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The Mediating Role of Dynamic Capability on the Relationship between E-Leadership Qualities and Innovation Management: Insights from Malaysia's Medical Ice Industry

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Abstract: The current research plans to investigate the role of e-leadership qualities in managing innovation with dynamic capability as a mediator with the aim to assess and measure how the rapidly changing demands are fulfilled for business sustainability through innovation management. Data have been obtained from a quantitative survey of 145 respondents using the stratified random sampling method. The samples were obtained from the medical device manufacturers located and registered in Malaysia. Data analysis was performed using Partial Least Square Structural Equation Modelling (PLS-SEM). The results show a significant influence of e-leadership qualities on innovation management indirectly with the mediating role of dynamic capabilities. Dynamic capabilities have a strong relationship with innovation management. This research shows the importance of different dimensions of e-leadership qualities in managing innovation for policy makers and practitioners and the impact of dynamic capabilities. Policy makers and managers can use these findings to use their resources to enhance their qualities and capabilities to perform better in managing innovation, which is among the top priorities of Malaysia at the national level. The results extend the literature on e-leadership qualities by empirically testing the relationship between innovation management and dynamic capability and by adding new contextual knowledge to the medical device industry.

Keywords: e-leadership qualities; innovation management; dynamic capability; agile leadership; medical devices

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Citation: Subramaniam, S.A.P.; Salamzadeh, Y.; Mujtaba, B.G. The Mediating Role of Dynamic Capability on the Relationship between E-Leadership Qualities and Innovation Management: Insights from Malaysia's Medical Ice Industry. *Sustainability* **2023**, *15*, 16778. https://doi.org/10.3390/su152416778

Academic Editor: Sooksan Kantabutra

Received: 25 October 2023
Revised: 7 December 2023
Accepted: 11 December 2023
Published: 13 December 2023

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1. Introduction

The issues in innovation management are not new, but the context of open innovation and business model innovation in digital transformation is always evolving [1]. The shifting context of innovation includes market expansion, market fragmentation, virtualisation, as well as increased concern about sustainability and the development of technological and social infrastructure. Digital transformation reduces the time necessary to create and launch innovations while shortening the lifetime of new products and services on the market [2], thus increasing competition among global market players.

The medical device sector is extremely fragmented, ever-changing, intensely regulated, and global in scope. The Malaysian government has selected the medical device industry as one of the high potential growth sectors in the twelfth Malaysia plan (RMK-12) with greater job opportunities [3]. One of the primary obstacles in managing the transition path of breakthrough medical technology from research laboratories to economically viable healthcare goods is regulatory challenges [4]. According to Chesbrough's [5] research, the adoption of "open innovation" within the medical device industry may give an effective route to market for many new innovations, as well as the possibility to share some of the risks. To gain attention, the implementation of open innovation management necessitates

the strategic leadership of senior executives [6]. Of course, no innovation can provide long-lasing competitive advantage or remain sustainable if it is not rooted in strategy and win-win outcomes for all relevant stakeholders. Additionally, transactional management based on short-term output cannot always be sustained in the modern era due to better and more efficient technologies. Modern and sustainable capabilities should be in full alignment with strategy and transformational leadership.

Leadership has a tremendous impact on fortifying knowledge and creativity in digital transformation, which is framed by people's competency and digital culture [7]. E-leadership is often referred to as digital leadership [8,9]. E-leadership is a type of leadership in the digital era that occurs in both the proximal and distal settings of a social influence process mediated by digital technology, resulting in a change in attitudes, feelings, thinking, behaviour, and performance [10]. Digital leadership is defined as "the ability of leaders to set a clear and meaningful vision for the digitalization process, as well as the ability to execute strategies to realise it" [11,12].

In this study, dynamic capability is used as a mediator to improve results in innovation management for business sustainability. Teece et al. [13] defined dynamic capability as an organization that is designed to sense opportunities to invest to capitalise on them and reconfigure internal and external competencies to respond to a rapidly changing environment [14].

Previous research has found evidence of digital leadership, dynamic capability, and innovation management focused primarily on structures, benefits, and implications in the Indonesian telecommunications industry [15]. However, research on the influence of digital leadership and innovation management, particularly in the medical device business, is lacking. Previous studies have limitations in terms of sample size, research model, research industry, and geography. As a result, this study was designed using an enhanced research model on the required e-leadership qualities and dynamic capabilities to manage the innovation process mediated by the dynamic capability for business sustainability.

Dynamic capabilities, as articulated by Schoemaker and colleagues [6], can only be developed and deployed with strong leadership to embrace the challenges of the innovation process. Another study by Elidjen and colleagues [15] indicated that digital leadership based on dynamic capability has a substantial effect on innovation in the Indonesian telecommunications industry. The current study focuses on the medical device industry to complement the existing literature on digital leadership, innovation management, and dynamic capabilities.

Companies in various industries can accelerate their pace of innovation by implementing new strategies and embracing newer technology or digitalization. It is critical for businesses to continue innovating and transforming industrial processes and business structures [3]. To remain competitive, businesses must prioritise productivity, increase automation and innovation, conduct more research and development, and implement best industry practices [16]. This study contributes to the discussion of how crucial e-leadership is in maintaining accelerated innovation management in an organization, thereby maintaining corporate sustainability through dynamic capabilities.

Malaysia is one of the well-known nations that has successfully transitioned from an economy based on agriculture and mining in the 1970s to one based on knowledge in the 2000s. It is a country that has been innovation-led from 2011 onward and is moving towards becoming a prosperous nation using knowledge and innovation based on the 12th Malaysia Plan 2020–2025 [17]. Unsurprisingly, Malaysia has focused on innovation as a tactical growth option. Malaysia started building the foundation for an innovation-driven economy through several plans. The National Policy on Science, Technology, and Innovation (NPSTI) and the Malaysian Education Blueprint 2015–2025 are two of the initiatives and policies the Malaysian government has launched with the goal of promoting innovation. To support startups and advance technology, the nation has also established a number of innovation hubs and research institutions, including the Malaysian Digital Economy Corporation (MDEC) and the Malaysian Global Innovation and Creativity Centre

(MaGIC). Through a number of programmes and policies, Malaysia maintained its commitment to fostering innovation in 2021 and beyond. The government made efforts to promote industries like e-commerce, fintech, and digital services, showing its focus on digital transformation and technology-driven economic growth. The MyDIGITAL initiative was launched with the intention of boosting the nation's digital economy and the uptake of cutting-edge technologies like blockchain and artificial intelligence. While obstacles like the COVID-19 pandemic affected the global innovation landscape, Malaysia showed resiliency and adaptability in its efforts to foster an environment that is favourable to innovation and technological advancement (Malaysian Ministry of Science, Technology, and Innovation-MOSTI, 2022). However, the overall performance is still far from the desired level, considering the Global Innovation Index. This is why, in Malaysia, research on innovation has become one of the most interesting issues at academic and government levels [18].

