

Original Paper

# Information Technology Ambidexterity, Digital Dynamic Capability, and Knowledge Processes as Enablers of Patient Agility: Empirical Study

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## Abstract

**Background:** There is a limited understanding of information technology's (IT) role as an enabler of patient agility and the department's ability to respond to patients' needs and wishes adequately.

**Objective:** This study aims to contribute to the insights of the validity of the hypothesized relationship among IT resources, practices and capabilities, and hospital departments' knowledge processes, and the department's ability to adequately sense and respond to patient needs and wishes (ie, patient agility).

**Methods:** This study conveniently sampled data from 107 clinical hospital departments in the Netherlands and used structural equation modeling for model assessment.

**Results:** IT ambidexterity positively enhanced the development of a digital dynamic capability ( $\beta=.69$ ;  $t_{4999}=13.43$ ;  $P<.001$ ). Likewise, IT ambidexterity also positively impacted the hospital department's knowledge processes ( $\beta=.32$ ;  $t_{4999}=2.85$ ;  $P=.005$ ). Both digital dynamic capability ( $\beta=.36$ ;  $t_{4999}=3.95$ ;  $P<.001$ ) and knowledge processes positively influenced patient agility ( $\beta=.33$ ;  $t_{4999}=3.23$ ;  $P=.001$ ).

**Conclusions:** IT ambidexterity promotes taking advantage of IT resources and experiments to reshape patient services and enhance patient agility.

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**KEYWORDS**

IT ambidexterity; dynamic capabilities; digital dynamic capability; knowledge processes; patient agility; hospitals; information sciences; information technology; digital health; health care; digital transformation; research models

## Introduction

### Background

In the age of digital transformation, modern hospitals need to simplify their current care delivery processes and sustainable business models to contain the rising health care costs and address the needs of the more engaged and informed patient. At the same time, hospitals need to adequately address the confluence of dynamic and unpredictable market forces in which they operate, optimally deploy, and enable their information technology (IT) assets; resources; and organizational, IT, and knowledge capabilities and focus on the state-of-the-art patient service delivery [1-6]. Physicians and other health care providers can use innovative IT solutions and the available exponential volumes of patient-generated data—including the patient's medical history in a single, easy-to-find location—to enhance the quality of care delivery [7-9]. As a result, hospitals today need to deal with a myriad of substantial organizational, political, and technological challenges over the coming years, also in the process of fully leveraging digital technologies [10,11]. Emerging technologies like big data analytics, the Internet of Things, distributed ledger technologies, social media, artificial intelligence (AI), and cloud-based solutions are, in essence, more than promising. These innovative technologies can truly disrupt the quality of processes and services, the effectiveness of medical outcomes, and the productivity of employees, and ultimately change lives [12-16]. Hospitals can now redefine their role in the hospital ecosystem so that the patient service quality and value might ultimately translate into substantial societal benefits [17].

Despite a wealth of attention for IT adoption and IT-enabled transformation in health care research [6,18-25], there is still a limited understanding of the role of IT as a crucial enabler of organizational sensing and responding capabilities to address the needs, wishes, and requirement of patients adequately [26-29]. Moreover, the extant scholarship has contended that IT could also hamper the process of gaining organizational benefits [30-33]. Understanding the facets that drive IT investment benefits is valuable in clinical settings [34]. As can be gleaned from this, substantial gaps remain in the extant literature. This paper, therefore, responds to two crucial limitations in the extant research. First, this paper tries to unfold how hospital departments can develop the ability to simultaneously pursue *exploration* and *exploitation* in their management of IT practices (ie, IT ambidexterity [35,36]) by practitioners often referred to as bimodal IT (eg, [37,38]) to drive a hospital departments' digital dynamic capability. This technical-oriented dynamic capability, in essence, represents the degree to which qualities and competencies are developed to manage innovative digital technologies for new, exceptional, and effective patient service development [39]. As such, this capability requires substantial undertakings toward embracing new digital technologies [39,40]. Second, this study tries to unfold the complementary effect of IT ambidexterity and digital dynamic capability on hospital departments' knowledge processes and their ability to adequately sense and respond to patient needs and wishes (ie, patient agility). Health care processes require close collaboration between different clinical

departments and disciplines, and IT is crucial in facilitating effective knowledge processes between key stakeholders (eg, physicians, nurses, and health information management professionals) [8,41-43]. Hence, IT-driven knowledge processes can enhance patient treatment processes and patient agility.

Gaining these insights is essential, as hospitals are actively exploring their digital options and innovations, and transforming their clinical processes and interactions with patients using digital technologies [43,44]. For instance, clinicians who use digital innovations in their clinical practice (eg, mobile handheld devices and apps) can increase error prevention and improve patient-centered care [45-48]. In addition, digital options and innovations provide ways for clinicians to be more agile in their work, improve clinical communication, remotely monitor patients, and improve clinical decision support [49-52], and hence improve the patient treatment process and quality of medical services [51,53]. Moreover, recent scholarship advocates the deployment of knowledge assets, processes, and digital-driven sense and responding capabilities as a way of achieving higher quality and patient-centered care and financial performance benefits in hospitals [46,54,55]. Moreover, Fadlalla and Wickramasinghe [56] argue that patient-centered (care that is respectful of and responsive to individual patient preferences, needs, and values) sensing, responding, and digital capabilities are crucial in facilitating high-quality care.

These insights are also important for hospitals in the Netherlands, as Dutch hospitals are bound to care production agreements (ie, so-called turnover ceilings) between hospitals and health insurers. The Dutch Healthcare Authority, an autonomous administrative authority falling under the Dutch Ministry of Health, Welfare, and Sport, oversees that these agreements focus more on patient quality and value creation than production. Therefore, more contract negotiations will be driven by focusing on the quality of care and patient value, achieving patient agility seems a valuable endeavor. Thus, this research tries to extend existing work on IT-enabled transformation in health care and does so by sufficiently capturing clinicians' attitudes toward IT ambidexterity, digital dynamic capability, knowledge processes, and patient agility of their hospital departments. In doing so, we adopt a practitioner-based approach [57,58].

