Dynamics of Health Technology Diffusion in Integrated Care System (DHTDICS): A Development and Validation Study

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Research article

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Abstract

Background: Limited diffusion and utilization of health technology have greatly halted the improvement of resource integration and healthcare outcomes. However, the dynamic mechanism of health technology diffusion in the context of the integrated care system (ICS) remained largely unknown. The purpose of this study is to develop and validate the scale on Dynamics of Health Technology Diffusion in Integrated Care System (DHTDICS) for providing instruments to investigate the health technology diffusion in the ICS.

Methods: The scale with 39 items was initially designed on the basis of the proposed model developed from previous research. And it was validated in a cross-sectional questionnaire survey including 246 participants. Exploratory factor analysis was used to assess domains in the questionnaire, and analyzed correlation, factorials, internal consistency and validity of the questionnaire. In addition, structural equation modeling was performed to determine the total effects of each domain on the health technology diffusion in the ICS.

Results: Reliability analysis revealed excellent internal consistency, as the value of Cronbach's alpha greater than 0.80 for all of the four DHTDICS domains in this study. An acceptable validity was confirmed through tests of construct validity, convergent validity and discriminant validity. With respect to the potential domains and dimensions that DHTDICS contributes, the results highlight the existence of 4 domains: personal beliefs, technical drivers, organizational readiness, and external environment. Among them, the impact on health technology diffusion is, in descending order, organizational readiness, personal beliefs, external environment, and technical drivers.

Conclusions: The findings of this study support the validity of the DHTDICS, and will be a helpful reference for developing future intervention strategies to promote health technology diffusion in the ICS.

Background

Integrated care system (ICS) can be defined as a health system that integrates the inputs, delivery, management of various health care services, including health promotion, disease prevention, treatment and rehabilitation [1]. As the importance of ICS becoming increasingly highlighted, the growth of the integrated care system (ICS) is accelerating worldwide [2-4]. In China, regional medical consortiums (RMC) is an important manifestation and carrier of the ICS, the participants in RMC mainly involve leading hospitals in local or cross-regional (they are usually public tertiary hospitals), county hospitals and community health institutions [5]. The most common collaboration between participants is technical assistance, which characterized as providing technical cooperation or support to each other. This collaboration model benefits promoting communication and collaboration between different levels of health institutions [6,7]. Meanwhile, it also puts forward higher requirements on the integration ability of health resources and the service quality [8,9]. Although some achievements have been made in the integration of health resources in the RMC, the problem of under-utilization of health technology still

exists in practice, and the value of many health technologies have not been given full play [10]. Taking des-gamma-carboxy prothrombin (DCP) for example, DCP is a tumor marker of primary hepatocellular carcinoma (PHCC), and the security, effectiveness and economy of DCP test in early detection of PHCC have been reported in many clinical practices and studies [11-14]. In addition to large hospitals [15,16], the role of DCP implementation has also been verified outside large hospitals in China [17]. However, in terms of coverage even in the context of RMC, the use of DCP in China is far behind Japan, which also has a high incidence of liver cancer but with DCP widely and routinely used to screen for liver cancer [18]. Since the dynamic mechanism of health technology diffusion in the ICS remained largely unknown, to provide theoretical guidance and supporting tool for promoting effective integration of health technology, this study aims to take DCP test as an example to develop a scale for measuring the dynamics of health technology diffusion in the context of the integrated care system.

Theories in Technology Diffusion

A lot of researches on technology diffusion have carried out in the disciplines of sociology, behavior, psychology, and so on [19-21]. The interpretations of technology diffusion vary depending on the discipline. According to the Innovation Diffusion Theory (IDT) proposed by Rogers, this study defines technology diffusion as the process in which technology is communicated between and within organizations of a social system [22]. The process of technology diffusion involves five stages: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. Among these, stages of decision and implementation refer to adoption and full use of a technology, which had been stressed more importance. In addition to the IDT, there are many other classical theories have been proposed to guide the adoption practices by exploring the effects of different sets of factors on technology diffusion, such as the Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), and Technology-Organization-Environment framework (TOE). Among these theories, TPB suggests an individual's behavior is ultimately influenced by behavioral intention, which is a function of attitude toward behavior, subjective norms, and perception of the ease with the behavior that can be performed [23]. TAM implies perceived usefulness and perceived ease of use as two crucial factors, which focuses on the impact of technology natures [24]. IDT demonstrates that the properties of technology and interpersonal communication can affect technology use [25]. TOE infers that the effect of technology, organization and external environment should be considered [26].