To sum up, the main research gaps, guiding us towards the current paper, the first gap is related to doing this study in the innovation ecosystem of Malaysia, which shares a new perspective to the academic works conducted in this context. Secondly, based on the importance of innovation after COVID-19, the current research fills a practical gap in linking e-leadership qualities to the innovation of businesses to help practitioners move their organizations towards a more resilient status. Another academic gap, which is filled by the current study, is related to studying the relationship of e-leadership qualities (all six altogether) on the innovation of the firm as in some previous studies, such as Zhong et al. [19], only some of the dimensions were studied, and they suggested to test all dimensions and also to test it in another context other than Chinese.

The current study plans to shed some light on some of the variables that can have an influence on innovation management in the Malaysian context, namely, e-leadership qualities and dynamic capabilities. The focus of the current research is on the medical device industry, which is one of the most innovation-sensitive industries.

2. The Literature Review

2.1. Innovation Management

Management activities and decision-making at the individual and organisational levels are all part of the innovation management process. An organization's innovation output is determined by the abilities required to execute daily tasks, address risk, and spend time and money [20]. To be innovative, all employees should have basic skills that allow them to be flexible to changing situations and more open to new ideas, according to the systemic integration model [21]. The ability to successfully innovate is one of the most important aspects of establishing and sustaining a competitive advantage for economic growth [22]. Open innovation management and collaboration, as examined by Davey et al. [4], will drive the future of the medical device industry. Tidd and Bessant's [22] contribution to innovation management employed a five-construct innovation model comprised strategy, organisation, process, learning, and networking. The main reasons for selecting this framework among many other available frameworks about innovation management are the comprehensiveness of the model, along with its fit and context, including the national vision, industry, and culture.

Strategy in innovation is the determination of strategies to construct the approach and methods to increase and improve an organization's innovative potential. An organization's top management can use an innovation strategy to actively monitor competitors' activities, reach out to customers to collect market information, effectively use the organization's resources, and make efficient investments in research and development, all of which will result in improved innovation performance [23]. The Tidd and Bessant model defines innovation as a process inherent in organisational product and service regeneration, revitalization, and production and distribution methods that yield perfect solutions [22]. Product innovation means meeting particular and diverse client needs, and the introduction of technology is an example of process innovation [24]. Organizational innovation entails

the implementation of innovative practices to manage a company's internal and external relationships [25]. Internal organisational innovation environments entail new policies, responsibility, decision-making power redeployment, and new structures that are critical for developing a competitive advantage [26].

Learning, innovation, and performance all have a positive correlation, where creativity necessitates individuals learning and sharing knowledge across the organisation [27]. Employees are given an increased ability to grasp knowledge from their surroundings, as well as greater core knowledge and innovation, through the exchange of memories, the use of external information, and the implementation of formal processes that collectively expand the knowledge reserve [28]. Through strategic collaboration within an organization's internal and external environments, networking accelerates the orchestration of superior assets and knowledge integration. Because of the endless capabilities required to generate innovation in adjusting to the dynamic global business environment, collaboration has become one of the most essential aspects driving innovation in organisations [29]. Collaboration speeds up the innovation process by connecting the non-competence value chain with the enterprises' core competencies [30]. Innovation management has also been introduced as one of the main tools for organizational success in the digital and industry 5.0 era [31]. Many researchers assume that the innovation management field is a fast-paced and changing profession in which new approaches are constantly developed, and the need to conduct research in this arena is very high [32].

In the current research, we have used the famous five-dimensional approach towards innovation management from Tidd and Bessant [22], who contributed to this field by presenting a five-construct innovation model, including strategy, process, organization, networking, and learning. Digital technology contributes to innovation and the formation of a new paradigm in business processes and supply chains, causing volatility in the business market. Changes in the paradigm also lead to market uncertainty, which is commonly referred to as volatility, uncertainty, complexity, and ambiguity (VUCA) [33]. Of course, a leader plays a critical role as top management in delivering innovation by promoting an innovation culture within an organization by directly involving themselves in the development and implementation of clear and relevant methods [34] to support innovation, as well as clear and frequent communication within the organization [35,36]. Thus, in the world of digital transformation, it is critical for organizational leaders to build digital leadership competence to manage the organization for business sustainability.

2.2. E-Leadership

Technology is a means to an end, but the key to achieving that end is the development of a digital leader in an organisation to drive the transformation into a digital corporation through investment in digital technology to generate new markets and empower organisational performance [36]. Through sustainable vision, leaders transform and lead people to high performance with, task and relationship orientations, character, and trust-building processes face-to-face or through digital means in any industry [37–41]. Digital leaders are described as innovative leaders, inspiring leaders, credibility leaders, knowledge leaders, collaborative and interactive leaders, and leaders who trust their subordinates [42]. By merging culture and the ability to optimise the use of digital technology to create value, digital leaders are undoubtedly dynamic and crucial to digital transformation [43,44].

The importance of e-leadership (digital leadership) on the performance of the businesses and even on the quality of their internal communications is discussed by some recent studies such as Kashive et al. [45]. Toduk and Gande [46] define digital leadership as an entrepreneurial characteristic that is closely related to creativity, innovation, and digital capabilities to make a competitive transformation with technology and build knowledge, thereby implementing digital technology to produce strong domestic and global networks that enable collaboration and stirring dependable contribution in an overall vision. Other studies have found that leaders must not just be creative and innovative but also be able to collaborate to seize opportunities [42]. Guzman et al. [47] demonstrated that critical

leadership skills that could contribute to the industry 4.0 context are cognitive skills such as creative thinking, decision making, strategic problem solving, and interpersonal skills such as social perceptiveness, coordination, negotiation, and persuasion to deliver the best in management and strategic skills allied with the organization's vision and mission.

Li and colleagues [48] described six constructs of e-leadership qualities that result in productive alignment between business strategy and digital technology, which increases a firm's longevity and growth prospects. The six constructs are as follows:

(1) Agile leadership is the capacity to respond rapidly to opportunities and threats and lead effectively in a variety of contexts, such as new, changing, and ambiguous situations with disruptive technology;
(2) Hybrid skill development is the capacity to explore new technologies and integrate them into the organisation and its business activities in terms of business strategy and IT skills to adapt quickly to market changes, digital trends, and new business opportunities;
(3) Architectural view is the leader's capacity to deliver design logic and arrangement in value, process, skills, organisational, and systems architecture that supports business and IT scope;
(4) Digital entrepreneurship is the ability to support the identification and interpretation of trends in the IT environment, allowing for the articulated expression of how developing IT competencies stimulate business innovation;
(5) Value creation is the ability to explore digital technologies to effect new products and services, which is a critically vital attribute in developing new strategies and competitive values; and
(6) Value protection is one's ability to improve processes and services across the value chain by leveraging data, digitising core business, and allocating limited resources.

Based on the literature, the six constructs of e-leadership qualities are evaluated in this study. The key reason for selecting this framework over the others is that, while it is simple to understand, it provides a comprehensive view of the competencies, and the dimensions are relevant to the context of our study and case.

