Information Technology Components and Their Role in Knowledge Management for Product Design

Mariam Ibrahim and Ma Huimin

***Abstract*—The present study aims to discuss the role of the information technology (IT) components (hardware, software and network) in knowledge management for product design. Data were collected through questionnaires, which were distributed 220 questionnaires to industrial companies in China. Simple regression analyses were used to determine the relationship between hardware and knowledge management , software and knowledge management, network and knowledge management, knowledge management and product design , also Multiple regression analyses were used to determine the relationship among hardware, software, network, knowledge management and product design, Results of the statistical analysis showed that the components of information management, knowledge management, and product design had a significant positive correlation, which suggests a strong relationship. Moreover, information management components, which support knowledge management, plays a vital role in product design to achieve competitive advantage. Therefore, companies must use information and knowledge management in obtaining their objectives to achieve a competitive advantage in their product design and be consistent with customer requirements to achieve consumer satisfaction. Product design does not only involve field product, and operations management or simple management participation. The foundation of product design the proper use of IT components are valuable knowledge.**

***Index Terms*—IT components. knowledge management, product design.**

I. Critical Review

How does IT affect product design and why? The literature suggests that the mediating factor between IT and product design is knowledge management [1]. Designing products well, integrating the performance of the company in the production process, and reducing the costs in an unstable technology environment, make a company efficient by using IT and knowledge management [2], [3]. IT helps solve many difficulties during product design, including the vast amount of external information and market changes to organize, analyze, and make appropriate decisions [4]. Knowledge is information results after evaluation, organize and benefit from its [5]. Critical knowledge is a source of competitive advantage for a company. Given the important role it plays in product design, intervention in the early stages of product design collects and analyzes information, evaluates, and sieves [6]. companies provides important location to knowledge management because of the globalization of work and the increasing use of IT, wherein the production base transitions to the knowledge base, and production must be changed in accordance with the continuous developments, it cannot be fixed [7]. The most prominent manifestation of the development of IT, wherein researchers did not experience any difference, are in the following components: hardware, software, and networks, [8] which are the focus of the current study. IT components, which complement their tangible and intangible instruments in enhancing the work environment, achieve increased satisfaction to internal and external customers and competitive advantage [9]. IT link directly and indirectly affects the product design through the mediating factor (knowledge management). An IT component enhances knowledge management at a company. Knowledge management then creates and exploits the compatibility among the product, customer, and managerial knowledge in the company [10]. Where we note that most of the companies are using information technology, knowledge management in the design of their products , but there are companies is out of the market early time, and some remains, but does not achieve a competitive advantage, and others achieve a competitive advantage. Through this research, we aim to clarify these links and relationships, and explain the effects of IT components effect on knowledge management, and knowledge management on product design.

II. Research Model and Hypotheses

Fig. 1 shows the proposed model in this research, which consists of five variable: hardware, software, networks, knowledge management, and product design. IT is influenced by its components on knowledge management and directly affects product design.

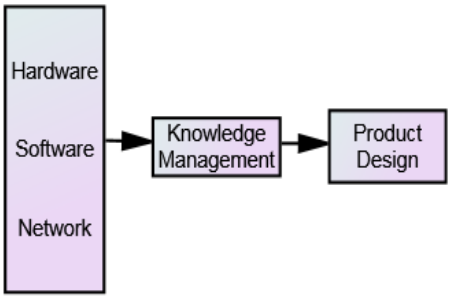

Fig. 1. Model proposed research.

A. IT Components

IT is a key factor in knowledge management [11]; it records, saves knowledge, and communicates through hardware, software, and networks [12].

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Mariam Ibrahim is with Business Administration at the School of Management, HUST, China, (e-mail: Mariama.hamood@uokufa.edu.iq).

Ma Huimin is with the Department of Information Management, School of Management, HUST, China (e-mail: Ma_huimin@hust.edi.cn).

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1) Hardware and software

Hardware and software cannot be isolated from knowledge management, where knowledge management depends directly on the efficiency of hardware and software to perform its operations and make the right decisions [13]. Thus, the following hypotheses are drawn:

H1: A positive relationship exists between hardware and knowledge management.

H2: A positive relationship exists between software and knowledge management.

2) Network

Networks are necessary for knowledge management to help obtain knowledge, maximize efficiency, and gain benefits [14]. Thus, the following hypotheses are derived:

H3: A positive relationship exists between knowledge management and product design.