Domains and Dimensions

Although many previous theoretical models or frameworks had focused on some stages of technology diffusion and investigated certain sets of potential influencing factors, there were still insufficient explanations in terms of health technology diffusion from different perspectives and facets. Therefore, we integrated these theories to provide a comprehensive insight of health technology diffusion and explore the dynamics of health technology diffusion in the ICS from four domains, namely the domain of personal beliefs, technical drivers, organizational readiness, and external environment (Figure 1).

As shown in Figure 1, physicians' behavior of technology diffusion evolving from the five stages of IDT is used to access health technology diffusion. The five progressive stages include "knowledge", "persuasion", "decision", "implementation", and "confirmation".

In this study, personal beliefs refer to the physicians' perceptions of the DCP test and its use. It is one of the domains strongly associated with health technology diffusion, which mainly depends upon three major factors: attitudes, subjective norms and perceived behavioral control. Attitude has been perceived as one of the most powerful predictors in technology adoption and use, while subjective norms are kind of perceived criteria and pressures from important individuals' judgments. And perceived behavioral control is often defined as perceived ease or difficulty of successfully performing a behavior. With respect to DCP test adoption and use, physicians' positive or negative attitude reflects different predispositions [27,28]. And for the physicians working in a clear hierarchy system such as the RMC, opinions on DCP test from leaders, supervisors and colleagues are forces to be reckoned with [29-31]. Besides, experience, expect support and potential barriers may influence their perception of whether the adoption of the DCP test would be successful or not.

The technical drivers, which involve the nature of technology including ease of use and price rationality, acts as an indispensable domain concerned with diffusion dynamics of health technology [32]. Innate properties of health technology can influence behavioral tendency [33]. Taking the DCP test, for instance, ease of use is a degree to which the physicians expect the DCP test can be performed with ease, while price rationality is an underlying important source of motivation [34,35]. These are of vital importance for county hospitals and community health institutions within the RMC. Because of limited funding support and human resource, these organizations tend to adopt technologies easier to perform with price rationality.

Moreover, studies have mentioned the importance of the domain of organizational readiness, which reflects the overall preparedness for health technology and the preference tendency of the entire staff [36]. Particularly in the emphasis of technology diffusion between organizations, the role of organizational-level factors is critical. For this paper, organizational readiness consists of three factors: organizational culture, technology absorptive willingness and technology sharing willingness. Organizational culture is the ensemble of values, norms, beliefs, language patterns and operating behaviors shared by individuals or groups within an organization, such as RMC or a hospital within it [37,38]. Technology absorptive willingness shows the willingness and readiness situations of introducing a new health technology into the organization [39], while technology sharing willingness is a degree of sharing knowledge with the other organizations [40,41].

The domain of external environment is generally considered as an important factor affecting health technology diffusion, which usually focuses on industry competition pressure [42,43]. In the context of RMC with good integration of health service delivery, in most cases, competition still occurs among hospitals of the same type and grade. Even in some conditions for soliciting more patients, there are some intense competitions among different levels of medical institutions within RMC. Both the trend in

the market and the tendency of business partners are the main concerns of the hospital managers while deciding on whether adopting certain technology [44].

Methods

Sample and Procedure

A cross-sectional study was conducted from October to December 2018 in China. Fujian province and Jiangxi province were randomly selected from the provinces with a high and low incidence of hepatocellular carcinoma, respectively. In each province, two RMCs were randomly selected and its tertiary and secondary hospitals were included in the survey. The questionnaire and informed consent forms were sent to the physicians who work at liver disease-related departments within these hospitals. If the physicians agreed to participate in the survey, they would fill out the questionnaire at their convenience and returned directly using email or mail.

