

AN ADMINISTRATIVE SUPPORT SYSTEM FOR DIGITAL TRANSFORMATION OF SMALL AND MEDIUM-SIZED ENTERPRISES IN VIETNAM

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Abstract: Digital transformation (DX) is complex with many automated parts, underlying integrations and processes that need to fit all together. Tools to support the management of DX activities are, therefore, crucial for every business. However, there are just a few of such tools available these days that can help businesses with the DX management both effectively and comprehensively, but none of them was designed particularly for small- and medium-size enterprises (SMEs) of Vietnam. In this study, we will conduct an overview of recent studies on DX, methods and models for SMEs, and relevant research works regarding information support systems for the management of DX for SMEs. We then propose a novel administrative support system that not only addresses the shortcomings of the current state-of-the-art DX management systems but also meets the requirements of DX for SMEs in Vietnam. In addition to the system design and development, we also implement and benchmark the software product at 11 SMEs in Vietnam (and some results if any).

Keywords: digital transformation, SME, MIS, digital transformation approach.

JEL Classification: M15, M19, O32.

1 Introduction

Digital transformation (DX) is considered a key and important factor to successfully approach the industrial revolution 4.0 and avoid falling behind. In fact, developed countries in the world are strongly growing thanks to this transformation. According to research by Microsoft and IDG in the Asia-Pacific region (Microsoft, 2018), DX can bring about 6% GDP in 2017, 25% in 2019, and about 60% in 2021. In 2018, the DX has impacted productivity by about 15% and is expected to increase 21% by 2020. At the same time, 85% of jobs will have to change and up to 27% of jobs will be lost due to the impact of DX within the next 3 years. However, the process of DX is not an easy job; businesses need to identify and develop DX strategies along with a multistage implementation plan suitable for their businesses. Several recent studies have shown that the majority of businesses are not satisfied with

the DX activities as their expectations (Graf, et al., 2019), especially SMEs.

SMEs have always been the backbone of the economies of developed or developing countries (Mittal, et al., 2018). However, SMEs often do not have digital resources and are limited in terms of finance, human resources, and qualifications, so they often face difficulties in the early stages of DX, and they often do not know how to start as well as how to plan and execute (IDC and Cisco, 2020). Particularly in Vietnam, SMEs account for 97.5% and are contributing about 40% of GDP and creating nearly 60% of jobs. However, the level of readiness for DX of enterprises in Vietnam in the period before 2019 is still low. According to the survey results on 2,659 industrial enterprises of Vietnam in 2018 by the Ministry of Industry and Trade on readiness for Industry 4.0 (Ministry of Industry and Trade, 2018), the majority of industrial enterprises in Vietnam (85%) have not had any preparation for

Industry 4.0, a small number of enterprises (13%) are at the "beginning" level, and only 2% of enterprises are assessed as having a basic level of learning. However, after the Covid-19 pandemic, there were bright spots about the readiness of SMEs in Vietnam to digitally transform. According to the survey results at the end of 2022 with 1000 businesses conducted by USAID and the Ministry of Planning and Investment, most businesses (mainly SMEs) are ready for the DX (USAID and Ministry of Planning and Investment, 2023).

From the results of analysis of research gaps when performing the above research overview, such as: 1) there is no model or method to support the implementation of DX of SMEs in a comprehensive and complete manner from the stage of assessing the current state of enterprises, strategies, roadmaps, and planning for implementation (Tuấn, et al., 2021); 2) there is not yet an information system to support from strategy formulation, DX roadmap planning to DX implementation planning and management; and 3) currently, there are not many studies on DX in Vietnam, especially SMEs. In this study, the author will propose a system model to assist in solving the above-mentioned problems. Then, the model was also developed into an information system and tested on several SMEs in Vietnam.

In this article, the author will conduct an overview of studies on DX methods/models in SMEs as well as studies on information systems supporting the management of DX to identify research gaps, which is presented in part II. After that, an information system to support collegial activities in enterprises is proposed, analyzed, and developed, which is presented in part III. The results of installation, testing, and evaluation of the proposed information system are presented in section IV.

2 Literature review

2.1 Digital transformation methods/model

The DX process is very complex and has an impact on all business activities. As a result, the formulation and implementation of a DX strategy have become a key concern for many businesses prior to DX, and a systematic approach is crucial to success (Hess, et al., 2016; Schulz and Tungseth, 2018). Rauser (2016)

states that the DX strategy refers to an enterprise's strategy applied to all DX initiatives, including the entire process: gathering all the necessary information, planning the strategy, recognizing risks and opportunities, and maintaining the DX strategy (Rauser, 2016).

According to Matt, et al. (2015), the **DX strategy** approach has two perspectives: 1) **Process**: how to develop, implement, and evaluate the DX strategy considering new aspects that DX brings to the organization; and 2) **Procedure**: the process of defining the strategy according to the aspects and components of the DX strategy (Schulz and Tungseth, 2018). In addition, several recent studies appear to add methods of using **maturity models** to build DX strategies (Pierenkemper and Gausemeier, 2021). Maturity model is a model that helps an individual or organization reach maturity (i.e., capabilities) in terms of people/cultures, processes/structures, and/or objects/companies. Technology follows a step-by-step continuous improvement process (Mittal, et al., 2018). Therefore, maturity models are an appropriate tool to guide enterprises in the process of assessing the maturity of enterprises in DX (Szedlak, et al., 2020).

Besides, researchers have also recently conducted research on different aspects and methods to support businesses in DX. According to the results of a recent literature review on DX and Industry 4.0 by many authors (Mittal, et al., 2018; Vial, 2019; Schmitt, et al., 2020), recent studies also use the following models/methods:

- **Roadmap** is a detailed plan of time, resources, stages, and implementation steps to manage and orient the implementation of DX (Cottrino, et al., 2020). Building a DX roadmap will help businesses understand in more detail their DX capabilities, the gap between reality and the target, and DX activities that should be prioritized.
- **Readiness model or readiness assessments**: Assessment tools to analyze and determine the level of readiness needed to achieve the objectives of conditions and resources at all levels (Mittal, et al., 2018) or as a necessary prerequisite of readiness for the use of a new technology.
- **Framework** is a consistent set of procedures, methods, and tools for the architecture (including design and engineering) of a system (Mittal, et al.,

2018). For DX, the goal of the framework is to arrive at a consistent DX strategy. The DX strategy frameworks are intended to guide businesses to start implementing DX without detailed instructions on how to do it.