Throughout this study, the dynamic capabilities framework is embraced [40,59,60]. As such, this study distinguishes between IT resources, a lower-order technical dynamic capability, and higher-order dynamic capabilities (ie, knowledge processes and patient agility) [40,61-63].

To summarize, the study's main research questions are:

- How does IT ambidexterity lead to perceived patient agility of the hospital department?
- What is the role of digital dynamic capability and knowledge processes in the process of converting the contributions of IT ambidexterity on the department's perceived patient agility enhancements?

This study's IT business value approach aligns with the industries' focus on operational and clinical excellence, patient-centered value, and a streamlined patient journey [64,65].

Hence, this paper proceeds as follows. First, it reviews the theoretical development by highlighting key literature on IT resources and ambidexterity, the dynamic capabilities view (DCV), and organizational agility. Second, section 3 highlights the study's research model and associated hypotheses. Third, section 4 details the methods used in this study, after which section 5 outlines key results. Finally, this study discusses the outcomes, including theoretical and practical contributions, and ends with concluding remarks.

## Theoretical Background

### *IT Resources and IT Ambidexterity*

Organizations need to pursue and make trade-offs in practice between two seemingly opposing paths (ie, the ability to adapt existing IT resources to the current business environment and demands, and their focus on developing IT resources that contribute to long-term organizational benefits) [36,66]. The balance between these two objectives is referred to, in the literature, as ambidexterity [67-70]. Organizations' simultaneous engagement of *exploration* and *exploitation* will likely provide them with superior business benefits [67-70]. IT exploration concerns the organization's efforts to pursue new knowledge and IT resources [35,66], for instance, thinking about acquiring new IT resources (eg, potential IT applications and critical IT skills) and an organization's ability to experiment with new IT management practices. On the other hand, IT exploitation is typically conceptualized as a construct that captures the degree to which organizations take advantage of existing IT resources and assets (eg, the reuse of existing IT applications and services for new patient services and the reuse of existing IT skills) [71,72].

### *Digital Dynamic Capability*

Digital dynamic capabilities can be considered the "organization's skill, talent, and expertise to manage digital technologies for new product development" [39]. Hence, it can be conceived as an organization's ability to master digital technologies, drive digital transformations, and develop new innovative patient-centered services and products. Our study embraces a hierarchical capability view [35,40,59,60]. Thus, the digital dynamic capability is conceptualized as a lower-order technical dynamic capability that organizations could embed and leverage in the process of developing higher-order dynamic organizational capabilities such as innovation ambidexterity, absorptive capacity, and organizational adaptiveness [40,61,62]. This current conceptualization is also in line with the previous scholarship. However, the digital dynamic capability is tough to mimic and establish within organizations as it requires specific, idiosyncratic, and heterogeneous competencies to develop [73,74]. As such, this capability requires substantial undertakings toward embracing new digital technologies [39,40].

### *Dynamic Capabilities and Knowledge Processes*

As its definition and conceptualizations suggest, digital dynamic capability builds upon a rich foundation of the DCV [74-78]. The DCV is a foundational strategic framework within the management and information system (IS) field [79,80], and is built from a multiplicity of theoretical roots [81]. The DCV claims that under conditions of high economic turbulence,

traditional resource-based capabilities do not provide organizations with a competitive edge [82-84]. Instead, within this framework, organizations seek a balance between strategies to remain stable in the process of delivering current business services distinctively and mobile so that they can anticipate and effectively address market disruptions and business changes [84].

These dynamic capabilities have been defined and conceptualized as sets of measurable and identifiable routines that have been widely validated through empirical studies [78,85,86]. In general, these capabilities can be conceived as the organizations' routines to integrate, build, reconfigure, gain, and release internal competences and resources to address changing market and business ecosystem demands [74,76]. In short, these capabilities can represent an organization's ability *to act* under changing circumstances [59,87], a first *derivative* of traditional resource-based capabilities: the ability to contribute to maintaining a competitive edge continuously.

Although the knowledge-based view of organizations strongly builds upon the organizational learning theories and literature [88,89], recent studies converged both strategic management streams toward the core idea of knowledge-related dynamic capabilities. Knowledge processes represent the crucial operations for the input of knowledge assets [90]. They focus on generating, analyzing, and distributing customer information for strategy formulation and implementation [55,91,92]. In addition, hospital knowledge processes are important for patient care, as acquiring new medical knowledge and insights can substantially impact patients' treatment [41]. Knowledge processes foster clinicians and medical staff to exchange and share medical and patient knowledge, and as such, these processes can be regarded as an effective way to integrate medical knowledge, enhance knowledge flow, and cultivate the use of evidence-based care that will likely have a positive impact on the quality of care [93,94]. As conceived in this study, knowledge processes are conceptualized as a dynamic capability [95,96].

### *The Concept of Organizational and Patient Agility*

The DCV argues that organizations can respond to changing conditions while simultaneously and proactively enacting influence in the environment. Organizational agility has been considered a critical capability for sustained organizational success under the DCV [84]. This particular capability has been defined and conceptualized in many ways and through various theoretical lenses in the IS literature [26,97,98]. For instance, Park et al [99] ground their conceptualization and operationalization in the information-processing theory [100] and argue that information processing capabilities strengthen the organization's sense-response processes to adapt to changing environmental conditions. Lu and Ramamurthy [101] embrace a complementarity perspective and perceive agility as the organization's ability to seize market opportunities and operationally adjustment capacity. Chakravarty et al [26] adopt a contingency factors perspective and operationalize the multidimensional concept of agility through the organization's ability to anticipate and proactively respond to market dynamics (ie, entrepreneurial agility and the organization's ability to react

to events without needing substantial strategic changes, that is, adaptive agility). A multidimensional view is also adopted by Lee et al [35], who likewise perceive organizational agility as a higher-order multidimensional dynamic capability that allows organizations to effectively and efficiently sense and respond to environmental conditions. Roberts and Grover [102] synthesized that, although there seems to be ambiguity in definitions as reflected by the concepts' operationalized capabilities, a set of high-level characteristics can be devised from the extant literature. Hence, to a certain degree, all studies show two high-level organizational routines: deliberately *sensing* and *responding* to business events in the process of capturing business and market opportunities. These two organizational capabilities are crucial for organizations' success [31]. Hence, our paper perceives patient agility as a higher-order manifested type of dynamic capability that allows hospital departments to adequately *sense* and *respond* to patient needs, demands, and

