs to be set up to make sure all regulatory and legal compliances are met [11]. Several regulations that need to be considered include intellectual property rights for any resulting innovation [29] and outsourcing policies [10], among others.

Funding will always be part of any project, let alone digital village development [8,36,37]. It is known that digital village development’s costs of implementation are among the highest [10]. The costs include electronic development [10] and costs of services [8]. A mechanism to channel the required funds needs to be set up [8,24]. Some funds can also come from sponsors/donors or researchers [28]. In relation to fundraising, the widespread problem that arises with digital village development is that the development often yields an unclear payback and return [11].

Among other things that arise in digital village development, several management concerns must be analyzed and resolved before proceeding with the development and implementation. The first one is that the implementation structure must have an applied, targeted, and effective policymaking mechanism [24,42]. The organization’s structure, leadership, the leader’s commitment, strategic thinking, political support, transparency, and development targets are among the concerns related to management that need to be considered during the implementation [31,36,37]. Lacking effective data governance, management, standardization [11], and transparency of the projects [6], as well as the issue of time overruns [10], are among the problems often faced in management. The lack of preliminary studies could also result in the implementation strategy not making any contribution to the success of the project [18]. Research and evaluation are also important parts of management when implementing the digital village concept [24].
3.5. Development and Management Concepts

3.5.1. Enterprise Architecture Concept

In implementing the concept of the digital village, an established implementation concept can be used as a base. One such concept is enterprise architecture. Enterprise architecture is an emerging discipline that can help guide the enterprise towards an expected future state \[43\]. It is a complex system composed of human, political, social, software, hardware, and technological components. The concept can be used to visualize the enterprise at many distinct levels. It can be used to define strategic, tactical, and solution architecture concepts aimed at a wide range of stakeholders. The steps involved in an enterprise’s architectural concept are planning, managing, developing, and documenting. Along the way, frameworks, standards, techniques, and tools will be used in the development.

There are four sub-architectures within the enterprise architecture concept. These are business, information, application, and technology architecture. Because of their importance, sub-architectures that cross-cut with other sub-architectures are often separately added. These include security-based, geospatial, and social architectures.

Business architecture refers to the overall successful outcome of the enterprise architecture. It consists of the business strategy, including vision and mission, operational models, drivers, goals, objectives, capabilities, and business processes. Information architecture constitutes the existence and exchange of information within an enterprise. Understanding the types of information that are handled, and which business functions and processes they are handled by, is an important part of this architecture. The architecture includes a conceptual information model, a logical data model, and a physical data model. Application architecture refers to the catalogue of applications used in an enterprise. It includes descriptions of interfaces and interactions between applications, among others. It can be visualized using application lists, diagrams, or matrices. In the business architecture, the application is often connected to capabilities and business processes. Technology architecture describes the logical, physical, and virtual infrastructure that supports the application services.

3.5.2. Project Management Concept

Projects can be managed using project management tools, techniques, and methodologies \[44,45\]. There are ten subtypes of management/knowledge included in project management, including scope, time, cost, quality, human resources, communication, risk, procurement, stakeholders, and project integration managements. The first four knowledge areas are the core knowledge areas that lead to the setting out of specific project objectives. The next five knowledge areas are the facilitating knowledge areas, which are the means to achieve the project’s objectives. The last knowledge area, project integration management, is affected by all other knowledge areas.

Scope management includes defining and managing all the work required to finish the project successfully. Time management includes estimating the time it takes to complete the work, developing schedules, and ensuring the completion of the project. Cost management includes preparing and managing the budget for the project. Quality management includes ensuring that the project satisfies the stated needs. The management of human resources includes making effective use of the people involved. Communication management includes generating, collecting, disseminating, and storing project information. Risk management includes identifying, analyzing, and responding to risks related to the project. Procurement management includes acquiring goods and services for the project from other organizations. Stakeholder management includes identifying and managing the expectations of and impacts on stakeholders. Project integration management includes managing all aspects such that they connect with one another.
3.6. Digitalization and Sustainability Management

Sustainability is a concern that must be addressed in each step of development. Sustainability lies in between environmental performance (planet), economic performance (profitability), and social performance (people) [46]. In considering how digitalization contributes to sustainability management, we might consider how digitalization enables the processes of HRM and SCM to be conducted effectively and efficiently [47]. In an era during which digitalization focuses more on economic impact, the integration of digitalization with HRM and SCM will help us to develop sustainability capacity and ultimately deliver sustainability value [47].

Regarding the sustainability evaluation, the ICT resources can be divided into four types: automate, informate, transform, and infrastructure [47]. Automate resources are used to automate business processes, reducing the hands-on role played by humans. Informate resources are used to make timely and relevant data available to stakeholders. Transform resources are used to restructure business assets, capabilities, practices, processes and/or relationships. Infrastructure resources comprise the deployment of standardized ICT services to support the work of other resources. A study on how to develop ICT resources’ sustainability capabilities [47] has shown that infrastructure resources are needed to contribute to the current and future internal conditions. Automated ICT resources are needed for the current implementation, transform ICT resources for future implementations, and informate ICT resources help in supporting external implementation.

4. A Concept Model for Managing a Sustainable Digital Village

4.1. Logical Model of Sustainable Digital Village Management

Based on reviews of previously implemented digital villages, there are six aspects of digital village implementation that need to be acknowledged in developing a sustainable digital village management model. The six aspects include management, branding and awareness, human resources, infrastructure, social and economy, and environmental aspects. The management aspect concerns the processes involved in managing digital village project development, implementation, and evaluation. The branding and awareness aspects concern the effort to improve resident awareness of and involvement in the project. The human resource aspect concerns the management and improvement of residents’ capacities to participate in the project’s development and implementation. The infrastructure aspect concerns the supporting technologies needed for running the digital village. The social and economic aspect concerns the provision of social and economic sectoral systems to accommodate all the resident needs. The environmental aspect concerns the sustainability of the project. Based on these six aspects, a model for managing a sustainable digital village is proposed in Figure 2.

Figure 2 shows the proposed model for managing a sustainable digital village with 19 types of management. The 19 types of management are compiled based on the reviews conducted on past digital village implementations, the prioritization of management approaches needed in successfully developing and implementing the digital village concept, and the availability of technologies supporting the digital village concept. The first seven managements are proposed as part of the solution in terms of general digital village management. The branding and awareness aspect includes four types of management. The human resources aspect includes two types of management. The infrastructure aspect considers four types of management. The social and economy and environment aspects include one type of management each. A review of and justification for the 19 management types is given below.
Figure 2. The proposed model for managing a sustainable digital village.