B. Knowledge Management

Knowledge management is the organization and establishment of cooperation, in addition to activities related to creation, conservation, and distribution. Knowledge assets, which are timely and sufficient, provide support and information exchange, and prevent information overload [15]. Organizational capability, as well as the transport and distribution of knowledge, can be a competitive advantage after identification, creation, or acquisition of knowledge [16]. Knowledge management leads to making the right decisions, solving problems quickly, minimizing the number of errors and their frequencies, reducing research cost, developing and enhancing customer relationship, and improving production; it help companies create, acquire, transfer, and distribute important information and experiences [17]. Knowledge management is effective and supports products [18].

Previous studies on the effect of creating knowledge on product designs have confirmed that knowledge management is a fundamental factor for firm success [19]; thus, we arrive at the following hypothesis.

H4: A positive relationship exists between knowledge management and product design.

C. Product Design

Product design represents a process; knowledge of structure and components of the product from the available relevant information are considered the input for product design given that product requirement factors are part of the product knowledge [20]. Therefore, knowledge and experience designers affect the product design process, where designers translate their ideas, draw the initial design, and discuss it [21]. As confirmed previously [22], knowledge management supports the design process by providing a knowledge database that can store and retrieve information, evaluate the product design, make the final decision in accordance with the customer requirements and design constraints, and neglect unacceptable product design alternatives. IT is also considered as the source or basis of knowledge; we need to generate production management activities as products and equipment; it is the ability to select, acquire, generate, and apply technology that meets the goals of the company [23]. Therefore, a relationship exists between knowledge management and product design, which plays an important role in influencing the products to meet customer needs, especially large investments for research and development with good performance [24]. that IT component achieves customer satisfaction by offering products meeting their needs and desires , which affects KM in providing these products through the design [25]Thus:

H5: A positive relationship exists among hardware, software, network, knowledge management, and product design.

III. Research Methodology

A. Data and Sample

Data were collected through a questionnaire using a five-point Likert scale, which ranges from strongly disagree (1) to strongly agree (5). The questions were answered and analyzed using an SPSS system.

The private sample determines the failure and success of the study. This sample is the reason for date generation to analyze and test the hypotheses through accurate answers using the questionnaire items. A total of 220 questionnaires were distributed to selected company managers, and department heads, engineers, designers, and employees related to product design in Chinese companies. Table I describes the research sample.

TABLE I: Research Sample

variable	Category	number	percent
The Enterprise Type	Private	20	9.1
	Joint-stock	20	9.1
	State-owned	140	63.6
	Joint venture	20	9.1
	Foreign-funded	20	9.1
Period of the enterprise development	11-20	20	9.1
	more than 20	200	90.9
Number of employees	more than 5000	20	9.1
	1000-5000	80	36.4
	500-100	80	36.4
	1-500	40	18.2
Total sales in 2015 (unit: Yuan)	50-100m	40	18.2
	100-500m	60	27.3
	more than 500 million	120	54.5
Age categories	20-30	65	29.5
	31-40	65	29.5
	41-50	76	34.5
	51-70	14	6.4
education	Associate degree	1	0.5
	bachelor's degree	146	66.4
	Master's degree or above	73	33.2
period of service in the company	1-5	53	24.1
	5-10	70	31.8
	10-15	15	6.8
	more than 15	82	37.3
period of service in the current position	1-5	129	58.6
	5-10	78	35.5
	10-15	10	4.5
	more than 15	3	1.4

B. Operationalization of Constructs and Instrument Validation

TABLE II: NUMBER OF ADOPTED ITEMS AND SOURCES

Main Variables	Main Variables	Number Of Items	Code Of Items	Reference
Hardware	H	3	H1	[26], [27]
			H2	
			H3	
Software	S	4	S1	[28]-[30]
			S2	
			S3	
			S4	
Network	N	3	N1	[31], [32]
			N2	
			N3	
Knowledge Management	KM	4	KM1	[33]
			KM2	
			KM3	
			KM4	
Product Design	PD	4	PD1	[34]-[38]
			PD2	
			PD3	
			PD4	