2.3. Dynamic Capability

Dynamic Capability is defined as the organization's capability to assimilate, build, recommence, and reconfigure resources and competencies internally or externally to adapt to the changing business environments [13]. Dynamic capability is the organizational capability to have the aptitude to learn and change [15]. According to Salunke et al. [49] and Haseeb et al. [50], dynamic capability highlights the resource capabilities of a firm that can be created, extended, and adapted to align with the changing environment to form a new transformation paradigm.

Schoemaker et al. [6] described several clusters of dynamic capabilities that are required in an organization to improve long-term transformation processes, which require sensing external change and identifying the shifts in the market. Organizational leaders must understand the implications of these shifts towards competition while seizing new opportunities in a timely manner by innovating and realizing new schemes that take the lead in external change. Finally, dynamic capabilities require transforming organizations or reconfiguring them and the ecosystems to gain the full benefit of new business models. As part of sensing, seizing, and transforming, transformation can be achieved by integrating, building, and reconfiguring competencies [51].

Sensing opportunities is about the organization being agile in scanning the business environment to identify new market opportunities. To be agile in screening the business environment, organizations should continuously review the effects of environmental changes on customer needs and analyse their product portfolios to ensure that they are aligned with the customer's demands [52]. Seizing capability is required to ensure the organization can make the essential investment to change existing practices. Thus, organizations should have internal procedures for making change-oriented decisions and even formal teams for

managing the launch of new products. It is possible for a company to identify a business opportunity yet fail to invest to capitalise on it [13]. Reconfiguration capabilities necessitate efficiency in the implementation of changes that drive new product development to integrate all existing processes with new ones while maintaining organisational efficiency. Redeployment and reconfiguration may also include business model redesign and asset realignment [26].

2.4. Hypothesis Development and Conceptual Framework

In their entrepreneurship and innovation theory, Schumpeter explained a systematic thought of the endogenous origin of innovation that imposes upon the identification of the concept of creative response as the result of a stochastic or random process that is influenced by the specific interactions between the action of the firm and the characteristics of the system [53]. This very much relates to the current study, as digital leadership is central to digital transformation since it has a significant direct and indirect influence on managing innovation by possessing not only capability and competence in digital technology but also a focus on market orientation, which accelerates innovation [15]. A study by Losane [54] revealed that leadership is required in an organization to focus on innovation management while showing behaviours that promote innovation, such as risk-taking, innovation support and rewarding initiatives.

The dynamic capabilities theory [13,55] explains the term 'dynamic' as the capacity to reintroduce competencies to attain strategic correspondence with the changing business environment. Meanwhile, the term 'capabilities' highlights the important role of strategic management in properly adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competencies to meet the demands of a changing environment [55]. Elidjen et al. [15] observed in their study that the process of innovation management involves the intellectual capabilities of management, particularly among leaders, to respond to the dynamic business environment, and thus, the dynamic capabilities are also necessary for a leader. Leader cognition is diverse; hence, leaders must be able to sense, seize, and transform to search for and discover proper opportunities in a timely manner [56]. Because leader cognition varies, leadership is regarded as a dynamic system with continuous learning abilities [25,57].

Many different studies [58–62] have used the three dimensions of the dynamic capability used in our research. However, we have developed the second hypothesis to make sure all these three dimensions are working properly and fit our context and research.

Similarly, for innovation management, previous studies have used the five dimensions used in our research, including strategy, process, organization, learning, and networking. As shared before, this framework, which was developed by Tidd and Bessant [22], was not tested practically until 2015, when Ferreira et al. tested and confirmed it. So, it fills the gap of the lack of similar studies on Tidd and Bessant's framework in the innovation management field. Again, we have developed a third hypothesis to test the fit and reliable loading of the dimensions to be used in our research context.

Finally, we developed the first hypothesis about the dimensions of e-leadership qualities, which was prepared for the first time in 2016 by Li et al. and subsequently used by other researchers [63–66] to test their fit for our study's context.

The current study explores the impact of e-leadership qualities on innovation management as mediated by the dynamic capability to fill research gaps. In the following subsection, the rationales for the proposed association are elaborated based on the literature. As such, the following hypotheses were created to assess the relationship between the identified sub-dimensions of e-leadership qualities, innovation management, and dynamic capabilities:

H1. *The six sub-dimensions of e-leadership qualities can be accounted for by a common underlying higher-order e-leadership qualities with significant positive connections;*

H2. *The three sub-dimensions of dynamic capability can be accounted for by a common underlying higher-order dynamic capability with a significant positive connection;*

H3. *The five sub-dimensions of innovation management can be accounted for by a common underlying higher order of innovation management with a significant positive connection.*

2.4.1. The Impact of E-Leadership Qualities on Innovation Management

Schoemaker et al. [6] revealed that innovation can be cultivated throughout the organization with a leadership approach starting from team leaders to the board. Leadership is required in an organization to detect, interpret, and act on uncertain signals of new threats and opportunities emerging rapidly. This discovery was found to be relevant in the context of the digital era, where digital leadership had a significant impact on innovation management [15,43]. In a study conducted by Mihardjo and Rukmana [43] on the intervening role of innovation management relationship between digital leadership and dynamic capability, it was discovered that digital leadership plays an important role in driving innovation management directly and indirectly. This finding was supported by Elidjen et al. [15] as they evaluated the role of digital leadership in developing business model innovation. In this study, it was revealed that the characteristics of digital leadership, such as being globally visionary, profound, creative, and tough, have a direct and indirect influence on business model innovation, which are aligned with digital transformation in Industry 4.0. In addition, Elidjen et al. [15] concluded that digital leadership was essential for digital transformation as it possessed the capability and competence in digital technology, and attention towards market orientation accelerated innovation; thus, it had a significant direct and indirect impact on managing innovation.

Besides testing the e-leadership qualities as a standalone variable, we plan to test the sub-dimensions as well. As such, more evidence about the relationship between each sub-dimension and innovation management is presented.

Agile leadership has a significant impact on innovation management as per previous research since it has been tested in different contexts and fields such as school administrators [67], project management [68], team management [69], product development [70], organizational leadership [71], and organizational politics [72].

Hybrid skill development has also been linked to innovation management processes and activities in previous studies such as Brandl et al. [73], Tsai et al. [74], and Chong and Duan [70], but testing it as a part of the e-leadership qualities model is pretty new and adds some contributions to the Li and colleagues' [48] model of e-leadership qualities.

Architectural view and innovation management were also studied in some previous research from different perspectives, such as innovation enhancement [75], architectural alignment [76], manufacturing systems [77], and design practices [78].

The link between digital entrepreneurship and innovation management is tested in many previous studies, and the correlation between these two is proven to be significant and positive. Some examples of these studies are Satalkina and Steiner [79], Endres et al. [80], Sedera et al. [81], Eneizat and Al-Kasabeh [82], Oliveira and Trento [83], and Elia et al. [84].

The correlation between value creation, value perception, and innovation management seems very clear rationally; however, there are many studies focusing on this relationship from different perspectives, such as Jarrar and Smith [85], Vala et al. [86], Hoerlsberger [87], Gloet and Samson [88], Battisti et al. [89], and Chesbrough et al. [29].