4.2. Review and Justification of the Proposed Management

4.2.1. General Management Aspect

Table 1 consists of descriptions of the 7 (seven) types of managements for the general management aspect including policy-making, business process, proposal submission and fundraising, financial, knowledge, evaluation, and administration and documentation managements. Policymaking management is broadly defined as policy governance. Policy governance recognizes that any governing board is required to provide the link between management and the operators, including users [48], and provide the means to frame the organization’s interactions [49]. Policies are formulated in layers, starting from a broad statement, and working downwards in logical succession [49]. In this regard, the necessity of including the policymaking mechanism in managing a digital village project has been discussed in [11,15,24,42]. Several regulations need to be set up for digital village implementation, including regulations regarding the implementation strategies, operational procedures, and evaluation mechanisms. To support the process, a management approach
that represents the policy environment, with its specific policymaking mechanisms, is needed. A policy environment [38] needs to be set up to make sure all regulatory and legal compliances are met [11]. Policymaking mechanisms need to be incorporated so that they can be easily applied in a targeted and effective way [24,42].

Table 1. Description of management approach in general management.

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<th>No</th>
<th>Management</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>Policymaking</td>
<td>Management of policy requirement analysis, policy submission, policy discussion, and policy approval processes.</td>
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<tr>
<td>2</td>
<td>Business Process</td>
<td>Management of business processes, as well as discussion, approval, documentation, and evaluation processes. Initiation of business discussions is based on the policy creation and/or approved project proposal.</td>
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<tr>
<td>3</td>
<td>Proposal Submission and Fundraising</td>
<td>Management of proposal submission and fundraising processes for other stakeholders. This includes management of the submitting, administrating, and monitoring of the progress of the proposal submission and fundraising processes.</td>
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<tr>
<td>4</td>
<td>Financial</td>
<td>Financial management includes the management of funds raised within the project and the expenses spent supporting the project.</td>
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<tr>
<td>5</td>
<td>Knowledge</td>
<td>Management of knowledge obtained from external sources and/or internal sources produced based on data or information from the digital village’s development, implementation, and evaluation processes.</td>
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<tr>
<td>6</td>
<td>Evaluation</td>
<td>Management of project evaluation, including completion and analysis of the evaluation of the development and implementation.</td>
</tr>
<tr>
<td>7</td>
<td>Administration and Documentation</td>
<td>Management of administration and documentation of processes included in the project. This also includes managing the project processes timeline and goods and services procurement.</td>
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A detailed business process is a scoping mechanism that is used as a base for project development and evaluation [44,45,47]. Related to the concepts of systems development and organizational change, business process reengineering is an important process, in which business processes are analyzed, simplified, and redesigned [50]. The organizational concept, including that of a digital village, needs to optimize workflows, and make sure that the business processes involved are of excellent quality. For that purpose, business process management is needed. This involves workflow management, business process modeling, process performance monitoring, and analytics. This enables organizations to manage the incremental changes required in many aspects of the business.

The initiation of projects within the digital village concept could originate from one of several sources, including personal, community-based, and external ones. Information about project priorities needs to be broadcast so that resident expectations can be managed. Proposal submission noticeably relates to fundraising, which can become a problem in relation to transparency. Progress reports of proposal submission and fundraising need to be released for this purpose. Moreover, funds that will be used to support projects can come from various sponsors/donors or researchers [28]. A mechanism to channel the required funds efficiently needs to be set up [8,24]. Project proposal and fundraising management are thus required in digital village implementation.

Financial management plays a key role in any organization, including during digital village implementation [44,45,51–53]. This concept has a close relation with management in general, as well as of technology, resources, personnel, and other aspects [51]. The tasks of this type of management include identifying the organization’s goal and maximizing the return of the funds raised to support the organization [52]. In detail, the tasks involve reconciling financial operations, such as inflow and allocation of cash, and transactions of real assets with the capital market, including via company valuation and shares commer-
cialization [51]. This process influences how the organization makes important decisions. The decision made will in return affect the value of the organization [53].

Knowledge management is a concept that is implemented to manage the knowledge existing within a system [2]. The concept is combined with various technologies such as data management [3], knowledge discovery [4], and data warehousing [54], among others. Knowledge management is needed such that existing knowledge can be incorporated into the system, and unknown knowledge hidden in data and information can be extracted to be used for further processes, such as prediction and decision-making processes, among others [4]. The construction of a knowledge management system does not only consist of inputting existing knowledge, but may also emerge from the development of a database system, such as an information system, or the extraction of data from external systems [2–4,54]. The process requires a data warehouse system that can accommodate summarized data for visualization or analysis purposes [3,54]. Past implementations of digital village systems [10,29,31] determined that the availability [10], integration [29], and provision [31] of knowledge management are essential considerations in making sure information is ready for residents. Its related processes, starting with extraction, transformation, and loading processes [6,31], need to be managed.

Evaluation is a regular activity within any project, and is undertaken to derive feedback regarding its development and implementation [21,24,28,33,55]. Evaluation allows an organization to distinguish between the worthwhile and the worthless, the good and the bad [55]. Evaluation leads to the discovery of merit or quality when making decisions. It also provides insights and accountability at different points of the project’s lifecycle, including needs assessment, quality control, risk management, and process improvement. The level of evaluation may differ in each implementation, starting from the lowest level, including quality assurance or performance measurements, and reaching up to the advanced level, involving the internalization of the evaluated value into the organizational culture [55]. Infrastructure for evaluation management, with a wide range of scope and detail, is required.

Administration, including scheduling and procurement, as well as documentation, is part of project management [44,45]. Administration itself is an activity whereby a particular individual(s) oversees the duties and responsibilities to be performed in an organization or cooperation [56]. Administration plays a vital role in making sure staff can carry out their functions properly, and that the organization continues to provide efficient services without losing sight of the satisfaction of its end users [57]. Administration involves directing formulated policies towards individuals or departments to ensure their effective enforcement [56]. On the other hand, documentation is needed to support administration. Its lifecycle includes creation, storage, access, retrieval, administration, reassignment, collaboration, distribution, preservation, and utilization [58]. Document management is usually supported by electronic systems, to allow ease of use [58,59]. The provision of documentation in an electronic format necessarily involves capturing, giving and receiving annotation, storage management and archiving, distribution, workflow, security, and system integration. Given the scope of work that needs to be performed, administration and documentation management is also a key requirement in the digital village concept.

4.2.2. Branding and Awareness Aspect

Table 2 consists of descriptions of the 4 (four) types of managements for the branding and awareness aspect including branding and awareness, information and news, help desk, and communication managements.
Table 2. Description of management in the branding and awareness aspect.