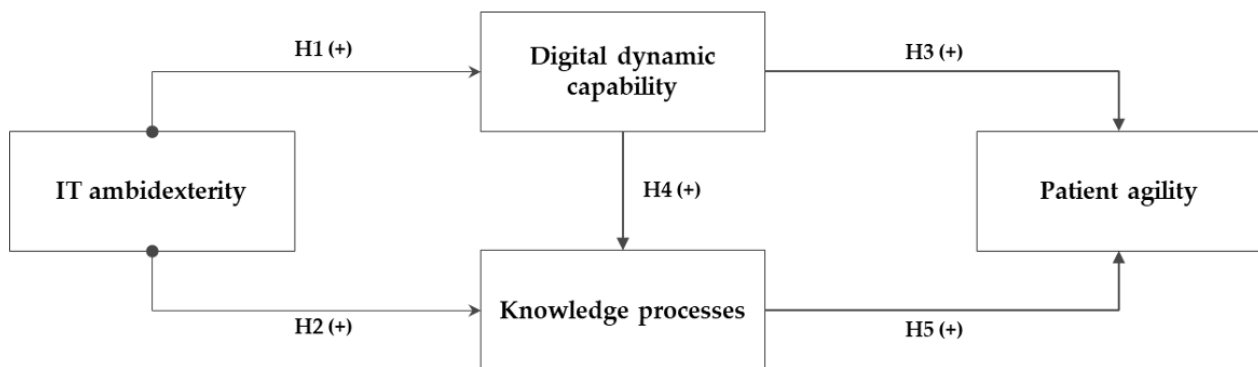
opportunities within a turbulent and fast-paced hospital ecosystem context [43,84,102,103].

By addressing these crucial questions, this paper contributes to the medical informatics and IS literature by unfolding the mechanisms through which the dual capacity of IT exploration and IT exploitation simultaneously drives patient agility in hospital departments.

### Research Model and Hypotheses

IT ambidexterity as a core organizational IT resource is expected to enhance hospital departments' level of patient sensing and responding capability (both conceptualized as higher-order dynamic capability) through digital dynamic capability (as a lower-order technical dynamic capability) and knowledge processes. Figure 1 demonstrates the research model and the associated hypotheses that will be clarified further in the paper. For the sake of simplicity, the figure does not demonstrate included control variables.

**Figure 1.** Research model. H: hypothesis; IT: information technology.



IT can be a transformative force in hospitals and contribute to enhanced patient services, efficiency and effectiveness gains, and clinical care [10,104]. However, IT implementations in hospitals are often exposed to cultural, organizational, and social challenges and inertia forces [10,104,105]. Therefore, an ambidextrous IT implementation strategy should be embraced, whereby short-term contributions (exploitation of current IT resources) and continuous progress of the IT resource portfolio (exploratory mode) drive IT-driven business transformation simultaneously [106]. When both short-term goals and ambitions are synchronized with the longer-term objectives, hospital departments are better equipped to develop digital capabilities and knowledge options, and to frame the hospital's business strategy and clinical practice [39,98,107].

IT exploration can be considered an enabler of digital dynamic capability. This mode promotes the use of and experimentation with new IT resources (eg, new IT platform implementation, decision support functionality, big data and clinical analytics, and social media) as a basis to reshape existing patient services. On the other hand, IT exploitation focuses on using, enhancing, and repackaging existing IT resources (eg, reuse or redesigning current electronic medical record for new patient service development and ensuring hospitalwide accessibility to clinical patient data and information). Therefore, digital dynamic capability relates well to the dual capacity to aim for two disparate modes of operandi in managing the department's skills,

qualities, and competencies to manage digital technologies and developments—like mobile, social media, big data analytics, robotic process automation, AI, cloud computing, and Internet of Things—for new patient service delivery. However, in practice, many organizations struggle to reach IT ambidexterity results because of resource constraints and conflicting ambitions and motives [108]. As the individual qualities of IT ambidexterity may, to some extent, strengthen hospital departments' digital options, they will likely not enhance the hospital department's digital dynamic capabilities in isolation [98]. The simultaneous engagement of IT exploration and IT exploitation will enhance the qualities and competencies to manage innovative digital technologies for new patient service development, as they depend primarily on the organization's investment decision to deploy simultaneous short-term improvement activities and long-term innovations [109].

Thus, IT resources play a substantial role in acquiring, processing, organizing, and distributing knowledge, and providing digital processes and knowledge options as enablers of agility [35,98,110]. This study argues that departments that can simultaneously exploit and explore their current IT resources portfolio will be better equipped to integrate existing and leverage new patient information sources, ensuring hospitalwide accessibility to clinical data and driving effective knowledge processes [111,112]. By leveraging the two modes of IT management practices, hospital departments can effectively

integrate and analyze patient knowledge, use it for interdepartmental meetings, and identify new health service development needs.

In line with this reasoning, this study defines the following hypotheses:

- Hypothesis 1: The greater the hospital department's IT ambidexterity, the higher the degree of its digital dynamic capability will be.
- Hypothesis 2: The greater the hospital department's IT ambidexterity, the more effective its knowledge processes will be.

