User Perception of Computerised Maintenance Information System Implementations

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***Abstract*--Computerised information systems are increasingly being used to capture, record, store and retrieve data to manage the maintenance of equipment and physical infrastructure. The justification for the costs incurred in implementing computerised information systems subsumes that acceptance of the associated technology by the users will provide the desired future benefits to the business organisation. The study applied the premise that *perception* influences *acceptance* to assess the implementation of computerised maintenance management software systems in a number of user organisations. Respondents to the study indicated that *ease of use*, *usefulness* and *system characteristics* were strongly dependent on the level of training of the user during the implementation of the computerised maintenance management software system, thus reiterating that user training influences perception which, in turn, influences user acceptance of technology.**

I. INTRODUCTION

Many organisations implement technologically advanced systems to improve their business processes and operations, as well as to provide better products and services. Computerised information systems are typically deployed and utilised in business operations to facilitate reporting and decision making. In many business organisations, so called *c*omputerised *m*aintenance *m*anagement *s*ystems (CMMS) are used to capture, store, retrieve and transmit data and information related to maintenance procedures for equipment, plant and infrastructure. According to reference [1], a CMMS is a 'software package used to track, schedule, and organize facility maintenance'. Current versions of CMMSs are particularly used to prompt schedule preventative maintenance actions as well as to manage data related to the condition of equipment ([2], [3], and [4]).

Computerised information systems that are properly deployed to automate business processes can improve overall firm performance, argues [5]. Although the consensus from vendors, suppliers and consultants suggests that a well-implemented CMMS should provide operational and cost benefits to a business (see [6], [4] and [7]), however, [2] and [3] indicate that among other factors, user perception and acceptance strongly determine whether the implemented systems fail or become underutilized. This provokes the question as to how to measure user perception and acceptance of technology encapsulated in the form of computerised maintenance management software systems.

This paper briefly describes a study designed to measure user perception and acceptance of CMMS implementations. The primary assumptions are that plausible definitions for user perception and acceptance exist, and that these two factors can be measured. The study which was conducted from the viewpoint of a CMMS implementation vendor was not longitudinal. User clients were contacted to respond once-off to a survey. The study focused on the reflexive user attitudes to CMMSs already implemented.

II. USER PERCEPTION AND ACCEPTANCE OF INFORMATION SYSTEMS TECHNOLOGY

Extrapolating from [8], information systems provide potential to improve the performance of any organisation but, the opportunities for success are often scuffled by reluctant and apathetic attitudes to the implementation of computerised systems technology. Whereas there are a number of definitions of user perception (see, for example, [9], [10], [11], [12], [13], and [14]), however, we have adopted the definition (cf: [15]) of user perception as "the process by which people translate sensory impressions into a coherent and unified view of…" computerised technologies installed and deployed to facilitate how people perform tasks.

Reference [16] points out that the tendency for users to remain apathetic to seemingly useful computerised systems does not abate despite the increased deployment of highly functional information technology in business operations. The reasoning from [17] suggests that attitudes are often rooted in a person's beliefs, cognition, thinking styles, behavioural preferences, and motivation, and these determine how a person may perceive and/or accept technology necessary to perform a task. Although [18] believes that positive user perception significantly impacts the adoption and continued deployment and utilisation of information systems, however, [19] expresses the latent concern that it is difficult to isolate and exclusively determine the benefits provided by computerised information systems.

The following ontologies summarise issues [20] which affect user perception of technology viz:

i. relative advantage - i.e., the superseding technology should be perceived as better;
ii. compatibility - i.e., the technology should be consistent with present standards, past experiences and requirements of users;
iii. complexity – i.e., the technology should be easily understood, learned and used;
iv. trialability – i.e., extent of testing of the technology by the eventual users;
v. observability – i.e., appreciation of the value of the technology.

The link between the perception of technology and its acceptance (see, [21], [8], and [22]) is summarised in the technology acceptance model (TAM) illustrated Figure 1.

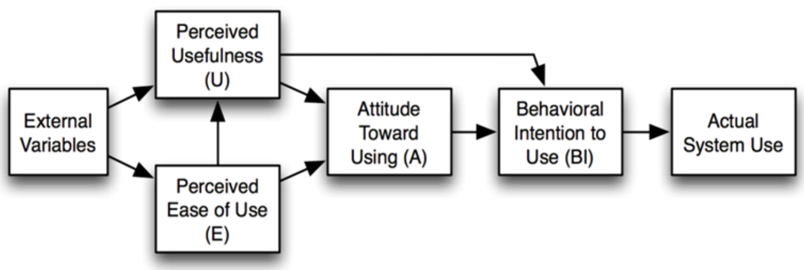


Figure I - Technology Acceptance Model (TAM) *Source*: [11]

According to [8] and [18], the model essentially depicts that user perception of technology comprises two related constructs:

i. perceived *ease of use*, and
ii. perceived *usefulness*.