<table>
<thead>
<tr>
<th>No</th>
<th>Management</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Branding and Awareness</td>
<td>Management of branding and awareness through branding discussion, evaluation, approval, and broadcasting processes. This includes the management of activities set up for improving resident awareness.</td>
</tr>
<tr>
<td>2</td>
<td>Information and News</td>
<td>Management of information obtained from digital village processes and news regarding the project's development, implementation, and evaluation. This is a type of push communication mechanism provided to residents.</td>
</tr>
<tr>
<td>3</td>
<td>Help Desk</td>
<td>Management of a help desk, which includes facilities to perform a Q and A between residents and the management. This is a type of arranged and pre-established collaborative communication mechanism.</td>
</tr>
<tr>
<td>4</td>
<td>Communication</td>
<td>The management of communication, including personal chatting and group chatting, among others, as needed. This is a type of free-flow communication mechanism to and between residents.</td>
</tr>
</tbody>
</table>

Branding and awareness are huge problems in digital village development and implementation [8,9,41]. These issues have been discussed in several digital village reports [8,17]. Branding is generated through communication between the brand owner and the users, who invest unpaid time and effort to build the brand [60]. In successfully creating the branding, branding management is required to allow the brand owner to define the vision and purpose, core brand values, and brand personality codes, and then combine them with strategic benefits and a physical signature, and incorporate them all into products (services) [60]. In terms of awareness, residents’ resistance could be based on system-oriented, people-oriented, and interaction-oriented factors [61]. Other factors could include system quality, information quality, and service quality [62]. The solutions could come in the form of applying a change management model or a directive approach, training, vision sharing, rewarding ideas, empowering users, documentation of new processes, information sharing, and the provision of a communication and feedback channel [61]. To implement the digital village successfully, branding and awareness are important points that need to be managed properly.

In order to transparently inform residents about the project and improve resident involvement, information and news are essential, and must be delivered to the community regularly [10,17,20,31]. Information and news standardization and the involvement of the community via information provision are needed [15,29]. Information management itself involves obtaining information from sources, transforming it, and providing access to those in need of information. This involves the work of several professional groups experienced in database design and development, information storage and retrieval, and the economics of information [63]. The practices of information management provide broader and less limited cooperation, the obtaining of clear and explicit information, timely access to information, reductions in technical information loss, and accelerated productivity with built-in training and increased customer satisfaction [64]. News management, on the other hand, is a collaborative process that helps to accomplish the desired organizational objectives [65]. It requires competencies in strategy development that are grounded in the analytics of data, which in turn require a high degree of creativity and collaboration. Given the needs for information and news, to successfully implement the digital village concept, management is strongly required.

To communicate the project’s progress and results to residents [10,28,44,45] and to heighten their awareness and involvement [35,37], a help desk represents one important interactive tool [29]. The help desk provides the organization with an internal support system and a means to provide support for the residents. The benefits that can be obtained include giving residents information and the provision of FAQs concerning frameworks
and approaches used in the organization, available 24 h a day [66]. It also acts as a troubleshooter. Good management at the help desk is needed.

Communication plays a key role, and is essential to the project’s success [10,28,44,45,67,68]. Its management is also part of the project management concept [44,45]. Several forms of communication have been discussed as part of several digital village projects [9,28,31]. Communication can occur in the form of internal or external, formal or informal, vertical or horizontal, official or unofficial, written or oral, and verbal or non-verbal [67]. Communication also has a strong connection to management and strategy, in that it represents a strategic management function [68] and can become a foundation of the communication management concept.

4.2.3. Human Resources Aspect

Table 3 consists of descriptions of the 2 (two) types of managements for the human resources aspect including users and collaboration groups, and training managements.

Table 3. Description of management in the human resources aspect.

<table>
<thead>
<tr>
<th>No</th>
<th>Management</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Users and Collaboration Groups</td>
<td>Management of digital village users, which include all residents, other stakeholders and groups, along with the setting out of their privileges.</td>
</tr>
<tr>
<td>2</td>
<td>Training</td>
<td>Management of training, including preparation of training material, setting up of training classes, and establishment of training activities for trainers and residents. This includes the documentation of residents’ capacities and certifications.</td>
</tr>
</tbody>
</table>

Users of the digital village can vary, including residents and business, as well as researchers [17,19]. Collaboration among them needs to be managed [7,15,24]. This state of inclusion helps to make sure that participation and coordination are smoothly facilitated [10]. User and groups management is an important part of digital village implementation, as in any ICT system developed based on collaboration, as it produces better interaction [69]. It requires the management of user information (authentication), grouping, and the management of user privileges in relation to access to the digital village’s facilities (authorization). However, some aspects of user information need to be managed properly via user and group management, given the issue of privacy and confidentiality problems [69].

Skill is an important element needed in a digital village project [8,32,35–37]. To improve resident capacity, training and education are needed [7,20,23,28], and will always be part of project implementation [34]. This includes training for those in need, such as the elderly, and people with disabilities, among others. To manage training and education, training management is needed. Training management consists of the identification of training needs and the analysis of goals, as well as planning and budgeting, learning management and evaluation, and transfer and outcome analysis [70]. Issues arise in each step of the lifecycle, and need to be addressed properly in the management process so that residents’ skills and capacities can be improved continuously. The management approach can help to improve and perfect the training process, improve the management level and work efficiency, and realize the automation of the training project with the help of ICT [71].

4.2.4. Infrastructure Aspect

Table 4 consists of descriptions of the 4 (four) types of managements for the infrastructure aspect including the automated facilities, system, system security, and infrastructure managements.
Table 4. Description of management in the infrastructure aspect.

<table>
<thead>
<tr>
<th>No</th>
<th>Management</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Automated Facilities</td>
<td>Management of all automated facilities involved in the project including automated input, process, and output facilities.</td>
</tr>
<tr>
<td>2</td>
<td>System</td>
<td>Management of supporting systems, including the setting up and maintenance of server systems for the digital village to run.</td>
</tr>
<tr>
<td>3</td>
<td>System Security</td>
<td>Management of securities in all systems involved, including data and network securities.</td>
</tr>
<tr>
<td>4</td>
<td>Infrastructure</td>
<td>Management of infrastructure, including the server hardware, connection, digital storage, computer/laptop, and electricity.</td>
</tr>
</tbody>
</table>

Contemporary application systems consist of several automated systems for data inputting and data processing, as well as for providing the output required to perform certain automatic actions [5]. It is a widespread practice, and it is now important to incorporate sensors such as for temperature, proximity, infrared, ultrasonic signals, light, smoke and gas, alcohol, touch, color, and humidity, among others, to provide input. The processing of inputs has also been conducted automatically, based on time or based on criteria that allow systems to perform tasks automatically [5]. As the output, automatic actions can also be part of the implemented systems via robots [3,5,54]. The inputs, processes, and outputs for the automated systems need to be managed to efficiently implement and use the systems in various ways, and to offer solutions within the digital village systems.

System setup and maintenance are part of the development of a digital village, and their means of implementation have been discussed as part of several previous digital village systems [8,17,19,35–38]. System management concerns technological choices made to support the system being developed. It is often imbued with a systemic architectural design, which reflects the ICT landscape and its environment [43,72]. The management will need to be implemented differently based on whether the system is meant for internal, external, or remotely distributed usage. The inclusion of a network-based systems concept for internal use, a web-based systems concept for external use, and/or distributed systems for remote deployment will change the technology being used. The decisions regarding hosting type and the inclusion of virtual private networks (VPN) will be part of how the system management works.