Measure

According to the proposed model in Figure 1, the scale of Dynamics of Health Technology Diffusion in Integrated Care System (DHTDICS) was initially structured with 3 parts, 39 items totally.

The first part includes 5 items about the physicians' behavior of technology diffusion, which was adapted from the five stages of IDT. The item of "knowledge" refers to the physicians coming into contact with the DCP test and taking the initiative to search for information about it. "Persuasion" means the physicians have an understanding of the DCP test's advantages and disadvantages and develop an attitude toward it. "Decision" presents the physicians decide to adopt or reject the use of DCP test, and take particular pre-adoption or pre-reject action. At the "implementation" stage, the DCP test is being put into practice. At the "confirmation" stage, the physicians will decide to reinforce or withdraw the use of the DCP test, like (not) recommending it to people around. Those 5 items were measured using a five-point Likert scale ranging from "rarely" (1) through "fairly" (3) to "regularly" (5).

The second part with 28 items is the measurement of the components of DHTDICS, which consists of 9 dimensions in 4 domains: personal beliefs, including dimensions of "attitudes" (ATT), "subjective norms" (SN) and "perceived behavioral control" (PBC); technical drivers, including dimensions of "ease of use" (EOU) and "price rationality" (PR); organizational readiness, including dimensions of "organization culture" (OC), "technology absorptive willingness" (TAW) and "technology sharing willingness" (TSW); external environment, namely "industry competition pressure" (ICP). All 28 items were measured using a five-point Likert scale ranging from "strongly disagree" (1) through "neutral" (3) to "strongly agree" (5).

The third part is used to collect personal socio-demographic characteristics, including 6 items of gender, age, education, professional title, administration position, and years in practice.

Data Analysis

Internal consistency was tested using Cronbach's alpha, composite reliability (CR), and the average variance extracted (AVE). The acceptance values of Cronbach's alpha, CR, AVE are 0.7, 0.5, 0.7, respectively [45-47]. Questionnaire optimization was in virtue of corrected item-total correlations by Cronbach's alpha, at least three or four items were used to interpret per factor. The validity was examined by construct validity, convergent validity and discriminant validity.

Exploratory factor analysis (EFA) was used to explore possible factors and factor structure in the pool of items, by principal components analysis (PCA) (the method of factor extraction). Kaiser-Meyer-Olkin (KMO) values, Bartlett's test of sphericity, factor loadings, eigenvalues, the correlation matrices and the squared multiple correlations were used to verify the factorability. The recommended threshold of KMO values and factor loadings are 0.7 and 0.5, respectively [48,49]. Factors with eigenvalues greater than 1 in the factor extraction were determined. Structural equation modeling was performed to determine the influence of each domain on the physician's behavior of technology diffusion.

Data analyses were performed using IBM SPSS software (SPSS, Inc., Chicago, IL, USA) and Amos 17.0 software. Statistical significance was set at $P < 0.05$.

Ethical Considerations

Ethical permission was granted for this study from the Ethics Committee of Fujian Medical University (No. 2017-17). Participation in the survey was voluntary. All potential participants of the survey had been given informed consent forms and all responses were anonymous in this study. If the participants completed and returned the questionnaire, it was considered informed consent.

Results

Sample and Data Description

This study included 246 physicians in total. The corresponding sample-to-item ratios of 9.84 was greater than the threshold of 5 [50], it can be considered that sample sizes collected were acceptable. Table 1 demonstrates the demographic characteristics of the 246 participants. Data on physicians' behavior of technology diffusion and each domain are shown in Table 2 and Table 3.