Based on the review of the previous literature, the hypothesis is formulated as follows:

H4. *E-leadership qualities have a significant direct and positive impact on innovation management.*

2.4.2. Mediating Effect of Dynamic Capability

Several studies evaluated the relationship between digital leadership, innovation management, and dynamic capability. In a study by Sasmoko et al. [90], the relationship

between digital leadership and innovation management indicates a weak correlation with a path coefficient of 0.262. Additionally, the relationship between digital leadership and business innovation also indicates a weak relationship with a path coefficient of 0.340. Business innovation is the combination of structure and content of innovation to create value for the organization in serving the rapidly changing market demands [15]. As a result, the dynamic capability was found to serve as a mediator between digital leadership and innovation management for a better result in innovation management and business sustainability. In a study on the intervening role of innovation management relationship between digital leadership and dynamic capability conducted by Mihardjo and Rukmana [43], it was reported that strategic and management capabilities, which are part of the dynamic capabilities, had a key influence on innovation with strong leadership vision. Sasmoko et al. [90] support this by stating that organizations should establish dynamic capabilities with an emphasis on strong adaptive capability and management capability decisions based on innovation management. This finding is confirmed by Schoemaker et al. [6], as they found that dynamic capability could enable a company to sense changes in the market, seize opportunities and threats, and transform to a new paradigm to be more agile in a turbulent environment.

Mihardjo and Rukmana [43] concluded that digital leadership had a direct and indirect impact on dynamic capability, which is required to anticipate changes in the market and is important for digital transformation in the disruptive era. Based on the review of the extant literature, the hypothesis and sub-hypotheses are as follows:

H5. *Dynamic capability mediates the relationship between e-leadership qualities and innovation management;*

H5a. *E-leadership qualities have a significant direct and positive impact on dynamic capability;*

H5b. *Dynamic capability has a significant direct and positive impact on innovation management.*

In accordance with the literature on e-leadership, dynamic capability, and innovation management, the conceptual framework for this research is depicted in Figure 1.

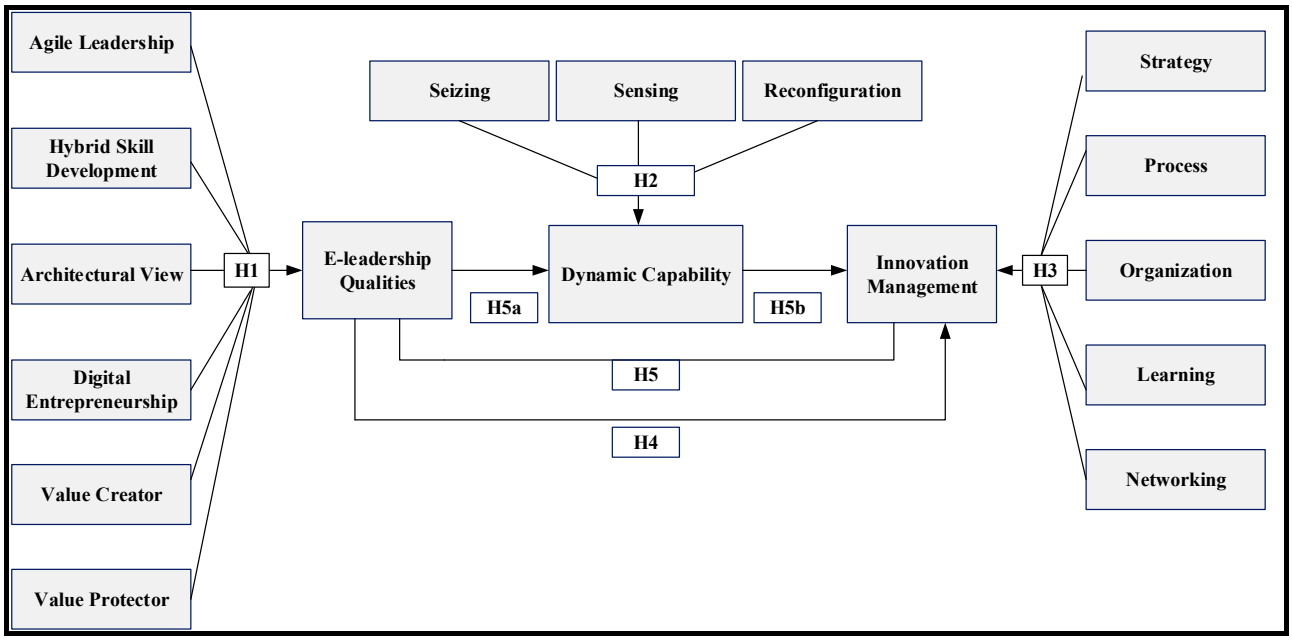

Figure 1. Conceptual framework of this study.

3. Methodology

3.1. Research Design

To test these hypotheses, an exploratory study based on a quantitative survey method was designed. Quantitative research methodology entails gathering data to quantify the information, which are then subjected to mathematical model data analysis to establish, confirm, or validate the correlations between variables and contribute to theory creation [91]. To gain a thorough knowledge of the impact of e-leadership on innovation management mediated by dynamic capability, a quantitative approach was used. The survey was conducted as a cross-sectional study designed to collect data and information from the sample on a single date.

3.2. Research Instrument

The questionnaire in this study was divided into four sections, with 57 questions in total. The questionnaire was created based on a review of the literature on e-leadership, innovation management, and dynamic capabilities. The first section includes demographic information about the sample. The second, third, and fourth parts each include a set of items designed to assess the research's theoretical framework. To ensure the content validity, the survey items were developed based on the previous research. The items for innovation management were mainly adopted from Ferreira et al. [92] and Nasiri et al. [93], whereas items for dynamic capability were adopted from Lopez-Cabrales et al. [26]. The items for e-leadership descriptions were self-constructed based on Li et al. [48]. Innovation management items were measured using a 5-point Likert scale from 'never' to 'always', whereas items for dynamic capability and e-leadership were measured using a 5-point Likert scale from 'strongly disagree' to 'strongly agree'.

To ensure that participants understood the questions and to increase the reliability and validity of the research, the retest method has been adopted. The standardized questions were developed with closed questions to increase the reliability and validity of the research. For the purpose of making sure participants were able to complete the survey in a self-paced manner, a pilot test was conducted, where 5 participants were requested to complete the questionnaire and were asked to explain their thoughts verbally. Although it is not scientifically relevant, this strategy proved useful in measuring the comprehension of the questionnaire participants.

3.3. Sampling and Unit of Analysis

The population frame of the medical device industry for this study was obtained from the MeDC@St, the official portal of the Medical Device Authority (MDA), Ministry of Health in Malaysia. The population size for this study was determined based on the organizations with actively operating licenses registered with MDA as manufacturers, which total to 356 organizations. Manufacturers are chosen as they are more involved in product and process innovation. The sampling technique used in this study was stratified random sampling, and the unit of analysis for this study was based on organizational level. The minimum sample size representative of the studied population was 100 based on the G-power 3.1.9.4 software considering F-test, linear multiple regression with an effect size of 0.15, and error probability of 0.05 [94,95]. However, the total responses received were 145, which was more than the minimum required sample size. Overall, 190 questionnaires were emailed to the businesses, and the final useable responses were 145, which was a bit more than our expectation, showing a response rate of 76 percent, and we made all questions compulsory to answer (starred in Google Form). Consequently, all collected responses were complete, and we had no missing data.