TABLE III: INTER-ITEM CORRELATION MATRIX

PD4	PD3	PD2	PD1	KM4	KM3	KM2	KM1	N3	N2	N1	S4	S3	S2	S1	H3	H2	H1	
.680**	.598**	.547**	.587**	.695**	.718**	.845**	.598**	.785**	.737**	.570**	.542**	.471**	.518**	.617**	.544**	.852**	1	H1
.604**	.503**	.501**	.528**	.658**	.691**	.775**	.499**	.715**	.642**	.477**	.459**	.390**	.420**	.556**	.567**	1		H2
.544**	.550**	.344**	.398**	.562**	.463**	.499**	.278**	.567**	.506**	.275**	.371**	.248**	.393**	.418**	1			H3
.687**	.574**	.575**	.766**	.815**	.775**	.688**	.701**	.788**	.735**	.501**	.766**	.674**	.642**	1				S1
.707**	.628**	.468**	.550**	.572**	.537**	.552**	.533**	.649**	.670**	.483**	.549**	.589**	1					S2
.608**	.495**	.576**	.738**	.605**	.598**	.531**	.645**	.707**	.636**	.481**	.622**	1						S3
.617**	.543**	.552**	.750**	.741**	.691**	.584**	.636**	.711**	.740**	.466**	1							S4
.502**	.477**	.518**	.500**	.551**	.686**	.461**	.563**	.599**	.502**	1								N1
.754**	.674**	.636**	.726**	.782**	.710**	.766**	.722**	.809**	1									N2
.860**	.750**	.738**	.875**	.862**	.856**	.820**	.691**	1										N3
.585**	.557**	.508**	.660**	.694**	.731**	.581**												KM1
.692**	.612**	.614**	.681**	.713**	.730**	1												KM2
.744**	.638**	.693**	.762**	.852**	1													KM3
.790**	.706**	.638**	.776**	1														KM4
.739**	.578**	.717**	1															PD1
.713**	.580**	1																PD2
.836**	1																	PD3
1																		PD4

Note. Correlation is significant at 1% level (two-tailed).

The questionnaire was designed according to the concepts and indicators adopted in other questionnaire measures, various studies, and opinions of experts to development of questionnaire in accordance with the research requirements. Table II shows the dependable sources to benefit from concepts and indicators, symbols of each variable, and the number of items.

The inter-item correlation results were acceptable within .20–.90, which indicates the validity of the scale in Table III [39].

Table IV shows the <.70 reliability of all variable results using the scale of Cronbach's alpha coefficient.

The previous data are valid for statistical analysis. Table V indicates that all the average search (i.e., agree) agrees with the research objectives. Thus, the researched companies have an acceptable level of application of research variables [40].

TABLE IV: RELIABILITY STATISTICS

variable	number of items	Alpha
Hardware	3	0.836
Software	4	0.877
Network	3	0.840
Knowledge Management	4	0.910
Product design	4	0.900

TABLE V: ANALYSIS OF RESPONDENTS' RESPONSES ACCORDING TO THE SCALE, STANDARD DEVIATION, ARITHMETIC MEAN, DEGREE OF AGREEMENT, AND THE STRENGTH OF THE ANSWER TO THE VARIABLES OF STUDY

item	Std.	Mean item	agreement degree of item	answer strength to the variables
H1	.501	4.52	strongly agreed	4.4394 strongly agreed
H2	.536	4.49	strongly agreed	
H3	.645	4.31	strongly agreed	
S1	.809	3.77	agree	3.9341 AGREE
S2	.712	4.21	strongly agreed	
S3	.771	3.94	agree	
S4	.815	3.81	agree	
N1	.813	3.85	agree	3.5758 AGREE
N2	.883	3.53	agree	
N3	1.061	3.35	agree	
KM1	.705	3.75	agree	3.7375 AGREE
KM2	.690	3.61	agree	
KM3	.753	3.85	agree	
KM4	.857	3.74	agree	
PD1	.658	3.93	agree	4.105 AGREE
PD2	.682	4.03	agree	
PD3	.582	4.28	strongly agreed	
PD4	.685	4.18	agree	

IV. FINDINGS/DISCUSSION

Table VI shows the results of the simple linear regression between hardware (independent variable) and knowledge management (dependent variable). A significant positive correlation exists at α=.01 wherein R=.767. The variance to knowledge management by 60% back to hardware, in accordance with R^2=.589, indicates that the hardware affects knowledge management and proves a significant effect that F(1,219) > F scheduled. The significant regression coefficient of hardware β=1.049, and T calculated > T tabular at α=.01 and .99=degree of confidence. These results validate the hypothesis and is consistent with the literature [41], [42].