Reference [22] makes the point that, although the perceived *ease of use* of technology may have a direct effect on the perceived *usefulness* of the corresponding information system, however, the reverse is not true, meaning that technology that is perceived as useful may not necessarily be easy to use. With regard to utilisation of technology, perceived *usefulness* has a greater influence than perceived *ease of use* as surmised in [19]. Reference [23] also confirms that acceptance is influenced by the perceived *ease of use* of a system, while [24] concurs that perceived *ease of use* and perceived *usefulness* both have significant impact on user acceptance of technology.

A third construct that works in cohort with the first two to influence user acceptance of technology (see [25] and [26]), is what we refer hereto as *system characteristics*. In comparison to [20], reference [26] further explains that a technology may be characterised by the following grouping of ontologies:

i. systems (e.g., complexity, size, distribution, heterogeneity, and variability)
ii. quality (e.g., reliability, availability, maintainability, and usability)
iii. programmability (e.g., flexibility, and customisability)

References [27] and [28] found that *training* also has an impact on how the user perceives the technology implementation. Reference [29] points out that installing the software is only a small part of the technology implementation. The argument is that inadequate training of users can create apathy, weaken acceptance and lead to failure, especially if the training focuses on the technology itself in a manner that does not equally emphasise, for example, how the technology engenders sound business principles and practice, or how it facilitates and supports a person's method of performing tasks. The implication is that user acceptance of technology can be measured in terms of the perception constructs illustrated in Figure 2 (the top half of the figure is adapted from [27]).

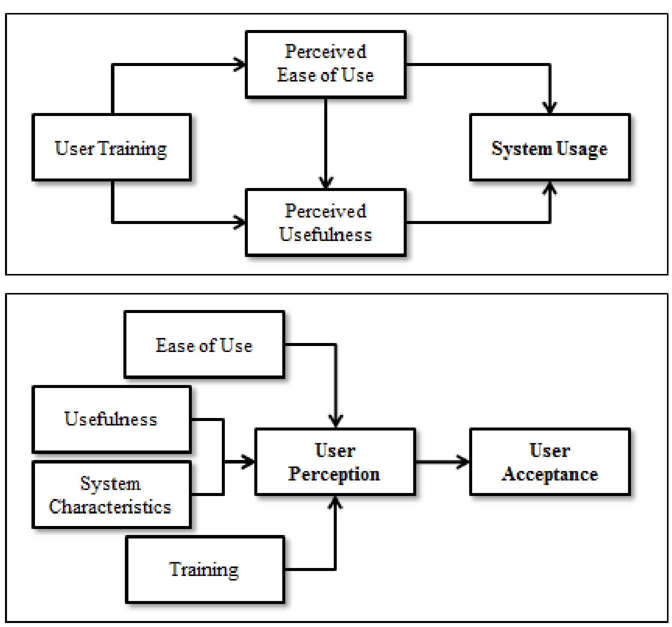


Figure 2 – Constructs for measuring user perception of CMMS implementations

We applied the four user perception constructs, i.e.,

i. *ease of use*,
ii. *usefulness*
iii. *system characteristics,* and
iv. *training*

In order to measure user re-collection of, and reflection on what happened during actual CMMS implementations, so as to gauge the level of acceptance of the technology (i.e., the functionalities of the particular CMMS deployed).

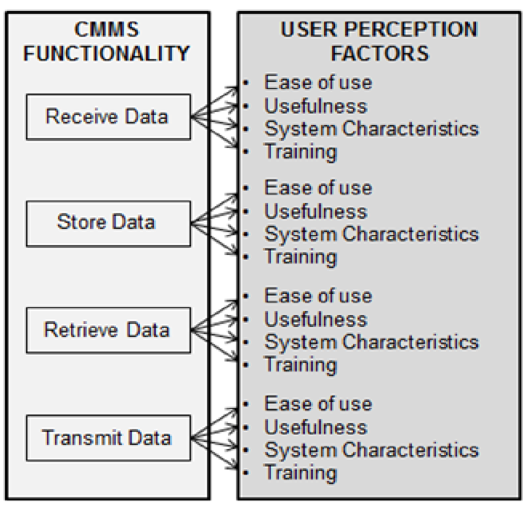
III. SURVEY

According to [29], the number of CMMS implementations depicts an exponential trend, in terms of applications to facilitate maintenance activities such as:

i. work order management,
ii. reporting on key performance indicators,
iii. spare parts management,
iv. planning, and scheduling,
v. budgeting, and cost control,
vi. document access and control,
vii. condition monitoring and reliability analyses, as well as
viii. to manage maintenance effort.

In order to measure user perception and hence provide an indication of the level of technology acceptance, we devised a questionnaire to assess each of the basic functionalities of a typical CMMS as depicted in Figure 3. The majority of the questions were close-ended using the *Likert* five-point scale where a value of 1 means that the respondent strongly agrees with the positive statement, and a value of 5 means that the respondent strongly disagrees with a positive statement. The user perception questions were derived using the matrix also shown in Figure 3.