3.4. Data Collection

The survey questionnaire was uploaded in Google Form, and the link to the survey form was distributed to targeted organizations through email for data collection. An introduction and consent form were added in the first section of the Google Form to describe

the goal of this study and the confidentiality of the data collected to provide respondents more security and confidence to be more open and submit accurate information. Because the target respondents in senior or higher management positions are multilingual, the questionnaire was distributed in English. The data were obtained within two months after the survey's launch, from 2 January 2023 to 2 March 2023.

The study was conducted on a volunteer basis, and consent was received from the respondents. Furthermore, no sensitive data were collected in the process of data collection, and no ethical concerns were found in the data-gathering process.

3.5. Data Analysis

Microsoft Excel was used to perform descriptive statistics on respondent demographics. Microsoft Excel was used to generate the frequency of variables, such as gender, age, total number of employees working in the firm, year of establishment, ownership status of the firm, revenue in the previous fiscal year, firm's innovation performance, position in the organisation, and the highest academic qualification. To test the hypotheses, Smart PLS 3.0 software with partial least squares (PLS) and sequential equation modelling (SEM) was utilised.

Smart PLS software can facilitate an SEM solution with any level of complexity in the structural model or constructs that reduce the multicollinearity problem [96]. Its ability to deal with formative constructs and the ability to generate robust findings, efficiently function with smaller or larger samples, and ability to deal with both formative and reflective constructs are reasons why PLS-SEM was chosen over CB-SEM in these studies.

Dimensions are markers of latent variables that may be assessed directly, whereas latent variables are the underlying factors that cannot be observed directly [97]. The measurement model that outlines the relationship between the latent variables and the respective dimensions for each variable was examined as part of the analysis. The structural model was then analysed, which specified the relationship between the independent variable (e-leadership qualities), dependent variable (innovation management), and mediator (dynamic capability). Prior to continuing with decision making, the measurement model was evaluated to ensure that the measures were accurate and valid.

4. Results and Findings

4.1. Descriptive Analysis

The demographic data of the respondents are summarized in Table 1. Out of the 145 respondents, 66.9% were male and 33.1% were female. Most of the respondents were in the age category of 30–45 years (62.1%). Most of the respondents were from the middle management position (76.6%). Among the respondents, 51.0% were bachelor's degree holders, followed by diploma (31.0%) holders, master's degree holders (15.9%), and 2.1% with doctorate qualifications. The majority of the respondents were from local firms (75.9%). The highest total number of employees in the organization of the respondents was above 500 (54.5%). In addition, among the respondents' organization innovation performance, the highest was "Medium Innovation Performance", at 57.9%, followed by "Low Innovation Performance", which was 33.1% and "High Innovation Performance", at 9.0%. Innovation performance is measured by number of innovations that take place in the firm in a year, where "0" innovation is low innovation performance, "1" is medium innovation performance, and "$\geq$2" is high innovation performance.

Table 1. The demographic data of the respondents.

Item	Categories	Frequency	Percentage (%)
Gender of the respondent	Male	97	66.9
	Female	48	33.1
Age of the respondent	<30	8	5.5
	30–45	90	62.1
	46–60	47	32.4
Position in the organization	Top Management	26	17.9
	Middle Management	111	76.6
	Lower Management	8	5.5
Academic Qualification	Doctorate	3	2.1
	Master's Degree	23	15.9
	Bachelor's Degree	74	51.0
	Diploma	45	31.0
Total number of employees in the organization	<20	6	4.1
	21–50	18	12.4
	51–100	32	22.1
	101–500	10	6.9
	Above 500	79	54.5
Ownership status of the organization	Multinational Company	35	24.1
	Local Firm	110	75.9
Organization innovation performance	Low Innovation Performance	48	33.1
	Medium Innovation Performance	84	57.9
	High Innovation Performance	13	9.0

4.2. Measurement Model

The measurement model's goal is to calculate the reliability, internal consistency, and validity of the latent variables' relationship to indicators. Convergent validity is founded on construct reliability and validity tests such as outer loadings, Cronbach's Alpha (CA), Composite Reliability (CR), and Average Variance (AVE), whereas discriminant validity is used to evaluate validity.

Seventeen items were removed from this study (S1, S2, S4, P1, P5, L2, L3, N3, DE2, VP1, SS1, SZ3, R1, R3, R4, 02, and O3) due to outer loading values being less than 0.6 for a better measurement model analysis.

As seen in Table 2, the outer loadings for all the items exceeded the 0.70 threshold value except for item VP3, where the outer loading was 0.657, which was acceptable as the summation of the loading results in high loading score, contributing to AVE scores greater than 0.6 [98]. The reliability of the individual items was reasonably judged. The Cronbach's alpha and composite reliability for all indicators were in the range from 0.709 to 0.923, which indicated that the scales were reasonably reliable and specified that all the indicators' construct values exceeded the minimum threshold level of 0.70. The average variance extracted (AVE) value for all the constructs was in the range between 0.638 and 0.838, which was above the threshold value of 0.50 [90]. The results indicated the satisfactory convergent validity of these constructs and good internal consistency of the measurement

model [99]. The collinearity among the indicators was assessed through the Variance Inflation Factor (VIF), which indicated how much of an indicator's variance was explained by other influences in a model. The occurrence of a VIF $\geq$ 3.3 shows the model pollutes with common method bias [100]. Based on Table 2, the VIF outer values for all the indicators are below 3.3.

Table 2. Measurement Model Evaluation.

Main Constructs	Indicators	Items	Outer Loadings	VIF	CA	CR	AVE
E-Leadership Qualities	Agile Leadership (AL)	AL1	0.868	2.504	0.755	0.860	0.672
		AL2	0.786				
		AL3	0.802				
	Architectural View (AV)	AV1	0.937	1.517	0.810	0.912	0.838
		AV2	0.893				
	Digital Entrepreneurship (DE)	DE1	0.868	3.192	0.736	0.883	0.790
		DE3	0.909				
	Hybrid Skill Development (HSD)	HS1	0.757	2.859	0.810	0.876	0.638
		HS2	0.826				
		HS3	0.836				
		HS4	0.773				
	Value Creator (VC)	VC1	0.878	2.760	0.735	0.842	0.728
		VC2	0.832				
	Value Protector (VP)	VP2	0.830	1.634	0.850	0.801	0.673
		VP3	0.657				
Innovation Management	Strategy (S)	S3	0.900	2.535	0.739	0.885	0.793
		S5	0.881				
	Learning (L)	L1	0.776	2.717	0.718	0.842	0.640
		L4	0.783				
		L5	0.839				
	Networking (N)	N1	0.943	3.292	0.875	0.923	0.801
		N2	0.828				
		N4	0.909				
	Organization (O)	O1	0.868	2.498	0.709	0.873	0.774
		O4	0.891				
	Process (P)	P2	0.822	2.610	0.846	0.896	0.684
		P3	0.863				
		P4	0.858				
		P6	0.762				