Exploratory factor analysis

A PCA of all the 28 items showed KMO values of 0.920 and Bartlett's test of sphericity was strongly significant ($P < 0.001$), indicating the great suitability of PCA for validity estimate. Four factors appeared with an eigenvalue greater than 1 and cumulatively explained 76.36% of the total variance. To further defined factors included clearly, the varimax rotation method was then used. The results (Table 4) show all items in each dimension are almost loaded to four different factors, which fits well with the proposed framework and indicates acceptable construct validity. Factor 1 to factor 4 explained 26.34%, 24.32%, 14.42%, and 11.28% of the total variance, respectively. Accordingly, we named factor 1 as "Personal beliefs", factor 2 as "Organizational readiness", factor 3 as "technical drivers", and factor 4 as "external

environment”, respectively. Besides, factor scores of the four factors were automatically generated into the last columns of the operation interface.

To keep improving the research model, the items need to be further optimized on the basis of the corrected item-total correlation and Cronbach's alpha if deleted [51]. Items would be deleted if its results satisfy both of two conditions: i) the corrected item-total correlation less than 0.6; ii) Cronbach's alpha of factor would be improved if this item deleted. As demonstrated in Table 5, all items have the corrected item-total correlation greater than 0.6, and Cronbach's alpha of the factor would not be improved if the item was deleted. Therefore, no item needs to be eliminated.

Next, we calculated Cronbach's alpha, CR, and AVE for each factor to identify reliability and validity. The Cronbach's alpha of all factors and the whole questionnaire are much higher than the recommended threshold of 0.7 (see Table 6), suggesting internal consistency is fairly well. All factor loadings of items were above the acceptability value of 0.5. Furthermore, AVE and CR values of all factors were above the recommended value of 0.5 and 0.7, which indicates a good convergent validity.

Then, we followed Fornel and Larcker's (1981) suggestion to calculate the square root of AVE [49]. As shown in Table 7, the square root of AVE (reported in the diagonal of the correlation matrix) of each factor is higher than its correlation coefficients with other factors, indicating its strong discriminant validity.

Meanwhile, we show the correlations between the items and factor scores of each factor. The results are shown in Table 8. Each of the factors was separated from each other on account of having a low correlation with each other. Additionally, items of the same dimension converged on the same factor and discriminated well with other factors.

Influence of each domain on physicians' behavior of technology diffusion

Table 9 presents the total effects of personal beliefs, technical drivers, organizational readiness, and external environment on physicians' behavior of technology diffusion are 0.316 ($P<0.001$), 0.180 ($P<0.001$), 0.353 ($P<0.001$), and 0.195 ($P<0.01$), respectively.

Discussion

Limited diffusion and utilization of health technology have greatly halted the improvement of resource integration and healthcare outcomes [52,53]. This issue has become even more severe and prominent especially under the background of continuous ICS growth worldwide. To bridge the research gap that few are known on the dynamic mechanism of health technology diffusion in the ICS, this study took the DCP test as an example and developed an instrument to measure and evaluate the dynamics of health technology diffusion in the integrated care system (DHTDICS). It will be provided as a scientific tool for investigating the mechanism and further promote health technology diffusion in the ICS.

By conducting EFA, analyzing the internal consistency, validity and dimensionality of the DHTDICS, the reliability and validity of this instrument have been confirmed. Results of reliability analysis revealed

excellent internal consistency, as the value of Cronbach's alpha all greater than 0.80 for four of the domains in this study. Regarding the validity test, EFA results showed all items in each dimension were loaded to four different factors, which fits well with the proposed framework and indicates good construct validity. AVE and CR values of all factors were above the recommended value of 0.5 and 0.7, which indicates an acceptable convergent validity. Additionally, it demonstrated items of the same dimension converged on the same factor, and discriminate well with other factors.