2.2 Studies on DX methods/models in SMEs

Not staying out of the general DX trend, the researches on DX in SMEs are very diverse with many different methods/models: 1) DX strategy: a) process (Li, et al., 2018; Hönigsberg and Dinter, 2019; Anim-Yeboah, et al., 2020; Pierenkemper and Gausemeier, 2021), b) procedures (Barann, et al., 2019; Virkkala, et al., 2020), and c) maturity model (Beliveau, et al., 2018); 2) DX framework (Becker, et al., 2018; Feichtinger, 2018; Marc Gruber, 2018; Trenkle, 2019; North, et al., 2020); 3) DX roadmap (Cotrino, et al., 2020); and 4) readiness model (Ministry of Industry and Trade, 2018; Cameron, A., Pham, T.H., Aterton, J., Nguyen, D.H., Nguyen, T.P., Tran, S.T., Hajkowicz, 2019; Dutta, et al., 2020; Pirola, et al., 2020). The paper will conduct an analysis of these models/methods to identify research gaps as well as problems that current methods have not yet solved in a comprehensive manner for the expectations of SMEs.

The author has analyzed the above studies and has identified the results and limitations of these DX methods/models as shown in Table 1.

2.3 Studies on information systems supporting the management of the DX process in enterprise

According to the search results about digital tools that manage the DX process through the keywords: "Digital transformation management" + System/Tool/Approach, there are currently quite a few research or commercial solutions on digital tools that manage the DX activities. Therefore, the paper will focus on three phases that have supporting numbers: 1) assess the current state of DX of enterprises; 2) develop a DX strategy; and 3) manage the DX projects.

Regarding the assessment of the current state of enterprises' DX, the research will propose a model of "Readiness" or "Maturity model" of DX and build a website to collect opinions of experts. However, these

websites only stop collecting opinions, aggregating results, and comparing industry averages. One of the solutions to mention is as follows:

- **Vietnam:**

- The set of indicators to assess the degree of transformation of SMEs by the Ministry of Information and Communications (2022): <https://dbi.gov.vn/danh-gia-chuyen-doi-so>.
- Assessing the readiness of enterprises for DX by the Ministry of Planning and Investment (2021): <https://digital.business.gov.vn/danh-gia-1/>.

- **World:**

- Impuls – VDMA: <https://www.industrie40-readiness.de/?lang=en>.
- According to research by Brozzi, et al., (2018), there are currently more than 10 tools to help businesses self-assess their readiness or maturity for DX (Brozzi, et al., 2018).

Regarding digital tools to build a DX strategy, there are currently not many studies or solutions. However, there are some studies that have used the Balanced Scorecard (BSC) method to build a DX strategy such as those of Fabac (2022), Maydanova, et al. (2019), and Yamamoto (2020). BSC has more than 25 years of history, so solutions or studies on BSC digital tools are quite popular and quite numerous (more than 300 studies with the keyword "balanced scorecard software"). In Vietnam, there are many enterprises providing software solutions for BSC. One of the typical suppliers is KPI software of global application technology development investment joint stock company (IHCM); Strategic Management Software (KPIBSC - BSC) of KPIBSC.

About digital project management tools are quite popular and widely used in many different fields. Some popular project management tools are MS Project, Trello, Jira, Basecamp, and Asana. In Vietnam, the solutions for digital project management tools are also very diverse, and most of the solutions are. Enterprises providing DX solutions all have their own project management software such as FastWork Project of Fastwork, MISA AMIS Work of MISA, and Base Work+ of FPT.

2.4 Identify research gaps

Based on a review of existing studies on DX methods/models for SME worldwide and information systems that support the management of the DX processes in enterprises, this study identifies the following research issues that need to be addressed:

- **Lack of comprehensive real estate management models for SMEs:** Currently, there are not many models or methods that can help SMEs manage their real estate in a comprehensive way from assessing their current state to building strategies, setting roadmaps, and planning implementation. Therefore, there is a need for a more comprehensive and complete real estate management model for SMEs.
- **Lack of supporting information systems for DX:** Most DX methods only focus on building and evaluating models and do not provide a supporting information system to help SMEs implement their own transformation process. Therefore, there is a need for supporting information systems that can help SMEs carry out their DX journeys.
- **Lack of research on DX in Vietnam:** There is currently not much research on DX in Vietnam, especially among SMEs. More research is needed to identify the typical factors, expectations, and challenges of SMEs in the process of implementing DX in the context of Industry 4.0.
- **Step 2: Analyze business processes:** Describe in detail the business processes that need to be modeled for the system.
- **Step 3: Analyze and design the system:** For the detailed analysis of the system, the paper will use the analysis method according to the Use Case and use the object-oriented system analysis and design method to design (Horton, 1992).
- **Step 4: Development and testing:** System development solutions will be analyzed and selected. Full testing will be conducted to ensure the quality of the system.
- **Step 5: Select enterprises to deploy system testing:** A few representative SMEs in Vietnam will be selected to conduct system testing, to test and evaluate the main functions of the system: enterprise position, develop the DX strategy, building a DX roadmap, and managing DX projects.
- **Step 6: Evaluation of test results:** The system will be evaluated by the tested SME based on the following criteria: 1) meeting the requirements and expectations of SMEs for a transformation support system number and 2) suggestions to improve the system.

3 The proposed model

3.1 Digital transformation methods/model

The system is developed using the waterfall model SDLC (Kramer, 2018), a sequential approach to software development that includes six main steps: From the business process, architectural model, and information system development process, the article will develop and test the system according to a 6-step process as follows:

- **Step 1: Determine the requirements of the system:** Determine the necessary functions of the system from the proposed model above. At the same time, define the criteria for evaluating the test results.

3.2 Determine the requirements of the system

The author conducted a Delphi survey with over 300 DX experts in SMEs in Vietnam using the Foresight approach to assess the features, challenges, and business vision of DX. The study also forecasts the future demand for DX in SMEs and the most important activities for implementing it. To calculate the sample size and determine the reliability level, the author used Yamane's (1967) sampling technique as a reference. The findings of the analysis were presented in detail in the study "Building a Digital Transformation Strategy for SMEs in Vietnam – Approaching Foresight" (Tuan, et al., 2023).

Most businesses need government assistance and tools during the DX process. In terms of support tools, most businesses have not used a comprehensive support system and desire one with the following capabilities.