System security threats can come from many areas of digital villages’ activities, including front-end and back-end system security, authentication, data security, and network security [72]. The digital village concept involves a lot of data, including community and personal data. The safety of data or information is strongly required [29,32]. User behavior could also be a source of security threats. Policy within an organization must be set up, and security awareness must be developed among users. In relation to system security management for the overall organization, system port management, service access management, secure data connections using the https protocol, layered authentication, data encryption, firewalls, hidden server systems, and antivirus systems, among other things [72], can be employed.

Digital infrastructures are important parts of digital village implementation [28]. These include connectivity, electricity, and updated computer systems, among others [8,10,11,28,32–34]. Some of them are prerequisites of the digital village project [8,10,32]. Infrastructure management includes the management of system availability and resident connection readiness. Since service applications are now all accessed by users through the internet, internet connection is a vital aspect to be managed. In relation to the individual user, the management approach needs to make sure that the capacity of the customer premises equipment (CPE) provided, which connects to the system, is high enough [72]. Connections can be made by digital subscriber line (DSL), cable modem, terrestrial wireless, or satellite. In the management, CPE, point of presence (POP), internet service providers (ISPs), internet exchange point (IXP), and network service providers (NSPs) need to be
monitored continuously [72]. This is to make sure that connections are available all the time. Other than the connection, the management also needs to make sure that the computer systems involved are updated all the time.

4.2.5. Social and Economic Aspects

Table 5 consists of description of 1 (one) type of management for the social and economic aspects including the sectoral systems management. Sectoral systems management is an essential part of the digital village concept, since the digital village is a setup intended to improve the economic and social performance of the village. Various sectoral systems are needed to support these objectives, including applications for the marketplace, finance, production, services, health, education, culture, and population management, among other things [9,12,15,29,31,32,40,73]. Services to the elderly, people with disabilities, or other stakeholders with special needs, are also managed herein. Moreover, the management must also ensure that social and cultural aspects of the community are thoroughly incorporated into the concept, with digitalization support. This is necessary to avoid parts of the community being left out from the concept.

<table>
<thead>
<tr>
<th>No</th>
<th>Management</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sectoral Systems</td>
<td>Management of sectoral systems, including the development of the economic and social systems required within the digital village project and their implementation and evaluations.</td>
</tr>
</tbody>
</table>

The problem with the development of various sectoral systems is that they relate to one another in terms of the data that they accommodate. All the sectoral systems require population data. Collecting some data can be considered the responsibility of one system, and collecting some can be the responsibility of others. Since data in one system will be needed by other systems, data exchange is also part of the concept. This task is commonly performed by the system interface, which allows data exchange and communication between one system and another [74]. This includes the use of data interchange standards such as JavaScript Object Notation (JSON) and eXtensible Markup Language (XML) [75]. Management of this aspect is essential so that the usage efficiency of all the systems reaches its highest level. Management will also need to set priorities, since a lot of the aspects of a digital village will need to be digitalized. The priority of policy and sectoral systems discussions, proposal submissions, and fundraising issues can be established in this area of management.

4.2.6. Environment Aspect

Table 6 consists of description of 1 (one) type of management for the environment aspect including the environment management.

<table>
<thead>
<tr>
<th>No</th>
<th>Management</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Environment</td>
<td>Management of environment, including the setup of the environment and its parameters, and the monitoring of its sustainability.</td>
</tr>
</tbody>
</table>

The concept of digitalization and integration within digital village implementation boosts the concept of environmental sustainability [14]. It precludes the inclusion of unnecessary tasks and the use of unnecessary resources. To achieve this, the environmental sustainability setup, progress, and performance need to be monitored and managed in a specific way. Using this setup, monitoring and evaluation can be regularly performed. Other than digital environment management [10,12,14,19,27,29] performed through digitalized
and integrated systems, wider management approaches, such as though the monitoring of smart energy, solar power, and water resources, among other things \([6,12,19,73,76]\), can also be undertaken.

4.3. Justification of the Proposed Digital Village Management Model to Other Concepts

4.3.1. Justification on Enterprise Architecture Concept

From the enterprise architecture point of view, the proposed model includes four pre-existent architectures within the concept \([43]\). Most management approaches are set up to support all the business aspects. They include policymaking, business process, branding and awareness, users and collaboration groups, training, proposal submission and fundraising, financial, evaluation, and administration and documentation managements. All these management approaches are set up to make sure the business of digitalizing the village goes properly and smoothly.

The model is also equipped with information architecture, supported by information and news, help desk, communication, knowledge, and administration and documentation managements. These management models are set up to make sure information and knowledge are available all the time, and mechanisms for residents to access them are provided.

This model is also supported by the applications architecture, using sectoral systems management. This management approach handles all systems other than the digital village management system. As the number of sectoral systems grows, the scope of management for the applications also grows. Its size increases exponentially compared to other management approaches.

Technology is an important part of the process of digitalizing the village. Management of the supporting technologies is needed. These are set up through the automated facilities, system, security, and infrastructure management modes, and make sure all supporting technologies are available when needed.

There is one management mode included in the proposed model that has no relation to the enterprise architecture concept: environment management. This can be included in sectoral systems management, which is part of the application infrastructure. However, since all aspects of the project require consideration in terms of sustainability, this management approach requires a distinct architecture within the concept.

4.3.2. Justification on Project Management Concept

Regarding the implementation of project management, the proposed model has been equipped with management models that can handle scope, time, cost, quality, human resources, communication, risk, procurement, stakeholders, and project integration \([44,45]\). The scope aspect is handled by policy and business process management, the time aspect is handled by administration and documentation management, the cost aspect is handled by proposal submission and fundraising, as well as financial management, the quality aspect is handled by evaluation management, human resources are addressed by users and collaboration groups as well as training managements, communication is dealt with by branding and awareness, information and news, the help desk, communication, knowledge managements, administration and documentation managements, risk is dealt with by proposal and fundraising, as well as evaluation management, procurement is handled by sectoral systems, automated facilities, system, security, infrastructure, and administration and documentation management, stakeholders is dealt with by users and collaboration group management, and project integration is dealt with by knowledge, evaluation, and administration and documentation management. Aspects related to project management are handled by more than one management approach, following the needs and reviews of digital village projects that have been implemented previously.

One management model in the proposed model that has no representation in project management is environment management. This shows the shortcomings of the project management concept. Any environmental or sustainability concerns should be analyzed for all aspects of any project, and solutions need to be proposed, monitored, and managed.
during the development process. In the proposed model, these issues are handled under environment management.

4.4. Sustainability Evaluation

The digital village is a concept aimed at digitalizing all the services in a village. Digitalizing means that manual processes can be conducted automatically with the support of ICT. Following the evaluation of sustainability based on the implementation of ICT resources [47], the implementation conditions of a digital village could be defined as in the stage of establishing infrastructure, transforming business processes, communicating data derived during the activities of the businesses, or automating all the business processes. In a broader sense, sustainability can be evaluated via the triple-bottom line of evaluation, which includes economic performance, social performance, and environmental performance [46]. In addition, the evaluation could also be performed in terms of the integration of ICT resources into HRM as well as SCM [47].