Table 2. *Cont.*

Main Constructs	Indicators	Items	Outer Loadings	VIF	CA	CR	AVE
Dynamic Capability	Sensing (SS)	SS2	0.859	2.884	0.785	0.875	0.701
		SS3	0.875				
		SS4	0.911				
	Seizing (SZ)	SZ1	0.782	2.303	0.877	0.911	0.673
		SZ2	0.810				
		SZ4	0.866				
		SZ5	0.741				
		SZ6	0.893				
	Reconfiguration (RC)	R2	0.783	2.730	0.858	0.913	0.778
		R5	0.825				
		R6	0.900				

Discriminant validity was assessed using Heterotrait–Monotrait (HTMT) criteria [101] between all the reflective constructs. Firstly, there were no cross-loadings among the measurement items. The results from Table 3 demonstrated that HTMT values were less than 0.85 [102], whereby the criterion for the discriminant validity was fulfilled.

Table 3. HTMT.

	AL	AV	DE	HSD	L	N	O	P	RC	SZ	SS	S	VC	VP
AL														
AV	0.570													
DE	0.801	0.655												
HSD	0.675	0.608	0.639											
L	0.799	0.759	0.634	0.837										
N	0.659	0.671	0.817	0.845	0.776									
O	0.612	0.653	0.799	0.631	0.759	0.774								
P	0.764	0.482	0.803	0.842	0.740	0.810	0.844							
RC	0.773	0.552	0.785	0.848	0.724	0.843	0.807	0.727						
SZ	0.702	0.397	0.748	0.848	0.778	0.757	0.736	0.787	0.845					
SS	0.648	0.277	0.758	0.763	0.697	0.785	0.594	0.660	0.801	0.815				
S	0.737	0.479	0.836	0.754	0.822	0.830	0.839	0.830	0.846	0.832	0.707			
VC	0.788	0.733	0.765	0.795	0.625	0.833	0.778	0.614	0.841	0.742	0.762	0.724		
VP	0.588	0.610	0.566	0.588	0.791	0.571	0.734	0.640	0.615	0.650	0.596	0.500	0.708	

4.3. Structural Model

Based on the measurement model results, it is confirmed that this model is valid and reliable. The structural model is observing the model's predictive relevancy and the relationships between the constructs. The structural model is evaluated by coefficient of determination (R^2), the predictive relevance of the model (Q^2), effect size (f^2), path coefficient (β value), T-statistic value, model fit (SRMR, rms Theta), and variance inflation factor (VIF).

4.3.1. Measuring the Value of R^2, f^2, and Q^2

The coefficient of determination measures the overall effect size and variance explained in the inner model. The R^2 results indicate the inner path model of 1.000 for the dynamic capability and innovation management, whereas 0.998 is for the e-leadership construct in this model. Hence, the R^2 explained that the exogenous latent variables collectively

explained more than 99% of the variance in the three endogenous variables. As suggested by researchers [103], an R^2 value of 0.75 is regarded as substantial; an R^2 value of 0.50 is considered moderate, and an R^2 value of 0.26 is regarded as weak. Hence, the R^2 value for e-leadership, dynamic capability, and innovation management in this study is substantial. The f^2 effect happened because of a change in the value of R^2 when an exogenous variable was removed from the model. The f^2 values of 0.35 are considered a strong effect, 0.15 is a moderate effect, and 0.02 is a weak effect [104]. In this study, e-leadership has the highest impact on dynamic capability with an f^2 value of 2.071, followed by e-leadership in innovation management with an f^2 value of 0.261, and the influence of dynamic capability in innovation management with an f^2 value of 0.195. The predictive accuracy of the model (Q2) results showed that the path model's accuracy was acceptable, with Q^2 values of 0.560 for dynamic capability, 0.540 for innovation management, and 0.480 for e-leadership. The results show that the Q^2 values for this study model are higher than the threshold limit of 0 [105] and confirm that the path model's predictive relevance was adequate for the endogenous construct.

4.3.2. Model Fit and Goodness-of-Fit Index

The SRMR is a measure of estimated model fit, which is an average magnitude of the differences between the observed and the model-implied correlation matrix. A value of SRMR < 0.08 [106] is considered the study model with a good fit. The current study model's SRMR was 0.074, which indicated that this study's model had a good fit, whereas the GOF was equal to 0.834, and RMS_theta, equal to 0.119, was also measured. The RMS_theta assesses the degree to which the outer model residuals correlate, and a value of <0.12 indicates a well-fitting model (Henseler et al., 2014). Goodness-of-Fit Index (GOF) is an index of the complete model fit to verify the model, which adequately explains the observed data. As described in Table 4, GOF is calculated using the geometric mean value of Average Variance Extracted (AVE) values and the average R^2 values [107]. The GOF index for this study model, which is 0.834, shows that observed data fit the model in a satisfactory manner.

Table 4. Goodness of Fit (GOF) Index.

Constructs	AVE	R^2
Agile Leadership	0.672	
Architectural View	0.838	
Digital Entrepreneurship	0.790	
Hybrid Skill Development	0.638	
Value Creator	0.728	
Value Protector	0.673	
Strategy	0.793	
Learning	0.640	
Networking	0.801	
Organization	0.774	
Process	0.684	
Reconfiguration	0.701	
Seizing	0.673	
Sensing	0.778	

Table 4. *Cont.*

Constructs	AVE	R^2
Dynamic Capability		1.000
E-Leadership Qualities		0.998
Innovation Management		1.000
AVE ∗ R^2	0.695	
GOF = SQRT AVE ∗ R^2	0.834	

4.3.3. Estimation of Path Coefficients and Hypothesis Testing

The hypothesis's significance was determined using the bootstrapping process [108]. For this study, the significance of the path coefficient and T-statistics values were tested using a bootstrapping procedure with 5000 subsamples. The hypothesis testing was carried out in two stages: partial hypothesis testing to assess the significance of the direct relationships between the variables; and simultaneous hypothesis testing to assess the indirect effect of the independent variable on the dependent variable with the help of a mediator. The results of partial hypothesis testing are summarised in Table 5, and those of simultaneous hypothesis testing are summarised in Table 6.

Table 5. Partial Hypothesis Testing.