Table 1. Evaluation of DX methods/models in SMEs
(Source: Authors' own research)

Author – Methods	Achievements	Limitations
Pierenkemper and Gausemeier, 2020	The method is quite complete with clear processes, analytical techniques, and strategies, and the method has also been applied in one enterprise	1) Failing to provide guidance on how to choose an appropriate adult model 2) Just stop at the level of formulating a DX strategy without mentioning the next steps on the roadmap, plan, and implementation of DX
Barann, et al., 2019	One of the perfect models both in methodology and proposals	1) The model is currently only theoretical and has not been implemented for any SME; 2) some steps of the method stop at the introductory level
Beliveau, et al., 2018	The model consists of three phases: 1) evaluation of the current SME, 2) DX strategy, and 3) DX goals	1) Only in theory and has not been implemented for any SME; 2) the model uses qualitative methods combined with quantitative methods, so it is necessary to conduct further studies to verify and evaluate the model
North, et al., 2020	The model consists of four steps: 1) realizing the growth potential enabled by DX; 2) develop DX-supported growth mindsets and strategies; 3) capture the growth potentials enabled by DX; 4) manage resources for DX	1) The model only stops at measuring maturity at four steps but has not yet suggested how to set up strategy, roadmap, and implementation plan; 2) in terms of the mature model for SMEs, the model has some limitations as follows: a) lack of personalization, which allows the selection of DX factors suitable for enterprises; b) some important dimensions for SMEs that the model has not mentioned: customers, products, and business models
Cotrino, et al., 2020	The method tested in three cases is quite detailed and shows reasonableness in the proposed steps	The method only stops at the level applied to a DX project, not yet showing the strategy and roadmap at the overall level of the enterprise. In addition, the method lacks the stage of assessing the current capacity of the enterprise before implementing the strategic development step
Pirola, et al., 2020	The model has a rather prominent feature of modular computation	The model only stops at the level of maturity survey but does not suggest how to set up strategy, roadmap, and implementation plan

Surveyed businesses want to have an information system capable of helping businesses develop a specific and appropriate DX roadmap (accounting for 88%), allowing businesses to share experiences through examples and good practice cases, as well as the ability to collaborate to form a DX community in SMEs (78%). SMEs are often limited in finance, human resources, and technology, so they will often choose some key activities of enterprises to perform DX first, so they want the system capable of allowing them to choose

DX pillars (customers, products, processes, etc.) that are suitable for step-by-step implementation (76%). Seeing possible DX scenarios in the future is also desirable when businesses build a DX strategy (73%). In addition, SMEs also want some other functions (over 65%) such as: 1) being able to manage and track the progress of DX projects (73%); 2) integration with external support such as innovation labs, research institutes, and consulting organizations (73%); 3) analyze and evaluate technology trends affecting

enterprises (72%); 4) simple tools, easy to use, and accessible anywhere and anytime (71%); 5) provide an overall and detailed view of all DX activities of enterprises from a strategic level to ongoing DX projects (67%); 6) assess the current digitization status, readiness, and expectation for DX from enterprises (65%); and 7) provide DX orientation in each specific field (43%).

3.3 Analyze the business process of the system

From the analysis results on research gaps when implementing the above research overview and system requirements from experts with experience in DX activities at SMEs in Vietnam, the article has proposed a DX management system to help SMEs manage DX activities easily, effectively, and comprehensively. The DX management system will support enterprises to carry out DX through four main stages, which are represented by four subsystems of the system, as shown in Figure 1:

- **Enterprise positioning module** will help SMEs answer the question of why (WHY) needs DX, including the following tasks:
 - **Establishing a DX strategy team:** Enterprises need to identify the key team in implementing DX and the key focal points to implement DX activities as same as responsibilities, duties, and powers of each member. There must be a leader in the role of the Chief DX Officer (CDO). The system will allow the representative of the enterprise to create a separate partition to manage the entire DX process of the enterprise and allows to set the rights and roles of members under the management of the enterprise. The system will automatically send an email to notify members of the account and password for the first time, requesting a password change when logging in for the first time.
 - **Select and adjust the evaluation model:** The system allows enterprises to edit, select, or add new DX pillars, supporting digital tools or Industry 4.0 technologies that enterprises are

currently using or in a future application orientation. Each Industry 4.0 technology will have descriptive information about these technologies, applicability, future appearance, investment costs, efficiency, etc. Each digital tool support will include basic description, application benefits, costs, and current solution providers. Each DX pillar includes basic description, tools digital technology, and Industry 4.0 technology support.

- **Assessment of the current status and needs of enterprises for DX:** A model to assess the current state of DX will be analyzed and selected for the purpose of determining the current status and needs of enterprises for DX. The assessment results also demonstrate strengths and weaknesses as well as a starting point to improve the DX activities of enterprises. The consulting module will be based on basic input information of enterprises such as size (capital and personnel), career, main product, business type, years of experience, strategy to focus on DX (products, business processes, technology, customers), and desired model type (change weights, select desired attributes) to propose suitable evaluation models. After that, the DX strategy team can choose the model that they find most suitable, or they can choose the model they designed themselves in step b above. After that, the enterprise will send a survey to experts inside and outside the enterprise to conduct an assessment to clearly determine the current DX position and the DX needs of the enterprise in the future. In this step, the system also allows enterprises to assess the barriers/difficulties when implementing DX as well as the motivations/expectations that DX can bring to enterprises. The community module will allow businesses to update new barriers/difficulties, motivations/expectations, news, and experiences about DX. At the same time, it also allows businesses to share experiences in the process of assessing the current state of enterprises.