Regarding the sustainability of the proposed digital village management model in terms of the use of ICT resources, the evaluation can be performed as follows:

1. The infrastructure of the digital village services has been incorporated into a model with automated facilities, system, security, and infrastructure management, including digital storage and connection management. As elaborated in [47], the involvement of infrastructure in the context of digital village development supports all the four states considered in the sustainability evaluation [47], including internal and external conditions as well as current and future conditions. With a comprehensive ICT infrastructure, it is guaranteed that sustainability can be maintained;

2. The transformation of business processes is achieved in the way the digital village is developed, including how the policies and business processes are set up through policymaking and business process management, how community awareness is improved using branding and awareness management, and how users are encouraged to collaborate with one another through users and collaboration management. Sectoral systems’ project management models have also been set up through the transformation of business processes, and include the proposal submission and fundraising, financial, and administration and documentation management. The development and implementation of sectoral systems also affects the sectoral business processes being used;

3. The informatization of the digital village concept is supported by the knowledge management, information and news, help desk, and communication management models. Informatization makes sure that the sustainability of future conditions can be maintained;

4. Automation is supported by automated facility management. Although only one mode of management is available to support automation, the business processes that are digitally transformed via the transformation and informatization aspects, as elaborated in point 2 and point 3, include certain types of automation processes that occur during the input, process, or output states. The sectoral systems developed within the digital village concept are representations of process automation.

Regarding integration into HRM [46], aside from maintaining sustainability using ICT resources, the sustainability of human resource capacities is also considered through the management of human resources. The model proposed for managing a digital village has the objective of improving the skills of residents in many aspects, including skills in digital business and ICT in general. All users involved in the digital village are representatives of the residents in the village, including the elderly and people with disabilities. Any required skill improvement can be accommodated through training via training management. This can be set up and maintained continuously. Records of training will be monitored so that residents’ skills and capacities can be maintained.

Regarding the SCM [46], the proposed digital village management model makes sure that all needs are identified, and solutions to the needs are analyzed, developed, and
implemented. The needs are accommodated through a transparent proposal submission and fundraising processes, by which the proposed model includes the SCM within the digital village concept. The training setup in the training management model shows that the capacity improvement of residents—a dominant part of the concept—has also been assured. The evaluation process, including the evaluation of digital village use and capacities, is set up to ensure that the concept maintains the sustainability of digital village implementation. In more detail, the SCM is also part of the implementation of the sectoral systems included in the project, which are always based on ICT use.

Regarding the three-bottom lines of evaluation [46], the model proposed is equipped with the environment management model, which is used to monitor environmental indicators to support the effort of managing environmental performance. This could be connected to water resources, air, soil, solar power use, electricity use, and other things, for monitoring purposes. Regarding economic and social performance [46], all the required sectoral systems will be incorporated into the digital village through sectoral systems management. The sectoral systems needed could differ from one village to another. However, any type of sectoral system that needs to be included will address any economic and social problems within the village. Moreover, user and collaboration groups and proposal and fundraising management make sure that the community participates in the development and implementation of the digital village. This concept creates a new form of culture between communities.

5. Development Model for a Sustainable Digital Village

5.1. Recommended Development Model

In developing a product or a service, the development mechanism is an essential part that needs to be chosen in advance to make sure all the processes required are understood by the stakeholders involved, and that all the outputs sought are delivered in an effective and efficient way [77]. Some digital village development projects have used a living lab approach [12,17], which combines the participation of residents with developers and managements. This approach was chosen to make sure that the interaction between the community and the project is maintained.

There are several development models available for the purpose of developing an ICT project, including Waterfall, V, Prototyping, Incremental and Iterative, Spiral, and Scrum [77–79]. These implement a variety of types of procedures and have different characteristics. Table 7 shows the models and their respective characteristics.

In analyzing the current practice of digital village development [12,17], the Scrum model is considered the best fit among other development models [78,79]. The processes involved in the Scrum model are the prioritization of the product backlog by the product owner, expanding backlog into daily tasks/sprints performed by the project team, producing results for the task/sprint, conducting daily scrum meetings, and finalizing a potentially shippable product. During the processes, the team needs to produce a product backlog, a sprint backlog, and a burndown chart, and to manage and monitor the project’s progress. The Scrum model has several advantages compared to other models. Scrum responds to the environment throughout the project. Scrum provides a team with flexibility and creativity. Knowledge transfer is conducted based on teamwork during the project. Finally, using this approach, the probability of success is higher compared to using the other development models.

The proposed digital village management model consists of the digitalization process, and the HRM and SCM of digital village implementation. It starts with the identification of needs by residents, and ends with implementation evaluation. Based on the evaluation results, the process is continued with the improvement of sectoral systems, or the creation and submission of a totally different proposal. The recommended development model is shown in Figure 3.
Table 7. Development models and their characteristics.

<table>
<thead>
<tr>
<th>No</th>
<th>Development Model</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Waterfall</td>
<td>A simple development model consisting of several steps including requirement analysis and definition, system and product design, implementation and unit testing, integration and system testing, and operation and maintenance. The main characteristic of the model is that each step needs to be finished first before going on to another step [77].</td>
</tr>
<tr>
<td>2</td>
<td>V Model</td>
<td>Similar to the Waterfall development model, with an additional concept that each step needs to be tested first to provide feedback before going on to the next step [77].</td>
</tr>
<tr>
<td>3</td>
<td>Prototyping</td>
<td>A development model that allows all steps to produce prototypes. Any deficits in any of the prototypes can be revised. The revision process can also be conducted by moving to earlier steps [77].</td>
</tr>
<tr>
<td>4</td>
<td>Incremental and Iterative</td>
<td>A development model used to generate one sub-output/deliverable at a time, until all sub-outputs/deliverables are produced. Once all sub-outputs/deliverables are produced, the model will only need to iteratively revise the products or parts of products as needed [77].</td>
</tr>
<tr>
<td>5</td>
<td>Spiral</td>
<td>A model that proceeds in a spiral for every step of the development process. Each step will have to be subjected to risk analysis before it is performed, and ends with a verification process [77].</td>
</tr>
<tr>
<td>6</td>
<td>Scrum</td>
<td>A framework for developing products in a short period. It is influenced by the Agile Manifesto, which articulates a set of values to guide decisions on developing higher-quality products. The characteristics of the Agile Manifesto are individuals working with others, trying to produce working products/software, collaborating with customers, and responding a lot to the changes required. Scrum teams do a little of everything all the time, rather than doing all of one thing at a time [78,79].</td>
</tr>
</tbody>
</table>

Figure 3. Development model for the sustainable digital village.