Digital dynamic capability is a crucial dynamic capability necessary to innovate and enhance business operations [39,61,113,114]. Various prior studies investigated the benefits that result from developing a digital dynamic capability. Wang et al [115] argue that digital dynamic capability allows leveraging IT and knowledge resources to deliver innovative services that customers value and that contribute to organizational benefits. Coombs and Bierly [116] empirically showed that a sophisticated digital dynamic capability enables competitive advantages. Thus, the extant literature shows that digital dynamic capability drives organizations to learn from experience in turbulent economic and competitive environments actively. Hence, in such an environment, it is essential to search continuously, identify, and absorb new knowledge and technological innovation such that they can be used to respond to changing customer behavior, demands, and wishes timely, adequately, and innovatively [28,113]. These claims are likewise consistent with results from Westerman et al [117], Khin and Ho [39], and Ritter and Pedersen [118], who showed that digital dynamic capability is crucial to deploy new innovative business models, enhance customer experiences, and improve business agility. Organizations can succeed in their digital options, products, and services by actively managing the opportunities provided by innovative technologies and responding to digital transformation [39].

A technological-driven capability is crucial for hospital departments that want to strive for patient agility in clinical practice because the process of achieving new digital patient service solutions is exceedingly dependent on its ability to manage digital technologies [39]. It requires proactively responding to digital transformation, mastering the state-of-the-art digital technologies, and deliberately developing innovative patient services using digital technology. Such a capability goes well beyond the notion of IT capabilities (ie, aggregation of IT resources and IT competencies in the vast majority of empirical studies) [119-121]. The development of a digital dynamic capability is tough to mimic and establish within hospital departments, as it requires specific, idiosyncratic, and heterogeneous competencies to develop [73,74].

The digital dynamic capability allows hospital departments, for example, to absorb and process sensitive patient information better, support clinicians in their decision-making processes, exchange clinical data, and facilitate patient health data accessibility [43,122]. As such, developing this capability makes the department more receptive to new patient data and information. The accumulation and storing of knowledge

necessary to develop these new technologies also improve a firm's ability to engage in transformation processes through its evaluation, use, and implementation. Finally, as a firm engages more in developing and mastering new technologies, they become more efficient in deploying the existing knowledge and, thus, generate more exploitative activities [123].

Hence, hospitals that actively invest and develop such a capability are likely to anticipate their patients' needs (of which they might be physically and mentally unaware) and respond fast to changes in the patient's health service needs using digital innovations and assessments of clinical outcomes [39,102,103]. Therefore, such a strategically significant capability is crucial for the departments' focus on quality, efficiency, essential patient information, and enhancing the patient's clinical journey. Based on the aforementioned arguments and building upon the DCV, the following two hypotheses are defined:

- Hypothesis 3: The more developed the hospital department's digital dynamic capability, the higher the hospital department's patient agility.
- Hypothesis 4: The more developed the hospital department's digital dynamic capability, the more effective the hospital department's knowledge processes will be.

Previous scholarship demonstrated that knowledge-based capabilities and agility are two crucial capabilities that mediate the impact of IT resources and capabilities on business benefits [98,124]. In the context of hospital departments, substantial investments in processing and analyzing patient data and information, and adequate interdepartmental knowledge and information flow will drive the department's ability to anticipate the patients' current and future needs [92]. In clinical practice, the diagnosis and treatment processes are composed of a multitude of interactions and coordination between care activities in different activity levels and multiple types of knowledge [53]. Moreover, departments that are more aware of their patient needs through information knowledge processes are likely to harness new patient knowledge more effectively, make better clinical practice decisions, and support the treatment process [53,92,124]. Thus, through knowledge processes, the department can develop and redesign its core processes and capabilities. Mature knowledge-based processes drive transfer of knowledge across and within the department, uniquely deploy knowledge resources, and allow hospital departments to enhance business processes and services, and better sense and seize business and patient service opportunities that ultimately can enhance business performance [55,84,87]. Recently, scholars showed that data and knowledge-driven capabilities, as intermediate constructs, contribute to hospital performance enhancements [125,126]. Moreover, in hospital departments, patient agility as a crucial capability describes the competence of the health care providers' ability to create patient value and drive patient satisfaction in a way that uniquely uses knowledge resources and processes [46,55].

In sum, this study argues that knowledge processes are crucial in the process of reconfiguring its existing patient sensing and responding capabilities [96] and that these capabilities, to a great extent, rely on the integration of knowledge processes in

the department [55,88,112]. Hence, this study defines the following:

- Hypothesis 5: The more effective the hospital department's knowledge processes, the higher the hospital department's patient agility.

## Methods

A deductive and quantitative approach was used to address the study objectives. Hence, hypothesized relationships among key constructs are analyzed by first cross-sectionally collecting field data and then analyzing the obtaining survey data.

### Data Collection Tool and Procedure

An online survey was developed to capture clinicians' attitudes toward IT ambidexterity, digital dynamic capability, knowledge processes, and patient agility of their hospital departments. Hence, we adopted a practitioner-based approach that used subjective measures because hospitals are typically more willing to provide subjective data than sensible objective performance metrics (eg, [57,58]). In practice, perceptual measures on processes and practices positively correlate with objective data [127].

This survey was pretested on multiple occasions by 5 master's students and 6 medical practitioners and scholars to improve the survey items' content and face validity. The medical practitioners all had sufficient knowledge and experience to assess the survey items effectively to provide valuable improvement suggestions. Within the survey, comprehensible construct definitions were provided, and the survey followed a logical structure. In one of the final questions, the participants were asked if they wanted to receive critical insights from the study. Various controls were also built during the data collection process so that each department completed the survey only once.

### Study Population

The target population was (clinical) department heads and managers, team leads, and physicians under the assumption that, at the hospital department level, these health care providers are actively involved in contact with patients or at least have intelligible insight into the department's patient interactions and the use of IT. Moreover, these are the foremost stakeholders who can provide insights into the unique and sometimes complicated situations where medical knowledge is exploited, enabling a unique treatment course [55]. This approach is a similar approach taken by many other key publications in the field surveying clinicians to obtain insights into how patient-based information affects the diagnosis, therapy, patient safety, and overall clinical practice and care to patients [55,128-130]. Therefore, these providers were considered to be the most important subject in this survey. In addition, our single informant strategy is consistent with prior literature on specialized not diversified units and departments [131].