With respect to the potential domains and dimensions that DHTDICS contributes, the EFA results highlight the definite existence of 4 domains and 8 dimensions: domain of personal beliefs (the effect of individuals' perceptions and impressions on subjective and interpersonal predisposition, including dimensions of attitude, subjective norm and perceived behavioral control), domain of technical drivers (the effect of characteristics of health technology on hardware predisposition, including dimensions of ease of use and price rationality), domain of organizational readiness (the effect of context preparedness in spiritual level, including dimensions of organizational culture, technology absorptive willingness and technology sharing willingness) and domain of external environment (the effect of forces that can exert influence on physicians from the outside of the hospitals, including dimension of industry competition pressure), which were in line with assumption of scale design and also consistent with the findings of previous research on health technology utilization [54-56]. This result reminds us that successful technology diffusion doesn't depend solely on the technology itself, on individual practitioners, on the promotion of organizations, or on the external environment, but is the outcome of the joint efforts or effects of all the aspects mentioned above. It emphasizes the importance of taking concrete measures from a multi-dimensional perspective to integrate the efforts of all involved parties while promoting health technology diffusion in the context of ICS.

Among multiple domains having an impact on the health technology diffusion, domains of personal beliefs and organizational readiness were illustrated as two of the most powerful domains in the DHTDICS in this study, which implied that more attention should be paid to these two aspects. For instance, the domain of personal beliefs, namely Factor 1 in this study, revealed that positive attitudes, strong subjective norms, and perceived behavioral control would facilitate health technology diffusion. Similarly, the domain of organizational readiness, namely Factor 2 in this research, consisting of organizational culture, willingness of technology absorptive, and technology sharing, highlighted the importance of developing an organizational atmosphere that advocates technology innovation and promotes inter-organizational technology exchange and cooperation. Thus, to promote the diffusion of some appropriate health technology in RMC, it is recommended to uptake some continuing education and training to raise the awareness of certain health technology and the importance of expanding its use. Besides, the positive role of subjective norm also highlighted the impact of peer and organization as mentioned above. Additionally, as confirmed by previous researches, organizational norms and values control the way individuals interact with each other within or outside the boundaries of the organization, which also directly impacts the health technology diffusion [28,34]. Apart from these factors, domains of technical drivers and external environment are also significant dynamics components that cannot be ignored in health technology diffusion in RMC.

Known to us, there is a dearth of empirical study related to the dynamic mechanism of technology diffusion in the context of ICS. To bridge the research gap, this study develops and validates an instrument for measuring DHTDICS, which will be helpful for identifying the dynamics of health technology diffusion in ICS. The results of this study will not only guide the real practice of promoting the utilization of DCP test for hepatocellular carcinoma screening but also provide clues or inspirations for the diffusion of other health technologies in RMC, given that the important dynamics of health technology diffusion determined in this study had been generalized to the setting of the ICS. However, there are also some limitations to this study. Firstly, owing to the social desirability bias [57], although we emphasized that all responses were confidential and solely for academic research when filling out the questionnaire, the physicians enrolled may not tend to voice negative assessment on the actual performance of themselves and the hospitals, which probably lead to overestimation of their attitude and utilization of DCP test. Secondly, this study is also limited by its cross-sectional design, and future research may collect cross-sectional data at different time points to form panel data, which will be more robust in investigating the determinants of DHTDICS. Thirdly, owing to time and funding constraints, the DHTDICS has only been validated with a specific technology, the DCP test. The generalizability of this instrument needs to be further validated with other technologies. Also, test-retest reliability has not been assessed as the second wave of data collection was not conducted

Conclusions

This study contributed to the knowledge of health technology diffusion by developing and validating the scale of Dynamics of Health Technology Diffusion in the Integrated Care System (DHTDICS), which comprehensively comprised multiple aspects as personal beliefs, technical drivers, organizational readiness and external environment. The scale will be provided as a robust tool for measuring and evaluating the dynamics of health technology diffusion in RMC, which will be also helpful in developing future intervention strategies to promote health technology diffusion in the ICS. As this study is an exploratory survey, the comprehensive understanding of DHTDICS can be further validated by assessing other technologies or conducting interviews with hospital managers and physicians in the future.

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the Ethics Committee of Fujian Medical University (No. 2017-17). Written informed consent was obtained from all study participants.

Consent to publish

Not applicable.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

LW designed and conducted the project, contributed to grasp the subject and revised the manuscript. DQ carried out the data analysis and drafted the manuscript. LW and DQ developed the questionnaire. All authors read and approved the manuscript before submission.