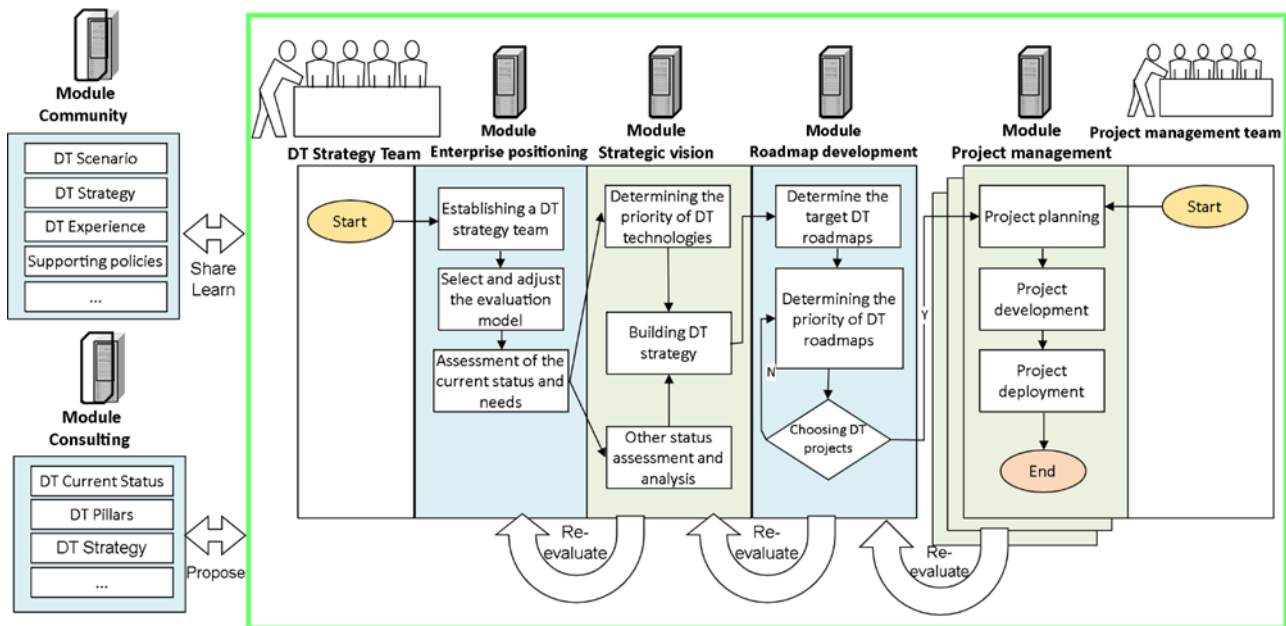


Figure 1. Business process of the DX support system for SMEs.
(Source: Authors' own research)

- **Strategic vision module** helps businesses answer the question of what (WHAT) needs to do DX, including the following tasks:
 - **Prioritizing the application of digital tools and Industry 4.0 technologies:** The recommender system will base on survey results to assess the current status and needs of DX in the above step to propose digital tools, and Industry 4.0 technology should be prioritized for implementation. After that, the DX team will select digital tools and Industry 4.0 technologies that will be applied to businesses.
 - **Integration with other analysis of the current situation of enterprises:** This aims to help SMEs have an overall and deeper view before forming a DX strategy, and at the same time, ensure that the DX strategy is effective and synchronization with other strategies of the enterprise. The system will appear suggestions for other status analysis that enterprises should perform and integrate into the system, for example: analysis of the current market and competitors; analyze the current business model in relation to external factors; analyze existing value chains, actors, and ecosystems; analysis of the current state of IT (infrastructure, information systems, services provided and used), and collect and evaluate customer requirements. Enterprises can use a number of tools to analyze the current situation such as SWOT analysis (strengths, weaknesses, opportunities, and threats); PESTEL analysis (political, economic, socio-cultural, technological, environmental, and legal); market analysis.
 - **Building a DX strategy:** The system will support enterprises to develop a DX strategy with the following tasks: 1) *select a DX scenario* that the enterprise is aiming for, each scenario will have a description details (Characteristics; How it happens; Opportunities and Threats) along with basic statistics on the number of businesses being selected; 2) *Answer questions about the DX strategy:* in order to help enterprises clearly define their DX strategy, the system will allow enterprises to answer questions about the DX strategy or choose yes available (guide to answer the set of 14 strategic questions by Trenkle (2019) or the set of 11 strategic questions by Hess, et al., (2016)). The community module allows businesses to refer to new DX strategies and scenarios from the sharing of other businesses.
- **The DX roadmap development module** helps enterprises answer the question of how the DX is

planned to be implemented (HOW TO PLAN), including the following tasks:

- **Determine the target DX roadmaps:** The DX team will base on the DX strategy and the results of prioritizing the application of digital tools and Industry 4.0 technology in the previous stage to determine Define target DX roadmaps. Each DX roadmap must have the following basic information: (1) title, description, and objective; (2) serving the development of which DX factors of enterprises, using technology trends or business models; (3) benefits and costs; (4) time and milestones; and (5) relevant departments.
- **Determining the priority of DX roadmaps:** The DX team will determine the priorities and dependencies between DX roadmaps. In order to help the DX team and businesses manage and track DX roadmaps conveniently and effectively, the system provides many different diagrams: 1) Gantt chart shows time, budget, related departments, and the relationship of DX roadmaps; 2) schedule diagram (calendar) shows a list of digital conversion activities in the form of a schedule (day, week, month).
- **Forming priority DX projects:** The DX team will rely on the above DX roadmap to form and select priority DX projects. DX projects will include basic information such as (1) project management, (2) budget, (3) relevant departments, (4) related DX projects, and (5) DX Pillars, 4.0 Technology, Related Digital Tools.
- **Phase of the DX project management** helps businesses answer the question of how DX is done (HOW TO DO), including the following tasks:
 - **DX project planning:** The project manager will rely on the descriptions, requirements, and objectives of the DX project described in the previous stage to begin to decompose the DX project tasks and plan their implementation. The system will support a Gantt chart to help project managers more easily plan and control the project.
 - **DX project development:** The project manager will monitor and update the project's tasks. The system will display warnings about the current

resource usage as well as the project progress to help the project managers make reasonable adjustments and help the DX team quickly understand the situation also.

- **DX project deployment:** After completing the above step, the DX project management team will introduce the functional components and how DX factors will be affected as well as proposing a plan to deploy the DX project for businesses and related impacts: personnel, processes, products ... for the DX strategy team. After the project deployment step, the DX strategy team will close the project and update the new DX score into the system.

3.4 System development

3.4.1 Selection of system development solutions

Based on the requirements of the system from the business process and analysis, system design, and the author's experience and advice from system development experts, the system development applies three methods: 1) self-developed from scratch, 2) based on open-source framework, and 3) hire a team to develop the system. After performing the pros and cons analysis of each method, as shown in Table 2, the method of hiring a system development team will be eliminated due to the problem of cost and scalability of the system.

Regarding the open source, the author has conducted research and analysis, and there are two open-source solutions, WordPress (<https://wordpress.com>) and Odoo (<https://www.odoo.com>), which are quite suitable. The author has analyzed the system requirements and responsiveness of these two open-source codes along with the development from scratch to see which method is the most suitable.

From the above analysis results, we have the following total score results:

- **Odoo: 40 points**
- **WordPress: 32 points**
- **Self-development: 28 points**

Therefore, the Odoo open-source platform was chosen to develop the system.