In this model, the development begins with the submission and approval of a proposal. If the project is started with policy changes, the proposal submission follows the policy set. If the project proceeds without a proposal, the policy is directly broken down into business processes used as a base for digitalization. If the project begins with a proposal, the approved proposal is broken down into business processes. The digitalization process is begun with the creation of a product backlog, which is used as a base to generate a more detailed sprint backlog. The sprint backlog is used to produce backlog tasks necessary to development and evaluation. The team will have a daily scrum meeting to discuss and evaluate the project’s progress. The process ends when the shippable product/system is ready. Once the system is finished, it will be deployed, and the implementation and uses by residents will be evaluated. The evaluation results are used to decide whether the system is good, needs improvement, or needs an additional sectoral system in the form of a totally different proposal. In this way, this development model makes sure that community
involvement is accommodated, and the digital village supply chain is maintained. The steps are elaborated in more detail in Table 8.

Table 8. Steps in the proposed development model of a sustainable digital village.

<table>
<thead>
<tr>
<th>No</th>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Policymaking</td>
<td>This step is conducted to make sure that the policies required for the system to be developed and implemented are in place. The policy submission can be initiated by the system’s requirements or based on management evaluation and decisions.</td>
</tr>
<tr>
<td>2</td>
<td>Proposal Submission</td>
<td>This step is conducted based on the need of the community to include a particular system in the digital village concept. The decision will be based on a discussion conducted with the community and priority selection conducted by management.</td>
</tr>
<tr>
<td>3</td>
<td>Business Process Analysis</td>
<td>Once a policy or a proposal is approved, the business processes involved in the proposed system are analyzed. This part is commonly conducted by a system analyst tasked with finding out all the requirements included in the proposed system. The result of this process is in the form of a requirement analysis document.</td>
</tr>
<tr>
<td>4</td>
<td>Product Backlog</td>
<td>This step consists of work by the product owner, including defining the product goal, developing product backlog items, and ordering the product backlog items. The product owner needs to make sure that the product backlog is transparent, visible, and understood. The product owner can be a manager or a project manager in an organization.</td>
</tr>
<tr>
<td>5</td>
<td>Sprint Backlog</td>
<td>This step is the work of the Scrum Master and Developers. The Scrum Master has to manage the Scrum team in producing high-quality products. During this step, discussion or confirmation of the product backlog with the product owner is conducted. The sprint itself is a subset of the product backlog selected by the teams to be performed during the sprint period.</td>
</tr>
<tr>
<td>6</td>
<td>Backlog Expanded by Team</td>
<td>The work to be performed in this step is detailing how the sprint will be conducted. This is usually performed in the beginning of the sprint period.</td>
</tr>
<tr>
<td>7</td>
<td>Daily Scrum Meeting</td>
<td>A meeting is conducted briefly to evaluate the progress of the work. The discussion involves the work done yesterday, the work to be done today, and help that is needed for the work.</td>
</tr>
<tr>
<td>8</td>
<td>Monthly Scrum Meeting</td>
<td>This step, which is also called the Sprint Review, involves reviewing the progress achieved during the past month. The product backlog could also be changed in this step, based on the discussion. In this meeting, an evaluation of team performance, processes, interactions, tools, and other aspects could also be conducted.</td>
</tr>
<tr>
<td>9</td>
<td>Shippable Product Packaging</td>
<td>This step is reviewing the resulting product. Here, the overall development aspects such as overall team performance, processes, and other aspects are discussed.</td>
</tr>
<tr>
<td>10</td>
<td>Product Evaluation</td>
<td>This step consists of an overall evaluation of the resulting and implemented product, including evaluations of product quality and product usage.</td>
</tr>
</tbody>
</table>

5.2. Development Strategies

To make sure that the project proceeds according to the purpose, strategies need to be set up. Some projects have incorporated several strategies, including ensuring a setup to accompany local businesses through the process of digital transition [12], and to encourage collaborative actions towards the emergence of an innovative and inclusive digital society [35]. These could be conducted by first performing policy analysis [29] and setting up appropriate policy and regulatory frameworks as required [28].

To promote resident involvement in the project, management could push for community awareness by conducting project socialization, policy seminars [29,31], awareness
campaigns [76], or events to inspire youth [31]. Management can also incorporate a marketing division in the development structure [28] and conduct activities such as hiring local influencers [17], conducting digital marketing, publishing advertisement [31], and promoting the uptake of digital services, including via the understanding and use of digital applications [34]. An understanding of the project could also be developed by producing a booklet of e-services [31] and ensuring the communication of the results and successes of the project to the residents [17].

To place the ownership of the project within the community, needs identification should be conducted by the residents [17,28]. This could be performed by evaluating village conditions and resource availability, identifying the opportunities and the needs related to digitization [34], defining coherent digital strategies, identifying new opportunities and markets [12], as well as mapping the village potency and the existing digitization of the agricultural and rural areas in the country [34]. During the process, encouraging communities to identify what is needed could also be a solution [33,41]. Training for need identification could also be conducted to make residents aware of the needs within communities [12].

Once needs are defined, analysis of each need can be performed. Strategies that could be implemented for this process include performing impact analysis and strategic studies [35], and defining priorities for the main types of intervention available [34,35]. Several considerations could be made when performing the analysis, including starting the overall project with some small projects [41] and considering the constructive collaboration between local culture and digital-based community services [80]. Developing rural digital hubs/competence centers is also a good idea and a key way to create the basis of a local strategic, technical, and skills ecosystems [35]. Turning villages into smart economic centers using e-markets could also be a good idea [31]. Applying solar home systems and pico-solar lights, mini grids or smaller electricity generations, and clean cooking technology would be environmentally beneficial and is recommended [24].

When the analysis is finished, the community needs to design necessary interventions [34]. The proposed services need to be co-designed with the government, local stakeholders, and citizens [33,35]. Several ideas may need to be transformed and combined to create a novel and innovative concept that works for a given rural area [17]. It also needs to be considered that digital transformation must go hand in hand with the physical, social, and environmental regeneration of the village, with networking and cooperation between rural communities, their citizens, and stakeholders at all levels [35]. It also needs to provide access to information through the development of a village information system [15,32].

Once the design is ready, proposals can be formed, and the process can proceed with fundraising. The proposal of every part of the digital village project should be broadcasted to make funding departments/agencies aware of the proposal [41]. This could be achieved by developing a website for uploading project proposals, which can include information on funding applications and the results of fundraising.

In project implementation, several strategies could be established, such as working with early prototypes [17], providing flexible participation models for residents [17], managing data to make them accessible [32], and implementing entities in the field [31]. Implementation testing also needs to be properly performed [31]. Implementation pilots are also essential when seeking to understand the actual cost [35]. In cases when the implementation involves rural service centers, they should be the first to be connected [35].

In ensuring that the project proceeds as planned, the management needs to set targets, allocate the necessary budget [34], and set overall plans and strategies [35]. Regarding the use of digitalized infrastructure in a digital village, the management needs to first strengthen government and community commitment. System usage needs to be constantly monitored [15]. The management must also provide support for the users [15], for example, by setting up a help line and help center [31]. The management should ensure that the village has access to intermediaries, brokers, and spaces to support the digital transition [33]. Establishing a participatory management system could be a solution to this [25].
environmental sustainability, the management could also provide precise, reliable, and quick information about energy consumption, security, and efficiency [10].