	Path Coefficient	Standard Deviation	T Statistics	*p*-Values	Result
Agile Leadership -> E-Leadership Qualities	0.271	0.014	19.732	0.000	Supported
Architectural View -> E-Leadership Qualities	0.122	0.018	6.929	0.000	Supported
Digital Entrepreneurship -> E-Leadership Qualities	0.219	0.018	11.869	0.000	Supported
Hybrid Skill Development -> E-Leadership Qualities	0.382	0.021	18.492	0.000	Supported
Value Creator -> E-Leadership Qualities	0.101	0.011	9.560	0.000	Supported
Value Protector -> E-Leadership Qualities	0.103	0.017	6.002	0.000	Supported
Strategy -> Innovation Management	0.169	0.009	18.301	0.000	Supported
Learning -> Innovation Management	0.226	0.009	24.854	0.000	Supported
Networking -> Innovation Management	0.273	0.011	25.194	0.000	Supported
Organization -> Innovation Management	0.160	0.007	22.553	0.000	Supported
Process -> Innovation Management	0.309	0.013	23.729	0.000	Supported
Reconfiguration -> Dynamic Capability	0.289	0.015	18.973	0.000	Supported
Seizing -> Dynamic Capability	0.490	0.016	30.854	0.000	Supported
Sensing -> Dynamic Capability	0.297	0.020	15.057	0.000	Supported
E-Leadership Qualities-> Innovation Management	0.476	0.082	5.805	0.000	Supported
Dynamic Capability -> Innovation Management	0.411	0.088	4.695	0.000	Supported
E-Leadership Qualities -> Dynamic Capability	0.821	0.027	30.014	0.000	Supported

Table 6. Simultaneous Hypothesis Testing.

	Path Coefficient	Standard Deviation	T Statistics	*p*-Values	Result
E-Leadership Qualities-> Dynamic Capability -> Innovation Management	0.338	0.075	4.507	0.000	Supported

The structural model showing the above finding is also shared in Figure 2:

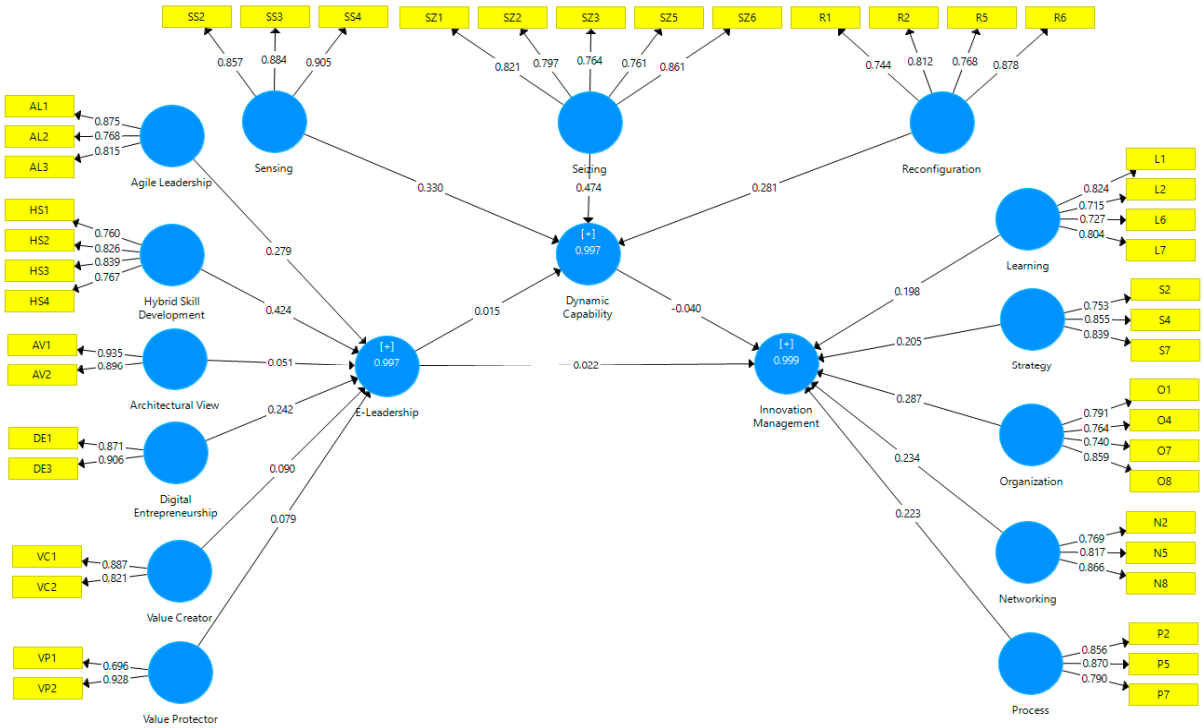

Figure 2. Structural model of this study.

As shown in Table 5, the sub-dimensions of e-leadership qualities exert a significant positive connection with the higher-order e-leadership qualities; the sub-dimensions of innovation management exert a significant positive connection to the higher-order innovation management, and the sub-dimensions of innovation management exert a significant positive connection to the higher-order dynamic capability (T values of all the sub-dimensions are more than 1.645; *p*-values < 0.001). Thus, H1, H2, and H3 are accepted. The structural model hypothesis testing results indicate that e-leadership qualities have a significant direct and positive impact on innovation management (T values, 5.805; *p*-value < 0.001), accepting H4. As shown in Table 5, e-leadership exerts a significant indirect positive impact on innovation management with the mediated role of dynamic capability (T values, 4.507; *p*-value < 0.001). There is a significant direct and positive impact relationship between e-leadership qualities and dynamic capability (T values, 30.014; *p*-value < 0.001) and between dynamic capability and innovation management (T values, 4.695; *p*-value < 0.001). Hence, H5, H5a, and H5b are accepted.

5. Discussion

This study sheds light on the impact of e-leadership qualities on innovation management, with dynamic capability acting as a moderator. The hypothesis testing (H1, H2, and H3) revealed that all identified sub-dimensions for e-leadership qualities, innovation management, and dynamic capabilities had a substantial positive relationship with the

higher-order model. Previous research, such as Ferreira et al. (2015), on innovation management, indicates that strategy, learning, process, networking, and organisation are important factors that contribute to an organisation developing clear innovation strategies for systemic analysis of new technological and marketplace developments to foster innovation. According to Teece [13], sensing, seizing, and reconfiguration are the dimensions of the dynamic capability to understand and explain the competitive advantage of an organization over time and trigger points to change the resource base for addressing the rapidly changing environments. In this digital era, the e-leadership qualities dimensions, agile leadership, architectural view, digital entrepreneurship, hybrid skill development, value protector, and value creator are the essential qualities that are required in an organisation for effective alignment between business and digital technology [48].

The hypothesis testing result, H4, on the association between e-leadership qualities and innovation management, was accepted, showing that leader's qualities are critical to driving an organization's innovation strategy for business sustainability in the digital era. Our finding was in line with previous research [15,43,109], which found that digital leadership had a major influence on innovation management. According to previous research, a leader with global vision, collaboration, reflectiveness, in-depth knowledge, and creativity will be able to sense and interpret the changing market, process decision making with the help of digital technology, and be creative to create innovative business models. The relevance of the path demonstrated in this study is comparable to the previous studies.