### Sampling Techniques

Data were conveniently collected between November 10, 2019, and January 5, 2020, sampled from Dutch hospitals through the 5 master's students' professional networks within Dutch hospitals. Convenient sampling is a nonprobability sampling

method where the sample is taken from a group of people easy to contact or reach and fit the profile [132].

### Sample Size and Inclusion and Exclusion Criteria

The survey software registered 230 active and unique participants. However, 101 cases had to be removed because of unreliable data entries or no entries at all. Additionally, 1 respondent (administrative function) did not belong to our target population and had to be removed from the sample. In a final step, 21 additional participants had to be removed due to substantial missing values (ie, more than 15%). Therefore, this study used 107 complete survey responses for final analyses.

### Constructs and Items

The selection of constructs and measures was made following previous empirically validated work. Additionally, this study includes only measures that were suitable for departmental-level analyses. Since this research was done in a health care setting, some original items had to be slightly reworded to fit the particular context. *IT ambidexterity* is operationalized using the item-level interaction terms of IT exploration and IT exploitation [35,69]. Items were adopted from Lee et al [35]. This study used three measures from Khin and Ho [39] for *digital dynamic capability* to represent the department's capability to manage innovative digital technologies for new patient service development. *Patient knowledge processes* refer to critical activities within the department that focus on generating, analyzing, and distributing patient-related information for strategy formulation and implementation. Six items based on the work of Jayachandran et al [92] are adopted. *Patient agility* concerns the departments' ability to sense and respond to patient needs adequately and is modeled as a higher-order (second) dynamic capability comprising the first-order dimensions *patient sensing capability* and *patient responding capability* [28,31,98]. Hence, this study used 10 empirically validated measures from Roberts and Grover [28] (see [Multimedia Appendix 1](#) for a complete overview of the construct and their associated items with their respective item-to-construct loadings [ $\lambda$ ], mean values [ $\mu$ ], and the SDs). All of the aforementioned items were measured using a 7-point Likert scale.

This study controlled the outcomes for both *size*, measured as full-time employees (log-normally distributed), and *age* of the department (5-point Likert scale, 1: 0-5 years; 5: >25 years).

### Ethics Considerations

Participants were allowed to complete the survey anonymously, and we did not log anything in the survey system that could trace participants. The participants could withdraw their entries if they wanted to. In addition, reusable personal data was not requested, and the survey did not include questions about personal or sensitive topics [132]. Furthermore, before starting the survey, the participants had to sign a consent form. This approach is in line with the General Data Protection Regulation. Finally, participants were given the option to leave their email addresses to receive a research report. These email addresses were removed from the data set after this report was sent.

## Data Analyses and Management

### Model Estimation Procedure

The research model's hypothesized relationships are tested using partial least squares (PLS) structural equation modeling (SEM). To estimate and model parameters, SmartPLS version 3.2.9, was used [133]. In essence, PLS-SEM allows assessing both the measurement model (ie, outer model) [134] and the structural model (ie, inner model) of the research model so that hypotheses can be tested [135]. The PLS algorithm establishes latent constructs from the factor scores. It, thereby, seemingly avoids factor indeterminacy [136] so that these scores then be applied in the following analyses [137]. A fundamental justification for using PLS-SEM is that its use is appropriate in exploratory contexts and for the objective of theory development [136]. In this research, the focus is on prediction as to which the PLS algorithm assesses the explained variance ( $R^2$ ) for all dependent constructs [136]. Additionally, PLS is less strict in terms of particular data distributions [134].

### Sample Justification

Another reason to justify the variance-based approach is that the current sample is relatively small [138]. However, the sample size does exceed minimum threshold values to obtain stable PLS outcomes [139]. A power analysis was done using G\*Power [140]. Hence, this study assumes the conventional 80% statistical power and a 5% probability of error as input parameters, while the maximum number of predictors in the research model is three (when including the nonhypothesized direct effect of IT ambidexterity on agility). Based on G\*Power's output parameters, a minimum sample of 38 cases were needed to detect an  $R^2$  of at least 24%. The current sample of 107 far exceeds this minimum requirement. The estimation

procedure makes use of the general recommended path weighting scheme algorithm [133].

### Nonresponse Bias

This study accounts for possible nonresponse bias by using a  $t$  test to assess whether or not there is a significant difference between the early participants ( $n=66$ ) and the late subsample ( $n=41$  participants) on the responses on the Likert scale questions. This assessment is crucial as nonresponse bias can significantly impact the study outcomes and requires careful examination [141,142]. Hence, this study included various elements, including department age, the number of patients, and all construct items in the assessment. Furthermore, no significant difference could be detected after running the analyses and assessing the Levine equality test (of variances) and the  $t$  test for equality of mean values. Hence, this confirms the absence of nonresponse bias. Finally, per suggestions of Richardson et al [143] and Podsakoff et al [144], Harman single-factor analysis was applied using exploratory factor analysis (using SPSS Statistics v24, IBM Corp) to restrain possible common method bias [143,144]. Hence, this study sample is not affected by method biases, as no single factor is attributed to the majority of the variance.

## Results

### Sample Demographics

Within the final sample of 107 participants, 36 (33.6%) work for a university medical center, 41 (38.3%) work for a specialized top clinical (training) hospital, and the final 30 (28%) work for general hospitals. [Table 1](#) shows the demographics of the participating hospital department (see also [Multimedia Appendix 2](#) for an overview of the survey responses per medical department).

**Table 1.** Demographics of participating hospital departments.

Element and categories	Participants, n (%)
<b>Hospital type</b>	
University medical center	36 (33.6)
Top clinical training hospital	41 (38.3)
General hospital	30 (28)
<b>Department age (years)</b>	
0-5	28 (26.2)
6-10	20 (18.7)
11-20	20 (18.7)
20-25	8 (7.5)
>25	31 (29.0)
<b>Experience at this particular department (years)</b>	
0-5	49 (45.8)
6-10	18 (16.8)
11-20	28 (26.2)
20-25	6 (5.6)
>25	6 (5.6)
<b>Amount of patients</b>	
<4000	25 (23.4)
4000-6500	21 (19.6)
6500-9000	12 (11.2)
9000-11,500	12 (11.2)
11,500-14,000	11 (10.3)
≥14,000	26 (24.3)

### Assessment of the Measurement Model

Various analyses were done to determine the reliability and validity of the study constructs. This is a crucial step before testing the study's hypotheses and evaluating the quality of the research.