For example, question 1 was focused on whether the system was easy to use (i.e. easy to generate a query) when applied to receive data, while questions 2 and 3 were about how useful the system enabled the user to receive data (i.e., prompt receipt of correct data requested in the query). Two general perception statements were included in the questionnaire (Questions 29 and 30). These statements were: "I feel positive using the system" and "The CMMS is a useful system and assists me in carrying out my daily activities". This was done to determine the effect of each of the constructs on user perception. There were questions regarding demographics of the respondents, including organisational sector, employment level and years' of experience with a CMMS. Before administering the survey, 15 persons were requested to complete the questionnaire so as to establish reliability and consistency *apriori*. The *Cronbach*'s test results in Table 1 shows $\alpha > 0.7$, meaning that this is acceptable for a questionnaire of this nature (cf: [30]).



	Ease of Use	Usefulness	System Characteristics					Training
			A	B	C	D	E	
Receive Data	1	2, 3	4	5	1	6	3	7
Store Data	8	9	10		9		11	12
Retrieve Data	13, 14, 22	15	16	17	13	18	19,21	20
Transmit Data	23, 24	25	26		24	28	27	

Figure 3 – Mapping of survey questions

TABLE 1 - CRONBACH'S A VALUES

	E	U	C	T	P	TOT
k	7	5	13	3	2	30
Σvar	4.91	3.92	9.18	4.43	1.29	23.7
var	13.1	10.6	40.9	10.7	2.12	211
α	**0.73**	**0.79**	**0.84**	**0.88**	**0.78**	**0.92**

The validated questionnaire was then sent via email to 165 respondents randomly chosen to reflect users of CMMSs in education, manufacturing, food processing, and information technology organisations. Complete responses were received from 102 respondents. It is important to note that the respondents were clients from only one CMMS implementation vendor.

IV. ANALYSIS AND DISCUSSION

Sixty-five respondents were male, and 37 were female, while 52 respondents were from food processing and information technology organisations. It was disappointing to obtain only 10 respondents from the utility organisations where maintenance is a dominant business activity, especially as such organisations tend to deployment CMMS extensively. More than 50% of the respondents had used CMMSs for more than 5 years.

The respondents' feedback as summarised in the descriptive statistics shown in Table 2 concurs with the view (see [27], [28], and [29]) that *training* strongly influences user perception of the CMMS. The feedback from the respondents' show that the mean and standard deviation were highest for the *training* construct than for the other three user perception constructs.

The *t*-test values in Table 3 do not reveal significant differences in the perception between two levels of employees in the CMMS user organisations that responded to our survey. A *t*-test indicates that there is a significant variance if the null hypothesis is true but our data showed t-values greater than 5% (0.05), thus signalling agreement on all four user perception constructs. It is surprising that operational personnel (whose utilisation of the CMMS tends to be higher) do not differ with management cadre in their respective reflections of how well the system functions.

V. CONCLUSION

Our study reiterates the view that user perception influences the acceptance of technology. This is based on the premise that *ease of use, usefulness*, *technology* (i.e., *system*) *characteristics*, and *training* are ontological constructs that may be applied to describe user perception. We have provided some empirical data that upholds the conventional wisdom that *training* has a very strong influence on how a user not only perceives but also, accepts a technology system. A ramification of our study is that *training* must not only focus on the functionality of the system but also, the content and process of *training* must appeal to the psychological pre-disposition of the eventual users of the system. The emphasis of *training* on the human psychological aspects may reduce apathy and engender positive impressions that the technology is invaluable to the user.

TABLE 2 - DESCRIPTIVE STATISTICS FOR USER PERCEPTION CONSTRUCTS

	ease of use	***usefulness***	***system characteristics***	***training***
Mean	1.94	1.64	1.80	2.03
Standard Error	0.07	0.05	0.05	0.09
Median	2	2	2	2
Mode	2	1	1	2
Standard Deviation	0.68	0.50	0.50	0.94
Sample Variance	0.47	0.25	0.25	0.89
Sum	198	168	184	207
Count	102	102	102	102
Upper Bound (95%)	2.07	1.74	1.90	2.22
Lower Bound (95%)	1.81	1.55	1.70	1.85

TABLE 3 – *T*-TEST RESULTS

	ease of use		***usefulness***		***system characteristics***		***training***	
	MAN	***OPS***	***MAN***	***OPS***	***MAN***	***OPS***	***MAN***	***OPS***
Mean	1.93	2.07	1.63	1.77	1.84	1.86	1.97	2.13
Stddev	0.68	0.75	0.39	0.60	0.50	0.53	1.06	0.91
Count	37	41	37	41	37	41	37	41
T-test	**0.39**		**0.22**		**0.86**		**0.49**	

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