As for the medical device industry, the turbulence for business sustainability in the rapidly changing environment with a fragmentary market, heavy regulation, and global in nature requires a leader who has qualities such as agile leadership, hybrid skill development, digital entrepreneurship, architectural view, value protector, and value creator. Agile leadership with agile culture, strategy, and proactiveness are important for leaders to rapidly implement the business strategy related to digital technologies in a drastically changing market. The architectural view is also important for a leader to transform the technology and organizational infrastructure into a collaborative platform for improved human capital management and external association. Moreover, hybrid-skill development is required by a leader to play multiple roles and have cross-disciplinary skills to better understand, explore, and align with business strategy and technology. Value creation enables the leader to prioritize the available resources supported by technology and create competitive value, whereas value protection enables the leader to digitize the core business and enable digital transformation. Finally, digital entrepreneurship is the key leadership quality, particularly when digital technologies are used as the stimulator of business innovation [110].

This study also demonstrates that test results for H5, H5a, and H5b are accepted, which indicates a significant direct and positive relationship between e-leadership qualities and dynamic capability, dynamic capability and innovation management, and the positive and indirect relationship of e-leadership qualities on innovation management with mediating role of dynamic capability. Thus, the dynamic capability was introduced as a mediator between e-leadership qualities and innovation management to mediate the relationship, which was also tested in other studies [15,111].

However, this study indicated a significant positive relationship between e-leadership and innovation management which contributes to the theoretical implications. Similar to the previous studies [15,43,111], the positive relationship between e-leadership qualities and dynamic capability and dynamic capability and innovation management are shown in this study. Open innovation management offers an effective way to accelerate innovation for product or process development, marketing strategy, and opportunity to share risk, which requires collaboration with others such as regulatory agencies, research institutions, and manufacturing companies [5]. As such, this study indicates that the leaders in the medical device industry are equipped with e-leadership qualities to manage innovation and are equipped with dynamic capabilities to sense market changes in detecting weak

signals, seize the opportunities and threats to develop scenarios and mitigate against the potential risks.

Digital leadership is the key factor in managing innovation in the digital transformation due to the uncertain market changes in the VUCA world [112,113]. It plays a significant direct and indirect impact on managing innovation in terms of decision making with a focus on market orientation, which accelerates innovation [6]. The dynamic capabilities of a leader could enable an organization in managing innovation to sense market changes by detecting the weak signals, seizing the available opportunities and threats, and reconfiguring them by mitigating the potential risks [6,55]. As such, dynamic capability enables leaders to transform the industry with a new paradigm and reform the environment to be more agile during market turbulence.

Overall, these results contribute to the theoretical debates on the impact of e-leadership qualities on innovation management and the relationship between e-leadership qualities and dynamic capability. There is inconsistency in the previous studies [15,43,111], which has been clarified in this study. Most studies [15,43,111] that included digital leadership as a variable in structural models have measured the construct based on global vision and collaboration, reflectiveness, in-depth knowledge, inquisitiveness, and creativity [109]. According to the researchers [6], the studies also included dynamic capability as a variable in the structural model, which measured constructs based on strategic capability, management capability, adaptive capability, and innovation capability, and the same for innovation management variable, where the constructs were based on product, process, position, and paradigm [1]. Our results contribute to earlier findings by using an upgraded research model in which the constructs for all variables were changed, and the outcomes showed a substantial relationship between the variables.

From the findings of this study, the sub-dimensions of the e-leadership qualities were suggested to be adopted and developed by the leaders in managing innovation in a better way. These qualities will help leaders to better understand their role, identifying the skills to be adapted and the impact of their leadership on innovation management in digital transformation [114–121]. In addition, leaders play an important role in embracing the challenges in the innovation process by developing dynamic capabilities that can only be achieved with strong leadership in an organization. These findings will assist leaders in identifying their weaknesses in embracing the accelerated pace of innovation and improving themselves to develop the necessary qualities and capabilities for better innovation management for their organisation to remain competitive in the global market for business sustainability.

6. Practical and Theoretical Implications

This study has a handful of implications both for practitioners and academics. One of its implications is related to being among the first studies considering e-leadership qualities, dynamic capabilities, and innovation management, all together in the Malaysian context. This implication is linked to testing the sub-dimensions of all three main variables of this study, and, as shown in this paper, all the sub-dimensions of e-leadership qualities, dynamic capabilities, and innovation management were significant. It provides insight for future researchers to use these dimensions for further studies in other industries. This finding also gives a better view of these concepts to practitioners and makes these variables more tangible and measurable for them. Practitioners can use these findings to start planning and integrating them into their strategies and practices while allocating the proper level of resources to them.

Another implication of this study is that, based on the findings of this research, if managers and decision makers plan to enhance the e-leadership qualities in their people, they can focus on the most influential factors, such as hybrid skill development, agile leadership, and digital entrepreneurship.

Our study also found that while all three dimensions of dynamic capabilities were important to gain this capability, the seizing sub-dimension had the most significant effect,

and managers needed to invest more in building systems, platforms, or capabilities to seize the recognized opportunities in their business environment.

The other contribution of this study is to the link between e-leadership qualities and innovation management, both directly and indirectly, through dynamic capabilities. Theoretically, this study introduces evidence on logical variables to be considered in future studies in this field and its sub-dimensions. It shows a roadmap to managers and practitioners on how they can have a positive impact on innovation management practices through building e-leadership qualities and dynamic capability, as developing systems, strategies, and development goals will be much easier when the influencing factors are clear to the decision makers.

7. Limitations and Future Direction

This study has some limitations and presents opportunities for future research. Firstly, the scope of this study is limited as it was conducted in one country, Malaysia. Since most of the high-level management is based outside of Malaysia, especially in multinational companies, future researchers can expand the scope to the global level to have more accurate data on the readiness of the industry leaders to embrace digital transformation. Secondly, this research was carried out using cross-sectional data. Future researchers can consider the longitudinal analysis that would enrich the study of evolving processes associated with e-leadership qualities, innovation management, and dynamic capability. Thirdly, this study only evaluated the direct and indirect relationships between the variables. The multi-dimension relationship is recommended for future researchers to better understand the relationships between the sub-dimensions and other variables in the model. It also can be considered by future researchers that using different models of e-leadership and digital leadership, such as the European e-Competence Framework (eCF), can be a suggestion for shedding light on this research area.

8. Conclusions

It can be summarized that e-leadership qualities have a significant influence on innovation management and dynamic capabilities. There is also a significant indirect influence of e-leadership qualities on innovation management with the mediating role of dynamic capabilities. Dynamic capabilities have a strong relationship with innovation management. Thus, this study reveals the importance of leaders having the qualities and capabilities to embrace digital transformation efficiently while considering rapidly changing markets and customer demand for managing innovation effectively. Leaders who do not improve themselves to be equipped with the necessary skills and talents will eventually fail to guide the organisation towards commercial sustainability. As a result, this study provides an important theoretical foundation for future research, along with practical implications.

Author Contributions: Writing—original draft, S.A.P.S.; Writing—review & editing, Y.S. and B.G.M.; Supervision, Y.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Statement: Informed consent was obtained from all individual participants included in this study. The participants completing the survey questionnaires were all volunteers and were not required to respond to the research.

Data Availability Statement: Data are contained within the article or Data are contained within the article.

Conflicts of Interest: The authors declare that they have no conflicts of interest. The authors declare no conflict of interest.

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