In the first step, the internal consistency reliability is investigated using both the Cronbach alpha measure and the composite reliability estimation value. In a subsequent step, this study assessed the convergent validity—using the average variance extracted (AVE)—of the first-order latent constructs [133]. All the AVE values exceeded the lowest recommended mark of 0.50 [145]. Construct-to-item loadings were likewise investigated to determine the degree to which a variable contributes to explaining the variance of a particular construct while considering the other measurements. These loading also exceeded minimum thresholds. In a final step, discriminant validity was established through the assessment of three tests. First, cross-loadings were investigated [146]. Analyses show that all items load more strongly on their intended latent constructs than they correlate on other constructs (see also [Multimedia Appendix 3](#)). Second, the well-known

Fornell-Larcker criterion is used [145]. In doing so, the square root of the AVE (see the diagonal entries in italics in [Table 2](#)) is compared with cross-correlation values. With this, each square root value should be larger than the cross-correlations [135]. As can be gleaned from [Table 2](#), all Fornell-Larcker values (ie, square root of the AVE) are higher than the shared variances of the constructs with other constructs in the model. In a final step, a newly developed measure, the heterotrait-monotrait ratio of correlations (HTMT), was used [147]. In general, acceptable outcomes of this analysis are HTMT values that are below 0.85 (upper bound). Discriminant validity is established between constructs. The HTMT analyses show that all values are well below the threshold value of 0.85. [Table 2](#) summarizes the entire assessment. The higher-order (formative) construct of patient agility was assessed using variance inflation factor (VIF) values for the constructs patient sensing and patient responding capability. These VIF values were well below the conservative threshold of 3.5. Hence, no multicollinearity was present within the research model [148].

As the reliability and validity of the model are now established, the model's associated fit indices can be assessed as well as the hypothesized relationships using the structural model.



**Table 2.** Convergent and discriminant validity assessment.

Constructs	AVE <sup>a</sup>	CA <sup>b</sup>	CR <sup>c</sup>	EXPLR <sup>d</sup>	EXPLO <sup>e</sup>	DDC <sup>f</sup>	PSC <sup>g</sup>	PRC <sup>h</sup>	KP <sup>i</sup>
EXPLR	0.888	.867	0.919	0.942 <sup>j</sup>					
EXPLO	0.790	0.937	0.960	0.502	0.889				
DDC	0.783	0.862	0.916	0.584	0.631	0.885			
PSC	0.723	0.904	0.929	0.375	0.502	0.588	0.850		
PRC	0.792	0.934	0.950	0.313	0.341	0.452	0.508	0.890	
KP	0.616	0.875	0.906	0.463	0.512	0.552	0.713	0.393	0.785

<sup>a</sup>AVE: average variance extracted.

<sup>b</sup>CA: Chronbach alpha measure.

<sup>c</sup>CR: composite reliability estimation.

<sup>d</sup>EXPLR: information technology exploration.

<sup>e</sup>EXPLO: information technology exploitation.

<sup>f</sup>DDC: digital dynamic capability.

<sup>g</sup>PSC: patient sensing capability.

<sup>h</sup>PRC: patient responding capability.

<sup>i</sup>KP: patient knowledge processes.

<sup>j</sup>The square root of the AVE was compared with cross-correlation values.

### Model Fit Assessments

This study used three metrics, that is, (1) standardized root mean square residual (SRMR; note, however, that the first two metrics for model fit should be interpreted with caution as these metrics are not fully established PLS-SEM evaluation criteria), (2) Stone-Geisser test, and (3) the variance explained by the model ( $R^2$ ) to assess the model's goodness-of-fit. We tried to get insights into how well the research model fits with the data obtained with these analyses.

First, the newly developed SRMR metric was calculated. The SRMR metric calculates the difference between observed correlations and the model's implied correlations matrix [135,149]. The obtained SRMR of 0.059 is well below the conservative threshold mark of 0.08, as proposed by Hu and Bentler [149]. Second, the Stone-Geisser test ( $Q^2$ ) was calculated using the blindfolding procedure to assess the model's predictive relevance. Hence, the current model's  $Q^2$  values (for endogenous constructs) all far exceed 0, indicating the overall model's predictive relevance.

Finally,  $R^2$  values were analyzed. The structural model explained 47% of the variance for digital dynamic capability ( $R^2=0.47$ ). The explained variance for patient knowledge processes is 36% and for patient agility 51%. These  $R^2$  outcomes are considered moderate to substantial effects [150]. Based on the assessed four metrics, it can be concluded that the research model performs well compared with the base values and that sufficient model fit was obtained to test the hypotheses.

### Assessment of the Structural Model and Hypotheses Testing

Following the model fit assessments and the assessment of the measurement model, we tested the hypotheses of the study that we developed in the section Research Model and Hypotheses.