Table 2. Evaluation matrix of development solutions and system requirements
(Source: Authors' own research)

System requirements	Evaluation	Score
Allows to select and edit the survey for self-assessment – like Google form		
Odoo	There is a survey module that allows us to design and create simple surveys. However, some advanced tools and functions are still not supported	8
WordPress	There is a free SurveyJS plugin. However, if used for the development of the system, it will cost 499€ In addition, you can use some other plugins FluentForms for \$ 59/year or WPForms for \$ 49/year	6
Self-development	FormBuilder library can be used from the link: https://formbuilder.online/	7
Integrate some reviews from word, pdf, and excel files		
Odoo	Available in general function	10
WordPress	Use the free WordPress File Upload plugin	9
Self-development	Free FilePond library at link: https://github.com/pqina/filepond	7
Display and evaluate in the form of matrix		
Odoo	Currently, there is no support module	4
WordPress	There is WPDataTables plugin for \$ 69/year for use; if used for system development, it is \$ 249/year	5
Self-development	Free DataTables library at link: https://datatables.net/	7
Representing Gantt chart and operations on the chart		
Odoo	There is a free Web Timeline module, but it costs to integrate into the system	8
WordPress	There is an UpStream plugin; if the calendar and timeline are displayed, it is \$79/year	5
Self-development	Free VIS-Timeline library at link: https://visjs.github.io/vis-timeline/	7
Project management: tasks, assignment, and tracking		
Odoo	There is a fully featured free projects module that can be used with only minor changes	10
WordPress	There is an UpStream plugin; if it displays a calendar and timeline, it is \$79/year. If you need technical support, it will cost \$ 12/time	7
Self-development	Open-source Hillfog can be used to integrate into the system. Hillfog is a Java web platform for KPI, OKR (goals and key results), PDCA, and BSC (balanced scorecard) functions. Since this is a platform and not a library, integration is time-consuming and costly.	6

3.4.2 Overview of the system architecture

Because the system is developed on the Odoo platform, the detailed architectural model of the system must also follow the standard Odoo architectural model. The Odoo architectural model is developed based on the multilayered architecture model (Reis, 2018). To ensure that the request can be accessed any-time and anywhere, along with support on different types of devices, the system will provide two access platforms: (1) a web-based with support responsive web design support (Baturay and Birtane, 2013) and (2) an XML-RPC web service that allows applications on mobile platforms or other systems to interact with the system through APIs.

In this model, the system will be divided into three main layers, as shown in Figure 2: (1) presentation layer, (2) business layer, and (3) data layer. This feature makes the system scalable (scale-out) easily to serve many users at the same time. In addition, the model also shows the relationships of the components inside the DX management module and the relationship between the DX management module and other Odoo modules. Based on system requirements, the DX management module will interact with the following Odoo modules: core module, dashboards, survey, project, personnel, contact, calendar, and discuss. Some modules will be improved to integrate features according to system requirements.

4 Experimental results

4.1 Experimental configuration

According to the hardware requirements of the Odoo server, with a 2-core CPU and 2 GB of RAM, it is possible to meet the requirements of 10 users using it at the same time. Because the system is in beta and the number of users simultaneously using the system is not high, the author has been hired a server of Azdigi company with the following configuration:

- **CPU:** Intel Xeon E5 dual core with 2.6GHz
- **RAM:** 2 GB
- **Hard Drive:** 30GB High-speed Enterprise RAID-10 SSD

- **Bandwidth:** unlimited and 100 Mbps transmission

In addition, a domain <https://quantrichuyendoiso.top/en> is also registered for use. Since there is only one server, everything will be installed on the same server. For security and future scalability, the server will use Nginx (<https://www.nginx.com/>) as a front-end proxy to receive requests from users. With Nginx, it will be easier to scale to meet the requirements of 1000 concurrent users later with load balancing for multiple Odoo servers at the same time. Regarding SSL, the system will use Let's Encrypt for free to save costs. However, Let's Encrypt is only valid for 30 days, so it is also necessary to set up automatic re-registration after 30 days.

The system installation will proceed according to the following model in Figure 3. The model will include five elements: Firewall, Nginx, SSL Let's Encrypt, Odoo System, and PostgreSQL (enterprise and shared data).

4.2 Experimental illustration of the proposal model

The DX management support system was first deployed at the economic informatics center around July 2022. In the early stages of the system, there were many errors and some problems arising in the process of testing the system. From the beginning of September 2022, the new system became stable and officially deployed to the Academy of Technology and Design of University of Economics Ho Chi Minh City at <https://quantrichuyendoiso.top/en>. After that, the system continued to be tested with more than 10 Vietnamese SMEs in many different fields and types of enterprises (micro, small, and medium) as shown in Figure 4.

SMEs were selected to test the system for the following main reasons: **1) Convenience:** due to the fact that the information about DX provided by enterprises is quite detailed and contains a lot of information related to business secrets or future plans of enterprises, so businesses will be afraid to share, so it is necessary to choose businesses that have good connections and are willing to share information when conducting experiments;