Table VI presents the results of the hypothesis with respect to software (independent variable) and knowledge management (dependent variable). Results show that R=.845, R^2=.714, F(1,218)=544.208, T=23.328, and β=.850 when α=.01, and the degree of confidence=.99. All acceptable results indicate the presence of a strong positive statistical correlation, and software change in knowledge management (85%) indicates the presence of the effect relationship and proves the validity of this effect that F Calculated > F tabular. Moreover, coefficient regression software β is proven significant, where T calculated > T tabular. Thus, we validate the hypothesis, which is also supported literature [43], [44].

There is a strong correlation significant between the networks(independent variable) and the knowledge management (dependent variable) that through (R=.922), where the change in knowledge management is at 60% back to the networks, which prove the effect of networks on knowledge management and confirms the validity of the regression model F(1,218) > F tabular. Moreover, T calculated > T tabular, which emphasizes the significant regression coefficient of networks β=.784 at α=.01 and the degree of confidence=.99, as shown in Table 6. The results emphasize the true of acceptance of the hypothesis, which is confirmed by references [45], [46].

TABLE VI: RESULTS OF MULTIPLE REGRESSIONS ANALYSIS

Theses4		Theses1	Theses2	Theses3	Theses4
independent		H	S	N	KM
R		.767	.845	.922	.857
R^2		.589	.714	.850	.735
DF		(218,1)	(218,1)	(218,1)	(218,1)
F tabular		6.63	6.63	6.63	6.63
F Calculated		311.901	544.208	1231.622	605.438
sig		.000	.000	.000	.000
Regressions Coefficient	dependent	KM	KM	KM	PD
	β	1.049	.850	.784	.734
	T tabular	2.581	2.581	2.581	2.581
	T Calculated	17.661	23.328	35.094	24.606

Simple linear regression was used to clarify the relationship between knowledge management as an independent variable and product design as a dependent variable, as shown in Table 6. R=.857, which indicates a strong positive correlation that is statistically significant at α=1% and degree of confidence=99%. R^2=.735 represents the variation ratio that moves product design back to knowledge management. That is, knowledge management affects the product design and proves the validity of the regression model, F(1,218) calculated > F tabular. However, it also proves a significant regression coefficient of knowledge management β=.734, which supports T calculated > T tabular by showing that we can only accept the hypothesis as confirmed by references [47]-[49].

The validity of the recent hypothesis is tested using multiple regression. The validity of the regression model is tested using the F-test, where F Calculated is 219.260 > F tabular is 3.32 at degree of freedom(4,215) and α=1%, which indicates the validity of the model to measure the effects of hardware, software, networks, and knowledge management (independent variables) on product design (dependent variable), as shown in Table VII.

TABLE VII: THESES 5, ANOVAA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	57.692	4	14.423	219.260	.000[b]
	Residual	14.143	215	.066		
	Total	71.835	219			

a. Dependent Variable: Product Design
b. Predictors: (Constant), Knowledge Management, Hardware, Software, Network

After validation, the regression model measures the impact that has extracted the R^2 cumulatively and R. Table 8 shows that all statistically significant correlations are positive at α=1%, and the variation that gets the product design increases. Thus, the independent variables have a positive impact on product design, which validates the hypothesis and confirms references [50]-[54].

TABLE VIII: THESES 5, MODEL SUMMARY

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.685[a]	.469	.466	.41846
2	.856[b]	.733	.730	.29745
3	.894[c]	.799	.797	.25824
4	.896[d]	.803	.799	.25648

a. Predictors: (Constant), Hardware
b. Predictors: (Constant), Hardware, Software
c. Predictors: (Constant), Hardware, Software, Network
d. Predictors: (Constant), Hardware, Software, Network, Knowledge Management

V. CONCLUSION/IMPLICATIONS

The results of the study reveal that the surveyed companies rely on IT components and knowledge management in their product design to achieve corporate objectives and customer satisfaction. The results prove a strong correlation and effect among IT component and knowledge management on product design.

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Mariam Ibrahim is Ph.D. student of the Department of Business Management, College of Management, Huazhong University of Science and Technology, China.

Her major research field is operation and production management, information technology, knowledge management.

Ma Huimin is the professor in the Department of Information Management, School of Management, Huazhong University of Science and Technology. Additionally he is also the vice director of the Electronic Business Center of HUST in 2004. His major research field is the application of information technology in corporation, especially the application of electronic business.