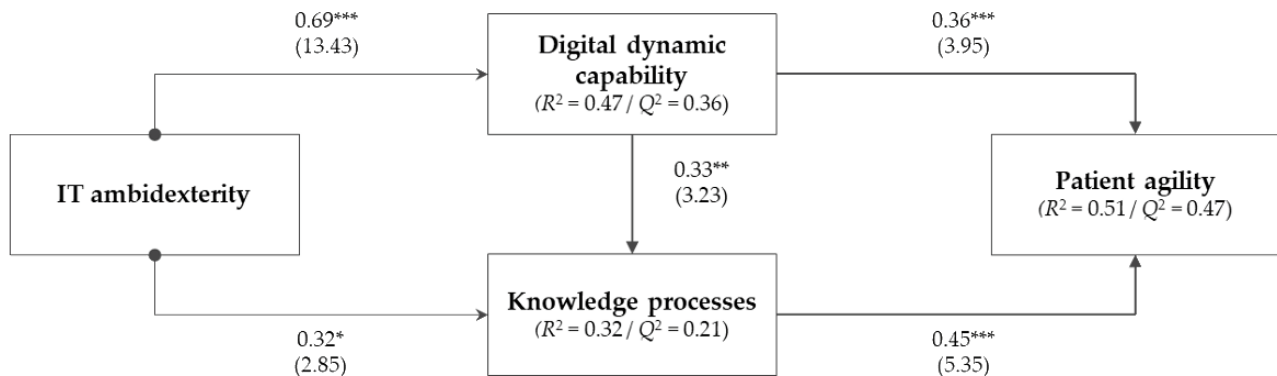
Based on the outcomes of the nonparametric bootstrap resampling procedure [135], this study found support for the first hypothesis, that is, IT ambidexterity positively impacts digital dynamic capability ( $\beta=.69$ ;  $t_{4999}=13.43$ ;  $P<.001$ ). Thus, our results showed that IT exploration and exploitation's simultaneous engagement enhances the qualities and competencies to manage innovative digital technologies for new patient service development. Likewise, this study found support for hypothesis 2 (ie, IT ambidexterity  $\rightarrow$  knowledge processes:  $\beta=.32$ ,  $t_{4999}=2.85$ ;  $P=.005$ ). Therefore, the outcomes showed that hospital departments that exploit and explore their current IT resources portfolio integrate and leverage patient information sources and drive effective knowledge processes.

Digital dynamic capability was positively associated with patient agility ( $\beta=.36$ ;  $t_{4999}=3.95$ ;  $P<.001$ ), providing support for hypothesis 3. The outcomes proved that digital dynamic capability is crucial for hospital departments that strive for patient agility in clinical practice. In addition, the structural model results support hypothesis 4 (ie, digital dynamic capability  $\rightarrow$  knowledge processes:  $\beta=.33$ ;  $t_{4999}=3.23$ ;  $P=.001$ ). Hence, hospital departments that engage in developing and mastering new technologies are more efficient in deploying the existing knowledge and, thus, generate more exploitative activities and effective knowledge processes. The results also showed that digital dynamic capability *partially* mediates the effect of IT ambidexterity on knowledge processes [135,151]. Finally, the results support hypothesis 5 (ie, knowledge processes are positively associated with patient agility:  $\beta=.45$ ;  $t_{4999}=5.35$ ;  $P<.001$ ). Therefore, these outcomes suggested that patient agility relies on the integration of knowledge processes in the department to a great extent. Furthermore, it can be concluded that also partial mediation characterizes the triangular relationship between digital dynamic capability, knowledge processes, and patient agility.

The bootstrapped PLS results showed nonsignificant effects for the included control variables: *size* ( $\beta=-.10$ ;  $t_{4999}=0.79$ ;  $P=.86$ )

and *age* ( $\beta=-.01$ ;  $t_{4999}=0.17$ ;  $P=.43$ ). Figure 2 summarizes the structural model assessment results.

**Figure 2.** Structural model results. IT: information technology.



\*  $P \leq 0.05$ , \*\*  $P \leq 0.01$ , \*\*\*  $P \leq 0.001$

## Discussion

### General Discussion

The digital transformation brings about an unprecedented challenge for modern day hospitals [152,153]. Decision makers and stakeholders across the hospital need to make sure that digital resources and technological innovations are aligned and deployed with care to enhance efficiencies, decision-making, and quality of services so that personalized and patient-centered care can be delivered [154]. Thus, it is needless to say that digital innovations can improve existing processes and medical procedures for diagnostics and patient treatment.

Using data from 107 hospital departments in the Netherlands, this study showed that the simultaneous engagement of IT exploration and IT exploitation within hospital departments (ie, IT ambidexterity) enhances the qualities and competencies to manage innovative digital technologies for new patient service development (ie, digital dynamic capability). In addition, the outcomes showcase that the greater the hospital departments' IT ambidexterity, the more effective are its knowledge processes. Furthermore, our results show that actively investing in digital dynamic capability is essential when departments want to enhance quality and patient clinical journeys. In particular, our study demonstrates that the more developed the hospital department's digital dynamic capability, the more effective will be the hospital department's knowledge processes. This outcome is important, as knowledge processes facilitate transforming clinical data into patient-related insights, thereby supporting clinicians within hospitals to make informed decisions concerning diagnosis and treatment. Our study shows that these data-driven processes allow clinicians to improve the patient treatment process and medical quality services and be more agile in their work, which is in line with the theory by Li et al [53]. Finally, our results show that digital dynamic capability is a crucial driver of patient agility, conceptualized as a dynamic capability. This capability provides the hospital department with adequate responsiveness by enabling the flexibility to sense and respond to patient demands and needs.

This study makes substantial theoretical and practical contributions, which will be discussed next.

### Implications for Theory and Practice

The process of digitizing existing patient services and developing new digital solutions remains time-consuming and challenging in many ways. In addition, from a research perspective, there is still a limited understanding of how IT resources and the digital capability-building processes can facilitate patient agility and contribute to the much needed insights on obtaining value from IT at the departmental level [35,155,156]. This study aims at addressing these particular gaps in the literature. Notably, this study designed and tested a research model, using a sample of 107 hospital departments from the Netherlands, arguing that IT ambidexterity would drive a department's patient agility by first enabling digital dynamic capability and knowledge processes. Outcomes of this study found support for these foundational claims. Furthermore, this study's structural model analyses unfolded that IT ambidexterity, which is a crucial antecedent of digital dynamic capability and knowledge processes. These crucial capabilities and processes, in turn, substantially impact the departments' ability to adequately sense and respond to patient needs and wishes (ie, patient agility).