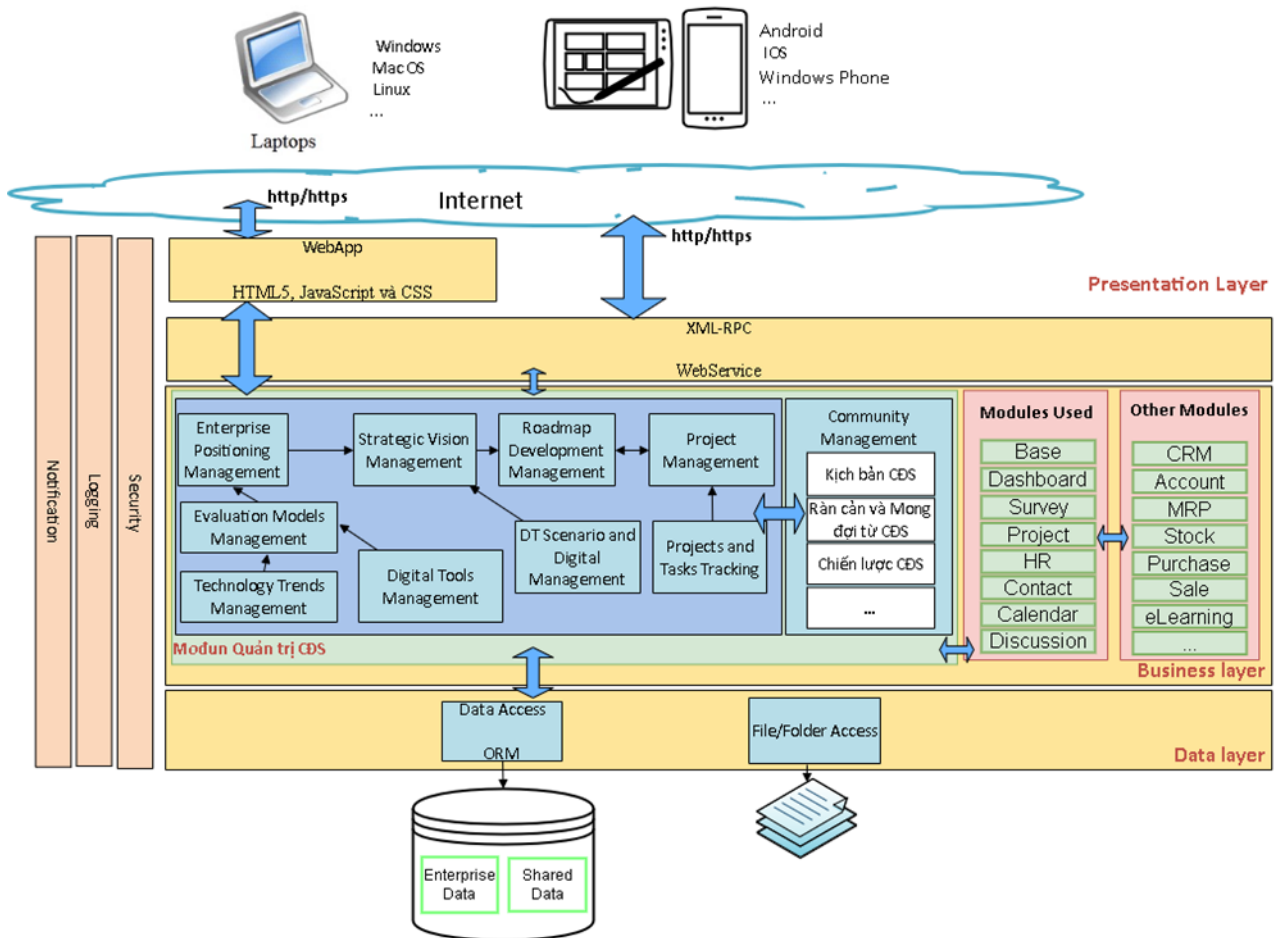


Figure 2. Proposed overall architecture.
(Source: Authors' own research)

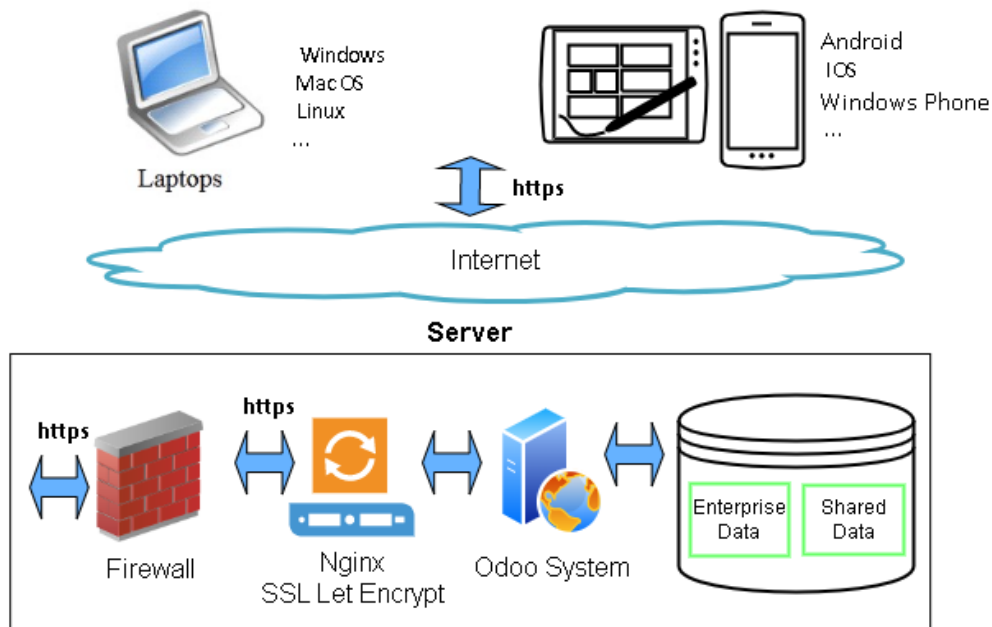


Figure 3. Deployment model of test system.
(Source: <https://quantrichuyendoiso.top/en>)

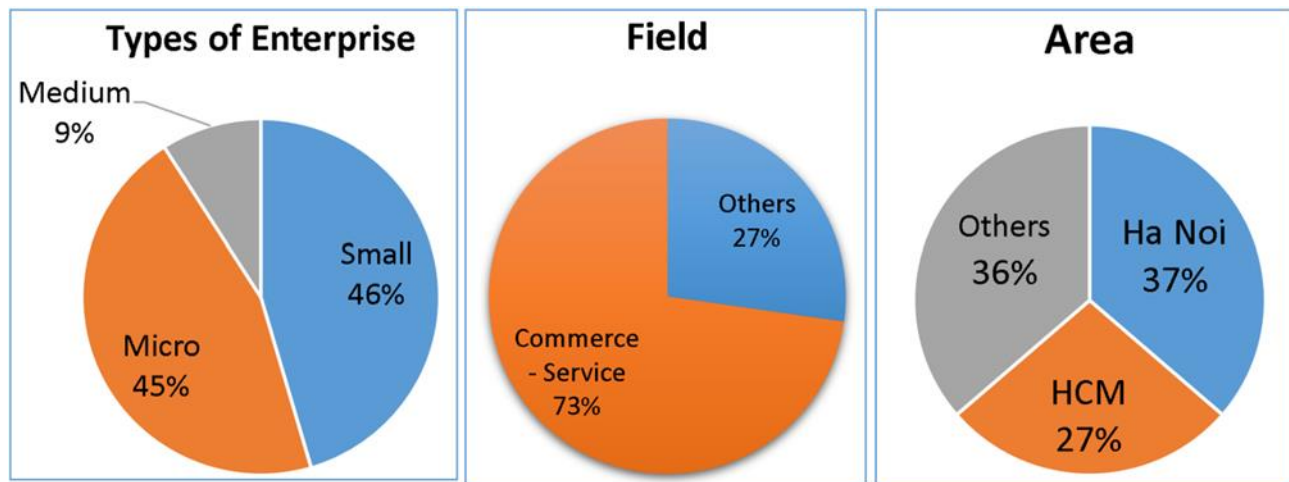


Figure 4. Proposed overall architecture.
(Source: Authors' own research)