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Abbreviations

ICS: Integrated care system

RMC: Regional medical consortiums

DCP: Des-gamma-carboxy prothrombin

DHTDICS: Dynamics of Health Technology Diffusion in Integrated Care System

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Tables

Table 1. Demographic characteristics of the 246 participants.

Variable	Frequency	Percentage (%)
Gender		
Male	163	66.26
Female	83	33.74
Age		
<35 years old	107	43.50
35~44 years old	99	40.24
≥45 years old	40	16.26
Education		
Junior college or below	23	9.35
Bachelor	140	56.91
Master	76	30.89
Doctor	7	2.85
Professional Title		
Junior	87	35.37
Intermediate	91	36.99
Senior	68	27.64
Administration Position		
Yes	51	20.73
No	195	79.27
Years in Practice		
<5 years	62	25.20
5~10 years	74	30.08
11~15 years	72	29.27
16~20 years	33	13.41
>20 years	5	2.04

Table 2. Items of physicians' behavior of technology diffusion.

Physicians' behavior of technology diffusion	Frequency/%				
	Rarely	Fewer	Fairly	More	Regularly
In the past year, I took the initiative to search information about the DCP test.	109 /44.3	57/23.2	44/17.9	17/6.9	19/7.7
My understanding of the advantages and disadvantages of DCP test.	68/27.6	43/17.5	91/37.0	29/11.8	15/6.1
In the past year, I discussed with the head of the department to implement DCP test.	150/61.0	37/15.0	23/9.3	16/6.5	20/8.1
In the past year, the probability that I used CEUS on all working days.	160/65.0	19/7.7	19/7.7	20/8.1	28/11.4
In the past year, the probability that I recommended further using CEUS to my peers.	160/65.0	20/8.1	26/10.6	18/7.3	22/8.9

Table 3. Items of perceptions on DCP and its diffusion.

Items of each domain	Frequency/%				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<i>Personal beliefs</i>					
ATT1. I think it's a right thing to use DCP for early diagnosis of hepatocellular carcinoma	0/0	6/2.44	51/20.73	83/33.74	106/43.09
ATT2. I think it's a wise choice to use DCP for early diagnosis of hepatocellular carcinoma	1/0.41	9/3.66	48/19.51	83/33.74	105/42.68
ATT3. I think it's good for all to use DCP for early diagnosis of hepatocellular carcinoma	0/0	7/2.86	47/19.11	81/32.93	111/45.12
SN1. People who are important to me tend to use DCP for early diagnosis of hepatocellular carcinoma	4/1.63	12/4.88	52/21.14	74/30.08	104/42.27
SN2. People who are important to me have a positive attitude on using DCP for early diagnosis of hepatocellular carcinoma.	5/2.03	12/4.88	53/21.54	70/28.46	106/43.09
SN3. People who are important to me think it's a right thing to use DCP for early diagnosis of hepatocellular carcinoma.	1/0.41	10/4.07	57/23.17	71/28.85	107/43.50
PBC1. Using DCP can make me have more choice in diagnosing liver cancer.	1/0.41	7/2.85	43/17.48	78/31.71	117/47.56
PBC2. Using DCP can increase my confidence in diagnosing liver cancer.	0/0	5/2.03	46/18.70	80/32.52	115/46.75
PBC3. Using DCP can make my diagnosis more recognized.	0/0	5/2.03	47/19.11	80/32.52	114/46.34
<i>Technical drivers</i>					
EOU1. We can easily obtain the materials and instruments needed for DCP test	5/2.03	11/4.47	75/30.49	68/27.64	87/35.37
EOU2. We can get the result of DCP test in a short time after detection	0/0	7/2.85	72/29.27	77/31.30	90/36.58
EOU3. We can be provided with assistance in clinical diagnosis by the result of DCP test	0/0	6/2.44	53/21.54	82/33.33	105/42.69
PR1. Compared with the same type of serological tests, the price of DCP is relatively cheaper	7/2.85	12/4.88	108/43.90	57/23.17	62/25.20
PR2. DCP test has a high cost performance	3/1.22	9/3.66	92/37.40	71/28.86	71/28.86
PR3. The price of DCP is affordable for most patients	4/1.63	5/2.03	79/32.11	70/28.46	88/35.77
<i>Organizational readiness</i>					
OC1. The hospital advocates the technical innovation to improve the clinical outcomes for patients.	15/6.10	12/4.88	51/20.73	79/32.11	89/36.18
OC2. The hospital advocates continuous learning and absorption of new technologies	10/4.07	6/2.44	44/17.88	79/32.11	107/43.50
OC3. The hospital advocates the exchange and sharing of clinical experience	10/4.07	6/2.44	48/19.51	76/30.89	106/43.09
TAW1. When DCP test appeared, the	15/6.10	14/5.69	70/28.46	71/28.86	76/30.89