In making sure that the system is easily accessed by the community, the capacity of human resources plays a key role. Resident training needs to be conducted by village officials [9]. The training can be conducted in the form of capacity-building or knowledge exchanges [24]. Regarding training, programs to develop new talents could also be set up [31]. Not only residents, but also local organizational capacities, need to be improved [15]. In order to make this easier to manage, developing a training unit could be a workable solution [31].

Regarding infrastructure, since a digital village involves information exchange, the construction of informatization infrastructure is a priority [20]. The establishment of inter-networking and network security infrastructure is also necessary. To provide alternative means of connection for residents, outsourcing for alternative ISP can also be performed [8]. Aside from internet connection, putting alternative electricity supply systems in place is also important [8].

In ensuring the sustainability of the digital village, the strategies that could be implemented include creating rural innovation ecosystems, building coordinated governance [34], building an innovation infrastructure [17], and establishing a digital council [17]. The management needs to boost local public–private partnership, integrated and multisectoral actions, innovation, cooperation, networking, area-based local development strategies, bottom-up elaboration, and the implementation of strategies [73]. This also can be ensured by increasing the digital research and innovation, deepening the digital cluster, and building strong digital ecosystems [40]. Managing cooperation with other digital players in wider regional and national ecosystems could also be a solution [33,40].


To set up an evaluation method, several aspects need to be considered. The first is the availability of deliverables [28]. The services should always be accessible. This is related to the available times of the services and the number of security breaches that may occur during service provision. Infrastructure should be ready for use by all stakeholders, especially from the user side [21,24,28,33], including internet connectivity, ICT support, data center services, service hub systems, and digital security [28,81]. This all could be summarized as part of the readiness index, which calculates how ready the services are to be delivered to the community [28].

The digital village could also be evaluated in terms of its implementation [28] by looking at the number of sectoral systems delivered [33] and the impact on the community, which will include the evaluation of outputs/deliverables and contribution to larger communities [28]. The development capacity provided by the digital village could be evaluated in terms of economic and social aspects, such as employment rate, education level, income per capita, and consumption level [21,24]. The evaluation should also consider the social integration between residents [81], as well as the improvement of the economy in the area, including increasing the number of economic entities [81].

Regarding human resources, the digital skills quality of the residents could be evaluated via the involvement of residents in the education and training provided [28,33]. These could also be evaluated by looking at the number of villagers accessing the digital village services [28,33]. From the management side, the evaluation could be performed in terms of the involvement of the community in the digital village’s development [20], and the creation of policy and procedures when setting up the digital village’s development and implementation rules [81].

Environmentally, the digital village could be evaluated in terms of the use of electricity, solar power, and water resources [21], in relation to ecological greenness [20]. This could also be evaluated by looking at the setup of each service provided by the digital village. All services should seek to be environmentally friendly in their development and implementation [21,24].
Based on the elaboration above, and looking at the availability of data sources in digital village development and administration, as in Table 9, the criteria that can be set out to evaluate the success of digital village development and implementation are as follows.

### Table 9. Evaluation method for sustainable digital village implementation.

<table>
<thead>
<tr>
<th>No</th>
<th>Indicators</th>
<th>Measure</th>
<th>Definition</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I. Management Aspect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Number of Proposals Approved to be Conducted</td>
<td>Item</td>
<td>Project Proposal: Proposal created as part of digital village development Approved to be Conducted: Approved to be delivered, even if there is no fund involved</td>
<td>System Data</td>
</tr>
<tr>
<td>2</td>
<td>Number of Policies and Business Processes Produced</td>
<td>Item</td>
<td>Policy: Rule or regulation generated for digital village development, implementation, and evaluation Business Process: Process of doing business within the concept of the digital village</td>
<td>System Data</td>
</tr>
<tr>
<td>3</td>
<td>Proportion of Complaints Received Per 100 Residents</td>
<td>Percent</td>
<td>Complaints: Submitted through complaints system Resident: people that live or intend to live in the village for more than 1 year</td>
<td>System Data</td>
</tr>
<tr>
<td>4</td>
<td>Proportion of Complaints Resolved Divided by the Number of Complaints Received</td>
<td>Percent</td>
<td>Resolved: Solutions have already been provided</td>
<td>System Data</td>
</tr>
<tr>
<td></td>
<td>II. Branding and Awareness Aspect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Number of Residents Submitting Project Proposal</td>
<td>Item</td>
<td>Submitting Proposal: Submitting project proposal as part of the digital village development</td>
<td>System Data</td>
</tr>
<tr>
<td>6</td>
<td>Proportion of Residents Involved in Preparing Proposal Per 100 Residents</td>
<td>Percent</td>
<td>Preparing Proposal: Can be as main creator, or just residents surveyed for the proposal</td>
<td>Proposal Data</td>
</tr>
<tr>
<td></td>
<td>III. Human Resources Aspect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Proportions of Residents Registering to Digital Village Per 100 Residents</td>
<td>Percent</td>
<td>Register: To get access to the digital village system</td>
<td>System Data</td>
</tr>
<tr>
<td>8</td>
<td>Proportions of Residents Using Training Facilities Per 100 Residents</td>
<td>Percent</td>
<td>Using Training Facilities: Use the facilities for training such as e-learning, e-education, or attend a training session at the center</td>
<td>System Data</td>
</tr>
<tr>
<td>9</td>
<td>Average Head of Household Level of Education</td>
<td>Years</td>
<td>Average: The average of level of education Head of Household: Person who pays for more than half of the household expenses Level of Education: Pre-primary, Primary, Lower Secondary, Upper Secondary, Higher Education</td>
<td>System Data</td>
</tr>
<tr>
<td></td>
<td>IV. Infrastructure Aspect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Proportion of Residents Having Access to Internet Per 100 Residents</td>
<td>Percent</td>
<td>Having Access to Internet: Having active internet connection (cable or wireless)</td>
<td>Resident Data</td>
</tr>
<tr>
<td>11</td>
<td>Downtime of Digital-Based Systems</td>
<td>Hour</td>
<td>Downtime: Range of time where the system is not available</td>
<td>System Data</td>
</tr>
<tr>
<td>12</td>
<td>Number of Security Breaches of Digital-Based Systems</td>
<td>Item</td>
<td>Security Breach: Breach to security of the system, such as illegal authentication, system intrusion, data intrusion, network intrusion</td>
<td>System Data</td>
</tr>
</tbody>
</table>
Table 9. Cont.