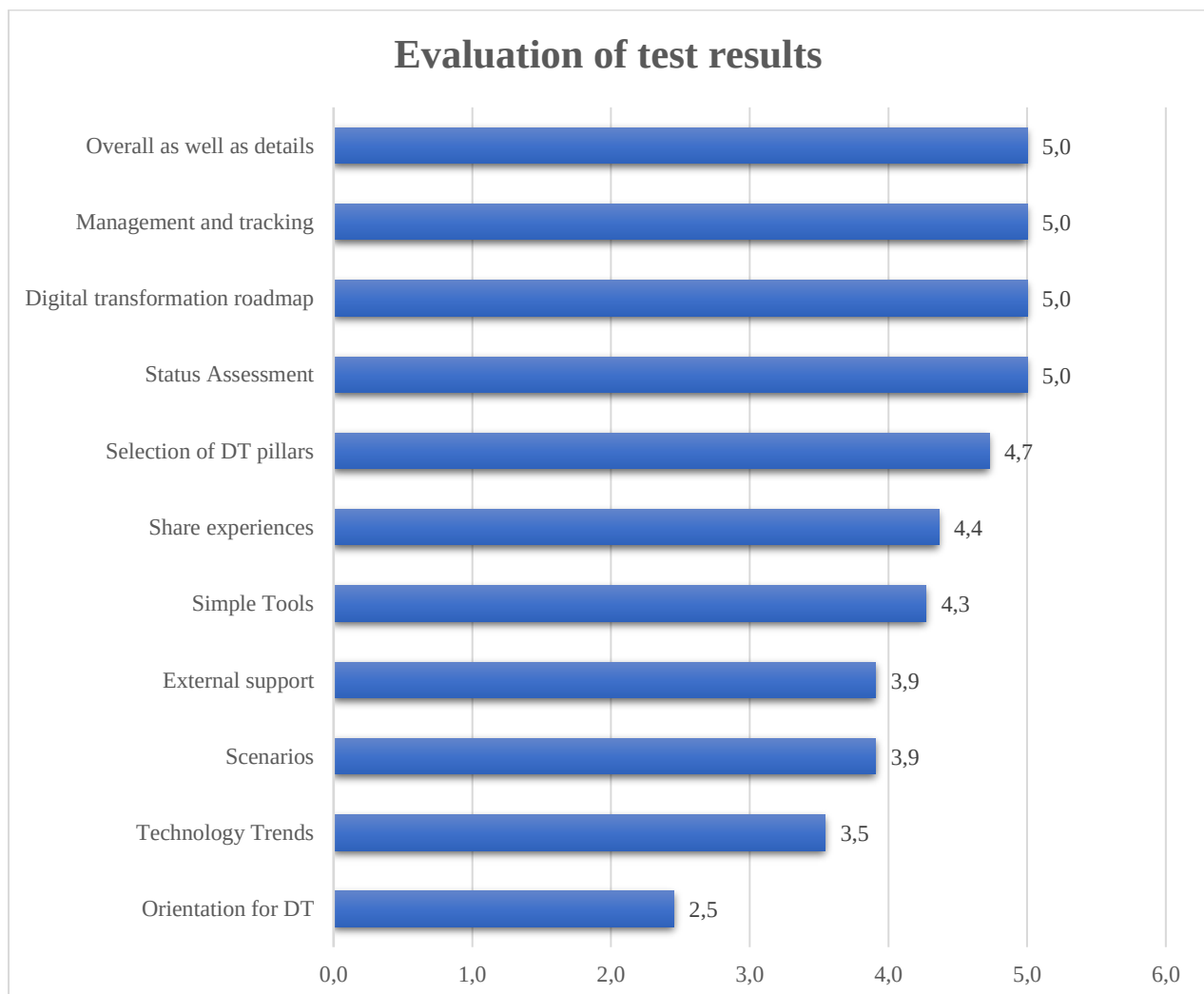


Figure 5. Level of agreement/satisfaction of test enterprises.
(Source: Authors' own research)

Table 3. Evaluate system test results according to SMEs' expectations
(Source: Authors' own research)

No	Expectations of SMEs
1	DX roadmap
	This feature is quite good and quite convenient, helping businesses clearly see the DX roadmap through two important views, calendar and Gantt. In addition, the system also provides a Pivot function for analysis in case the data are too large. However, the Gantt chart feature still does not work well on mobile screens, and it is also suggested that the system should support more features to link roadmaps as well as view resource usage statistics like MS Project.
2	Share experiences
	With the Community module, businesses have a lot of experience in DX, have good ideas, and have new business models, new digital tools, digital tool providers, or new trends that can help new businesses access DX faster and easier. Currently, the system is supporting: 1) 4 different DX scenarios with full information on characteristics, scenario conditions, opportunities, challenges as well as characteristics of 9 pillars enterprise's main; 2) 2 sets of questions with full suggested answers; 3) 58 different number tools; 4) 20 digital tool solutions including 17 excellent "Make in Vietnam" digital technology solutions were announced and introduced on the website Smedx.vn of the Department of Informatization under the Ministry of Information and Communications; 5) 11 technology trends; 6) 9 main pillars that businesses need to implement DX; 6) 49 Barriers/Difficulty in DX classified into 13 groups; 7) 10 solutions to overcome the Barriers/Difficulty of DX; 8) 33 DX expectations are classified into 7 groups; 9) DX policies, experiences, and news. When using the system, enterprises can use this public information or can create their own data and not allow other enterprises to access it. According to user reviews, the feature runs well and meets the requirements of enterprises and runs well on mobile screens. Users also suggested some additional features such as: 1) Can automatically read news about DX in some official websites or social networking sites, and 2) it is necessary to provide features so that digital solution providers can integrate with the system because many times businesses need to interact with these providers, and the interaction management feature of the system is quite good.
3	Selection of DX pillars
	Users appreciate this feature of the system because it will help businesses be more flexible and proactive in evaluating and implementing their DX strategy. Instead, like some other metrics, having to answer all the questions can be irrelevant and time-consuming. All 11 businesses have created their own digital toolkits in line with their current desires.
4	Scenarios
	The system has provided four different DX scenarios with full information as well as the characteristics of activities in enterprises when using these scenarios. In addition, the system also allows other businesses to contribute different DX scenarios to enrich the DX activities of SMEs in Vietnam. Due to the current capacity of enterprises not having enough knowledge and experience to propose DX scenarios, enterprises only use the available scenarios and choose the digital management scenario.
5	Management and tracking
	This is a pretty good feature that has helped businesses reduce a lot of time tracking and managing jobs. Previously, businesses managed work through emails, messages, meetings, or direct contact, so it was quite difficult to manage and monitor, and there were many jobs with unclear roles, responsibilities, or progress reporting. With the system's features, it helps businesses to better assign work and control work, as well as have an overall view of the entire operation of the business.
6	External support
	Described in item 2 Share Experiences above. Since only 11 enterprises are using the system, the support between different enterprises is still unclear. It is suggested by users to have some additional features such as: 1) create a support request and 2) provide a paid consulting feature to attract DX experts to use the system or help companies solve difficult problems.
7	Technology trends
	The system provided 11 key technology trends of Industry 4.0 along with basic descriptions of these technology trends. Because these are technology trends, the application also faces many difficulties when conducting testing or implementing. Right now, only For Her enterprise has begun planning to research and test augmented reality technology to help customers choose and mix clothes. In the process of using this function, an error was discovered in the strategy function: the priority matrix plotting system was wrong. After that, this bug has been fixed and enterprises can continue to use this function. Users who want technology trend function need accompanying solutions from vendors like digital tools and provide more information: applicability, future likelihood, cost investment, efficiency ...