hospital allocate relevant staff to collect information					
TAW2. When DCP test introduced, the hospital provide training for the staff	24/9.76	9/3.66	68/27.64	75/30.48	70/28.46
TAW3. When DCP test adopted for clinical practice, the hospital promoted its use more widely.	22/8.94	11/4.47	73/29.68	72/29.27	68/27.64
TSW1. The hospital is willing to send the information of DCP test with other institutions	10/4.07	9/3.66	51/20.73	80/32.52	96/39.02
TSW2. The hospital is willing to discuss the problems of DCP use with other institutions	9/3.66	8/3.25	52/21.14	82/33.33	95/38.62
TSW3. The hospital is willing to share the experience of DCP use with other institutions	10/4.07	7/2.85	46/18.70	87/35.37	96/39.01
<i>External environment</i>					
ICP1. DCP has been widely used for early diagnosis of hepatocellular carcinoma in the medical industry	10/4.07	6/2.44	66/26.83	78/31.71	86/34.95
ICP2. Many surrounding hospitals are using DCP for early diagnosis of hepatocellular carcinoma	14/5.69	20/8.13	88/35.77	61/24.80	63/25.61
ICP3. Our business partners recommend DCP for early diagnosis of hepatocellular carcinoma	7/2.85	9/3.66	84/34.15	74/30.07	72/29.27
ICP4. The application of DCP in the early diagnosis of hepatocellular carcinoma has become routinized.	7/2.85	10/4.07	86/34.95	68/27.64	75/30.49

Table 4. Exploratory factor analysis.

Items	Factors and Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
ATT1	0.838			
ATT2	0.874			
ATT3	0.874			
SN1	0.837			
SN2	0.809			
SN3	0.833			
PBC1	0.730			
PBC2	0.753			
PBC3	0.743			
EOU1			0.613	
EOU2			0.646	
EOU3	0.555		0.586	
PR1			0.792	
PR2			0.768	
PR3			0.783	
OC1		0.809		
OC2		0.879		
OC3		0.883		
TAW1		0.763		
TAW2		0.744		
TAW3		0.726		
TSW1		0.900		
TSW2		0.893		
TSW3		0.890		
ICP1				0.749
ICP2				0.736
ICP3				0.721
ICP4				0.725

Table 5. Items' corrected item-total correlation and Cronbach's alpha if deleted.

Item	Cronbach's Alpha	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ATT1	0.960	0.846	0.897	0.954
ATT2		0.853	0.878	0.954
ATT3		0.901	0.923	0.952
SN1		0.852	0.891	0.954
SN2		0.812	0.913	0.956
SN3		0.843	0.903	0.954
PBC1		0.762	0.776	0.958
PBC2		0.829	0.934	0.955
PBC3		0.823	0.915	0.955
EOU1	0.912	0.708	0.647	0.904
EOU2		0.771	0.799	0.894
EOU3		0.736	0.690	0.899
PR1		0.740	0.735	0.899
PR2		0.768	0.798	0.894
PR3		0.814	0.750	0.887
OC1	0.957	0.790	0.776	0.954
OC2		0.855	0.904	0.951
OC3		0.864	0.911	0.950
TAW1		0.776	0.820	0.955
TAW2		0.744	0.882	0.957
TAW3		0.749	0.758	0.956
TSW1		0.898	0.925	0.949
TSW2		0.896	0.952	0.949
TSW3		0.897	0.938	0.949
ICP1	0.899	0.747	0.717	0.879
ICP2		0.718	0.616	0.892
ICP3		0.812	0.806	0.856
ICP4		0.829	0.846	0.849