Evidence unfolded that digital dynamic capability partially mediates the relationship between IT ambidexterity and knowledge processes. Similarly, a partial mediation characterizes the triangular relationship between digital dynamic capability, knowledge processes, and patient agility. These outcomes corroborate existing IT-enabled agility and dynamic capability studies [102,124,157,158]. The results also support the core idea that the hospital department's capacity to obtain value from its knowledge assets is a crucial success factor in achieving patient agility [110,158].

This study embraces the dynamic capabilities and knowledge-based view of IT resource deployments and advances the current insights on the resource and capability-building perspective [74,98,101,155]. It does so by unfolding the

nomological path from *resources* to the *IT-enabled value perspective* [21].

Outcomes of this study suggest that hospitals—that are committed to the process of ambidextrously managing their IT resources—are more proficient in promptly sensing and responding to patients' medical needs and demands. These theoretical contributions are valuable as these particular insights remained unclear in the extant literature, and future research can take these insights into account when investigating the IT benefits in hospitals. Likewise, unfolding the benefits of hospital departments' dual capacity to aim for two disparate things at the same time using empirical data is relevant from a practical perspective, as the business value of IT and the preceding IT investments can be justified [35,159,160]. The outcomes corroborate with the "theory of swift and even patient flow" [44] in that digital capabilities support the process of optimizing current hospital assets and help adequately respond to patient's needs by improving hospital operations (eg, better diagnoses, scheduling, and coordination of patient care). Hence, it supports the *call* for researchers to demonstrate the best ways to optimize digital health care solutions [21].

This study provides hospital department managers and decision makers with valuable practical implications. Hospital departments must direct IT investments to bring about the highest IT business value, given the many substantial challenges to ensure high quality across the patient care delivery continuum. This research shows that IT ambidextrous departments can adequately develop new innovative digital opportunities and patient services to enhance the hospital department's knowledge processes and patient agility levels. This development path is crucial for successful hospital departments that strive to enhance the patient's clinical journey and provide patients with fitting health services. However, it is important to note that IT ambidexterity can help hospital departments indirectly obtain high levels of patient agility. However, this development might be hindered if departments do not fully leverage their dual IT exploration and exploitation capacity to drive digital dynamic capability and knowledge processes and enhance patient agility.

Digital dynamic capability is crucial in the development of knowledge processes and patient agility. Hospital department managers should develop the core competencies, knowledge, and skills to process patient information better, adequately respond to digital transformation, master the state-of-the-art digital technologies, and deliberately develop innovative patient services using digital technology. Hospital department managers should also be aware of the crucial role of knowledge processes. Mature knowledge processes enhance decision-making processes and drive patient agility in hospital departments. Therefore, they should dedicate their resources to leverage these capabilities fully so that they are better equipped to search, identify, and absorb new technological innovations; integrate, process, and exchange patient information; and use them for decision-making processes, and to anticipate and respond fast to changes in the patient's health service needs. Our study results highlight the need for hospital departments to focus more on patient agility, a crucial antecedent of enhanced patient care. Hospital

department managers and decision makers should also deliberately pay attention to end user's psychological meaningfulness, stakeholder involvement, and providing adequate resourcing and infrastructures when implementing new digital technologies [33,161-163]. These aspects are crucial when implementing new digital technologies so that the hospital staff is supported and perceived value can be related to individual behavior changes and key stakeholders' needs and expectations. The outcomes are particularly relevant for practitioners now, as hospitals worldwide need to take action to transform health care delivery processes using digital technologies and increase clinical productivity during the COVID-19 crisis [164].

In summary, hospital departments should strive to be agile in the modern turbulent economic environment. This study provides crucial insights and guidance to achieve this.

### Limitations and Future Studies

Several study limitations should be mentioned. These limitations suggest future research avenues. This study used self-reported data to test the developed hypotheses as obtaining objective measures is typically a challenging endeavor. The decision to use self-reported data is still justifiable as empirical outcomes, as these data types are strongly correlated to objective measures [127,165,166]. Another concern is that data were collected using the single informant strategy. As such, method bias could still be a concern. This study did pay considerable attention to account for possible measurement errors and method bias. Future research could embrace a matched-pair design where different participants address independent (explanatory) and dependent constructs. Another opportunity for future research is triangulating the included measures with, for example, potentially available archival data from public sources. These insights, next to possibly applying the current model to other countries, could help validate the outcomes further. In addition, a more substantial sample of hospital departments will further contribute to the robustness of the results. Scholars could confirm this research's outcomes using a replication study in different (non-Western) countries. Future research could also investigate patient agility, focusing on specific departments, as this study encompasses various participating departments. Focusing on a few departments with more responses could capture a richer view of the subject matter.

Finally, this study did not include patient service performance outcomes and benefits beyond this paper's scope. Hence, it would be interesting to investigate the relationships between patient agility and the hospital department's performance outcomes, as patient agility is considered a crucial ingredient in delivering high-quality patient value and overall streamlined patient journeys. Hence, this research's outcomes inform further research about whether patient agility impacts clinical care quality and efficacy. Scholars could then investigate patient agility's contribution to increasing, for example, clinical productivity and quality enhancement during different stages of the COVID-19 pandemic [164]. Finally, future work could also involve the patient engagement and digital technology co-design perspectives [163,167,168].

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## Conflicts of Interest

None declared.

## Multimedia Appendix 1

Survey constructs and items and descriptive statistics.

[\[DOCX File , 19 KB-Multimedia Appendix 1\]](#)

## Multimedia Appendix 2

Survey response per medical department.

[\[DOCX File , 16 KB-Multimedia Appendix 2\]](#)

## Multimedia Appendix 3

Cross-loading analysis for the first-order factors.

[\[DOCX File , 18 KB-Multimedia Appendix 3\]](#)

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## Abbreviations

- AI:** artificial intelligence
- AVE:** average variance extracted
- DCV:** dynamic capabilities view
- HTMT:** heterotrait-monotrait ratio of correlations
- IS:** information system
- IT:** information technology
- PLS:** partial least squares
- SEM:** structural equation modeling
- SRMR:** standardized root mean square residual
- VIF:** variance inflation factor

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