No	Expectations of SMEs
8	Simple tools
The system allows users to control the access rights of members of the DX team, thereby helping users only see the functions relevant to them and easier to manipulate. In addition, the system is developed to support mobile devices well, so it will help users to use the tool simply and easily. However, according to the feedback of some users, the task and project management functions are still difficult to use and need to remove or hide unnecessary features to make the tool simpler. Currently, with a small amount of work in the project, it can still be used, however, with a large project, and it may be difficult to separate the work and link the jobs with each other.	
9	Overall as well as details
Users are quite impressed with the tracking panel feature that can be customized according to the subjects they are interested in as well as having an overall view of the active business. The multilevel detailing feature has also brought many benefits to users, helping users reduce a lot of time having to open and close different functions. A tracking board (Dashboard) allows people to track the overall objects they manage or the objects they are interested in.	
10	Status assessment
The system has provided a variety of status assessment features and has many assessments in many different aspects: 1) difficulties/barriers of DX, 2) solutions to overcome current difficulties/barriers, 3) expectations/motivations for DX, 4) evaluation of digital tool application, 5) evaluate application of technology trends, and 6) self-assessment according to its own set of indicators. This feature is rated quite well, only having problems sending emails. Email sending function is not working in the first stage due to policy change from Gmail.	
11	Orientation for DX
In general, the system's functions are quite good according to the assessment of the business directors who have tested most of the system's functions. However, the system needs to be used in more enterprises to further evaluate the functions such as: 1) confidentiality, ensuring that the data of different companies are not seen or changed, 2) the system's processing speed when many people use the system at the same time, and 3) special requirements of some specific enterprises.	

2) Enterprise diversity: because SMEs are very diverse and have many different needs for DX, the system has been tested on many different types of businesses from micro to medium, many different fields from manufacturing, construction, to trade and services. From the test results, it has been proved that the modularization of the DX pillars of the model is suitable for SMEs in Vietnam, micro and small enterprises have limited resources, so they only need to choose the pillars that they are interested in. In addition, some businesses operating in special fields can create new DX pillars such as enterprises operating in the education sector that have created new pillars of Admissions and Training or agricultural enterprises that have established new pillars of DX as Smart Farm pillar.

4.3 Results and discussion

After completing the experiment in enterprises, the author conducted interviews with some personnel who are using the system to assess the suitability, problems, and improvements of the system. The

evaluation content will include 11 criteria, and these are also the 11 expectations of SMEs about a tool or system to support DX mentioned above. For each criterion, the testing enterprises will fill in two information: 1) the level of agreement/satisfaction about the system's ability to meet the requirements (from 1 to 5 points) and 2) enterprise's assessment of the function to use: advantages, disadvantages, errors encountered, suggestions... . Figure 5 is the statistics on the level of agreement/satisfaction with the system of testing enterprises.

Table 3 is the detailed evaluation of the test enterprise after using the system.

Currently, the system is still maintained at <https://quantrichuyendoiso.top/en> so that other businesses can access and conduct testing. Enterprise can experiment with the accounts below or contact the author to get a separate account for enterprise:

- **Management:** full control of the enterprise and can grant other rights to members of the enterprise
 - UserName: quanly@quantrichuyendoiso.top
 - Password: ***
- **Staff:** can choose one of the two employees below. Each employee will have different permissions and will have a different interface depending on the manager's settings.
 - UserName: nhanvien1@quantrichuyendoiso.top
 - Password: ***
 - UserName: nhanvien2@quantrichuyendoiso.top
 - Password: ***

5 Conclusion

The article has made an overview of studies on DX methods/models in SMEs as well as studies on information systems supporting the DX management. At present, there is still a lack of models or methods that can support SMEs in Vietnam to implement DX activities in a comprehensive and complete manner from the stage of assessing the current state of enterprises, developing strategies, setting up a roadmap, and planning for implementation. From this result together with the requirements of the system to support DX activities from SMEs in Vietnam, the article has proposed an information system that can support SMEs in Vietnam to implement DX holistically and fully from the stage of assessing the current state of enterprises, developing strategies, setting roadmaps, and planning to implement DX. A systematic business process consisting of 12 steps and divided into 4 stages in the entire DX activities of enterprises has been analyzed and described in detail: 1) enterprise positioning stage, 2) strategic vision stage, 3) development phase of DX roadmap, and 4) DX project management phase.

The article also conducted analysis and selection of system development solutions. A matrix of system

requirements and developed solutions was analyzed and evaluated. The resulting Odoo open-source solution is the most suitable. A detailed overall architectural model on the Odoo platform has also been designed. After that, the system tested the system with 11 SMEs in Vietnam. The test enterprises were quite satisfied and highly appreciated the system's functions as well as the suitability of the system to the needs of enterprises.

However, due to time and budget constraints, the research is still limited and there are still many gaps for future research. Currently, the module only supports the function of determining the priority of DX activities for enterprises. In the future, the recommender system needs to add more functions such as proposing a model to evaluate the current state of DX based on basic information of enterprises, proposing next activities to be carried out to achieve higher level of DX, suggesting suitable digital tool solution providers. In addition, only 11 enterprises have implemented the system test, so the factors have not been fully evaluated yet others such as 1) confidentiality, 2) processing speed, and 3) ability to suit different types and sizes of enterprises. Therefore, the pilot implementation should be continued to apply to more SMEs before it can be brought to market.

5.1 Research and managerial implications

This research on DX for SMEs in Vietnam has important implications for their development in the context of the 4.0 industrial revolution. It can help SMEs keep up with new technology trends, improve competitiveness, and achieve sustainable growth.

Strategically, the research provides guidance for Vietnamese SMEs in implementing DX. The comprehensive DX management model proposed in the study can help these businesses develop DX plans and strategies tailored to their specific needs.

In terms of implementation, the research has developed an information system to support SMEs in the DX process. This system can help businesses automate processes, collect and analyze data, and make informed decisions.

The research has also helped to raise awareness of DX among SME managers. The system provides information and knowledge and creates awareness for SMEs as they learn to use the system. It also shares information about the DX process between SMEs, creating a knowledge base for them.

Overall, the research is expected to have a positive impact on the productivity, efficiency, and competitiveness of Vietnamese SMEs. Digital transformation can help these businesses save costs, improve labor productivity, and create new products and services to meet market needs.

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