<table>
<thead>
<tr>
<th>No</th>
<th>Indicators</th>
<th>Measure</th>
<th>Definition</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. Social and Economic Aspect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Number of Sectoral Systems Developed</td>
<td>Item</td>
<td>Sectoral Systems: Systems within the digital village that are developed to answer community needs socially and economically</td>
<td>System Data</td>
</tr>
<tr>
<td>14</td>
<td>Proportions of Farmers and Small and Medium Business Enterprises Per 100 Residents</td>
<td>Percent</td>
<td>Farmers: Work as farmer at plantation, farm, or fishery Small and Medium Business Enterprise: Enterprise that has a certain number of workers, or enterprise that generates revenues no more than a certain amount a year or with a net worth of a certain amount. The values depend on the definition used in each country.</td>
<td>Business Data and Resident Data</td>
</tr>
<tr>
<td>15</td>
<td>Proportions of Residents in Healthy Conditions Per 100 Residents</td>
<td>Percent</td>
<td>Healthy Condition: Without any chronic pain</td>
<td>Resident Data</td>
</tr>
<tr>
<td>VI. Environmental Aspect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Number of Services with Environmentally Friendly Setup</td>
<td>Item</td>
<td>Services: Digital-based systems including sectoral systems and management systems Environmentally Friendly: Considering smart energy, use of electricity, solar power, and water resources</td>
<td>System Document</td>
</tr>
<tr>
<td>17</td>
<td>Reduction Rate of Electricity, Solar Power, and Water Resource Use</td>
<td>Percent</td>
<td>Reduction Rate: Total reduction in uses divided by number of residents</td>
<td>Survey</td>
</tr>
<tr>
<td>VII. Implementation Aspect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Proportions of Residents Accessing Digital Village Systems Per 100 Residents</td>
<td>Percent</td>
<td>Accessing: Login and access to a service</td>
<td>System Data</td>
</tr>
<tr>
<td>19</td>
<td>Average Number of Accesses by Accessing Residents</td>
<td>Access</td>
<td>Average: Among the resident accesses</td>
<td>System Data</td>
</tr>
<tr>
<td>20</td>
<td>Proportions of Elderly Cared Utilizing the System Per 100 Residents</td>
<td>Percent</td>
<td>Elderly: Over 60 years of age Cared Utilizing the System: Using healthcare systems provided by digital village</td>
<td>Resident Data and System Data</td>
</tr>
<tr>
<td>21</td>
<td>Proportions of Disabled Utilizing the System Per 100 Residents</td>
<td>Percent</td>
<td>Disabled: Impairment in a person body structure, function, or mental functioning</td>
<td>Resident Data and System Data</td>
</tr>
<tr>
<td>VIII. Impact Aspect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Unemployment Rate</td>
<td>Percent</td>
<td>Unemployment: Someone that is willing and able to work but does not have a paid job Rate: Proportion of unemployment divided by total labor force</td>
<td>Resident Data</td>
</tr>
<tr>
<td>23</td>
<td>Birth Rate</td>
<td>Percent</td>
<td>Birth rate: The ratio between the number of live-born births in a year and the average total population of that year</td>
<td>Resident Data</td>
</tr>
<tr>
<td>24</td>
<td>Mortality Rate</td>
<td>Percent</td>
<td>Mortality rate: The ratio between the number of deaths in a year and the average total population of that year</td>
<td>Resident Data</td>
</tr>
<tr>
<td>25</td>
<td>Number of Public Information Accessed by External Stakeholders</td>
<td>Access</td>
<td>Public Information: Information provided for public accesses External Stakeholders: Users accessing the system without logging in</td>
<td>System Data</td>
</tr>
</tbody>
</table>

The evaluation method is constructed based on the six aspects compiled from the reviews conducted of previously implemented digital village projects. These include the management, branding and awareness, human resources, infrastructure, social and economic, and environmental aspects. These were included to make sure that the six aspects are evaluated regularly, so that the aims and deliverables of digital village development are achieved, and concerns related to digital village development are promptly recognized and
resolved. Two other aspects are added to the evaluation, which are the implementation and impact aspects. This is to make sure that the digital village is implemented sustainably, produces impacts, and provides a base for the community to have a good life.

7. Conclusions

The concept of the digital village has been practiced in many countries with different forms of implementation. However, the approaches used are often lacking aspects, such as management, human resources development, and environmental sustainability, among others. The model proposed in this paper is developed based on the reviews of general aims, expected deliverables, and existing concerns reported for several digital village implementations. There are six main aspects that we need to be aware of during the development and implementation, including management, branding and awareness, human resources, infrastructure, social and economy, and environment aspects. The proposed model adheres to the concepts of enterprise architecture and project management, making sure that the model can be applied as effectively as possible and heightening the rate of success in its development and implementation.

In the model, 19 types of management are included. All the management types are mapped into the aspects of development and implementation aims, deliverables, and concerns. Some aspects are represented by more than one management type, based on the conducted reviews, the differences in the business processes involved in each management type, and the availability of technologies.

Policymaking, business processes, financial, evaluation, and administration and documentation management types are all parts of the general management approach that is always needed in any organization. Proposal submission and fundraising, branding and awareness, information and news, communication, training, and infrastructure management are included to answer the concerns arising in relation to previously implemented digital villages. They cover all the concerns as reviewed and presented in Section 3.4. Knowledge, help desk, users and collaboration groups, automated facilities, system, and system security management are included in the implementing of digitalization and the incorporation of available technologies such as data management, knowledge discovery, data warehousing, data security, and network security concepts. Sectoral systems and environment are types of management that are at the core of the digital village concept, and are required for improving the social, economic, and environmental performances of the village.

Regarding the mapping of the proposed model to the concepts of enterprise architecture and project management, all the managements were mapped well, except that environment management could not be mapped into the enterprise architecture or project management concepts. This shows that the two concepts lack environmental aspects in the formulation and derivation of their architectural and management concepts.

The proposed model is also evaluated as regards its sustainability. Regarding the three-bottom line of evaluation, the model provides facilities to make sure social, economic, and environmental performance are maintained. The model also makes sure that the human resources and supply chain are managed within the concept, with the integration of ICT resources into HRM and SCM. Regarding the use of ICT resources, infrastructure, automate, informate, and transform resources are included in specific management approaches in the proposed model. All this proves that the proposed model shows sustainability.

In addition to the proposal of a sustainable digital village management model, this paper also proposes a new development model to be used as guidance for digital village development. The proposed development model is based on the Scrum development model, in combination with the management processes conducted for its development. The model was chosen because it is useful for inferring practices commonly used in previous implementations of the digital village concept. The Scrum development model ensures that the development is managed in a regular manner. This management ensures that community needs are accommodated, and the supply chain is managed in a sustainable manner.
This paper also proposes an evaluation method for the implementation of the digital village model. The method consists of 25 indicators, representing the aspects of management, branding and awareness, human resources, infrastructure, social and economy, environment, implementation, and impact. These criteria are also chosen based on the availability of data sources in the village. The last two aspects that feature in the evaluation criteria are included to make sure that the implementation and the impact of the concept are evaluated, that the concept is utilized regularly, and that it provides maximum benefits to the community and beyond.

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