Table 6. Results of reliability and convergent validity analyses.

Item	Factor Loading	Cronbach's α	AVE	CR
ATT1	0.947	0.960	0.892	0.987
ATT2	0.937			
ATT3	0.961			
SN1	0.944			
SN2	0.955			
SN3	0.950			
PBC1	0.881			
PBC2	0.967			
PBC3	0.957			
EOU1	0.804	0.912	0.736	0.944
EOU2	0.894			
EOU3	0.831			
PR1	0.857			
PR2	0.893			
PR3	0.866			
OC1	0.881	0.957	0.874	0.970
OC2	0.951			
OC3	0.955			
TAW1	0.906			
TAW2	0.939			
TAW3	0.871			
TSW1	0.962			
TSW2	0.976			
TSW3	0.968			
ICP1	0.847	0.899	0.747	0.921
ICP2	0.785			
ICP3	0.898			
ICP4	0.920			
The whole questionnaire		0.957		

Table 7. Correlation matrix for the factors.

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	0.945			
Factor 2	0.575***	0.935		
Factor 3	0.873***	0.552***	0.858	
Factor 4	0.729***	0.548***	0.838***	0.864

*** $p < 0.001$.

Table 8. Pearson correlation matrix for the items and the factors.

	Factor 1	Factor 2	Factor 3	Factor 4
ATT1	0.838**	0.129*	0.169**	0.176**
ATT2	0.874**	0.101	0.106	0.130*
ATT3	0.874**	0.163*	0.203**	0.155*
SN1	0.837**	0.147*	0.185**	0.151*
SN2	0.809**	0.190**	0.131*	0.135*
SN3	0.833**	0.126*	0.154*	0.169**
PBC1	0.730**	0.211**	0.296**	0.060
PBC2	0.753**	0.194**	0.361**	0.182**
PBC3	0.743**	0.227**	0.388**	0.156*
EOU1	0.309**	0.140*	0.613**	0.319**
EOU2	0.461**	0.069	0.646**	0.259**
EOU3	0.555**	0.139*	0.586**	0.205**
PR1	0.154*	0.200**	0.792**	0.236**
PR2	0.253**	0.191**	0.768**	0.260**
PR3	0.319**	0.180**	0.783**	0.202**
OC1	0.223**	0.809**	0.188**	0.000
OC2	0.245**	0.879**	0.104	-0.012
OC3	0.214**	0.883**	0.140*	0.004
TAI1	0.043	0.763**	0.053	0.371**
TAI2	-0.050	0.744**	0.089	0.361**
TAI3	-0.040	0.726**	0.210**	0.382**
TSI1	0.222**	0.900**	0.086	0.097
TSI2	0.261**	0.893**	0.115	0.065
TSI3	0.239**	0.890**	0.150*	0.075
ICP1	0.283**	0.153*	0.254**	0.749**
ICP2	0.156*	0.170**	0.355**	0.736**
ICP3	0.283**	0.214**	0.331**	0.721**
ICP4	0.347**	0.167**	0.284**	0.725**

** $p < 0.01$; * $p < 0.05$.

Table 9. Total effects of each domain on the physicians' behavior of technology diffusion.

Domain	Total effects
Personal beliefs	0.316***
Technical drivers	0.180***
Organizational readiness	0.353***
External environment	0.195**

*** $p<0.001$; ** $p<0.01$.

Figures

Figure 1

The proposed model for the dynamics of health technology diffusion in the ICS.

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