The Role of Knowledge Systems in Supporting Environmental Decision Making Systems

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Abstract— The central and increasingly contentious roles of modern technology in companies have given rise to a plethora of scientific and practical controversies over the production processes. This research aims to harness the concept of knowledge systems as an essential element in the dissemination of an organisation's knowledge to support planning, analysis and environmental decision-making systems that could improve some types of environmental systems. This is because when the companies effectively gain leverage of knowledge systems this assists with rapid decision-making with fewer oversights or errors. This will enhance the environmental performance. A conceptual model based on the literature review and consultations with knowledge workers is developed. Also, a pilot study with collaborating organisations which are active in manufacturing in Iraq was conducted to validate the conceptual model and facilitate exploratory investigation regarding the relationships. The surveys were administered on random samples within these firms. The study however identified high correlation between knowledge systems and environmental performance. Also, a computer based relationship between environmental decision-making systems and environmental performance was developed. Accordingly, the research limitations/ implications have focused on exploring the perceptual impacts of knowledge systems in supporting environmental decision-making systems. The clarification of outcomes must be taken with cautious. Accordingly, this paper discusses the role of knowledge systems; namely, environmental systems data mining in knowledge systems for environmental applications. Therefore, the data analysis in this research shows the relationship between this research and some published work within this field. The results analysis has confirmed that knowledge systems play a fundamental role in encouraging and improving the exchange of experience. This leads to improving creativity and performance and the removing of barriers and obstacles. Where tensions exist in organisations, (e.g. between production and environment), they must be solved by top management and by push and pull processes of knowledge. Consequently, the conceptual model in this research has been applicable to the companies' experiences. This is because the model has identified gaps and inadequacies in their KSs and processes. It has taken into account both formal and informal knowledge transfer methods. Thereby, in a manufacturing context KSs can include regular updates on the progress of the company at a company board level, as well as other intra-company reporting systems at all levels of the management hierarchy.

Keywords: Environmental decision support system, Knowledge systems in environmental directives, Environmental performance

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1 Introduction

At present applying computer-aided Knowledge Systems (KSs) and the aggressive acquisition and retention of knowledge workers are two of the major KSs activities. A KSs is the infrastructure necessary for the organisation to implement its Knowledge Systems Processes (KSP). This development can be viewed as a 'knowledge platform', where the objective of the KSs is to support the construction, sharing, and utilization of knowledge in organisations. KSs have appeared in various formats in different industries. Indeed, there is no single model for a KSs. Also, there is no single role of information technology (IT) in KSs just as there is no single technology comprising KSs (Syed & Xiaoyan, 2013).

Thus, the modern approach to decision support assumes greater autonomy for the decision maker. The role of the system is in assisting a decision maker in finding relevant information, which the decision maker can convert to actionable knowledge by making sense of the problem situation.

This requires the Decision Support Systems (DSSs) to have an extended functionality for supporting knowledge work, including memory aids, explanation facilities, and some learning capability (Mehrjoo & Bashiri, 2013). DSSs supporting such functionality can be equally termed KSs. Accordingly, "knowledge work support systems" emphasise the major focus of modern technology as a mediator between the user and the cognitive requirements of the task he or she needs to undertake. This new field combined research fields such as KSs, DSSs; [Group Decision Support Systems (GDSS), Executive Support Systems (ESS) and Expert Systems (ESs)] and Environmental Performance (EP). Also, a computer based relationship between environmental decision-making systems (EDMSs) and EP was developed to creating new discipline termed environmental informatics which assimilates environmental science with computer science (Al-dujaili, 2011). Baeshen (2008) confirms that currently there is an emerging "new discipline called environmental informatics which integrates environmental science with computer science**.**

2 Literature Review

According to Plessis (2005), the following factors are very important in KSs: "(1) initiate action based on knowledge; (2) support business strategy implementation; (3) become an intelligent enterprise; (4) create an innovative culture and environment; (5) entrench collaboration as a work practice; and (6) ultimately improve work efficiency", because of these factors it is very significant that every bit of knowledge about the operations, potential of enhancement, innovation etc… be efficiently publicized, collected and circulated among all performers involved in the process of Environmental Management (EM) (Cortés et al. 2001).

That is to say, corporate environment, knowledge retrieval and knowledge transfer can be integrated in environmental

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information systems (Tochtermann et al. 2000). Therefore, the system advises on environmental issues and identifying new practices, techniques and technologies (Gupta et al. 2005).This is because, the progress in the promising field of KSs, the intelligent processing and distribution of information, holds out the possibility of integrating industrial ecology into standard business practices.

This system provides organisations with the elements of an effective EM system in order to achieve environmental and socioeconomic goals (Arnoni 2001). Furthermore, these KSs from the outside firms can be a significant stimulus for change and organizational development (Jian and Wang, 2013).Meanwhile, Morgan et al. (1983) suggest that learning environment (LE) occurs when members use learning to solve a common problem that they are facing. According to Helleloid et al. (1994), every organisation will develop the learning method that is most suitable to the needs, and characteristics of the organisation itself.

March (1991) stated that there are two types of LE. Firstly, exploitative learning can occur when new behavioural capacities are framed within existing insights. Exploitative learning is described in the literature as a "single loop" that can be characterised as "first-order", "evolutional", "frame-taking", "reactive" and "incremental". Secondly, exploitative learning occurs when organisations acquire behavioural capacities that differ fundamentally from existing insights. Exploration is about discovery, variation, effectiveness, flexibility and innovation.

This is a dynamic process that involves various organisational levels. At different levels of knowledge creation; individual, group and organisational there are different processes at work. Inkepen et al. (1995) identified three processes; at the individual level, the critical process is interpreting; at the group level, integrating; and at the organisational level, institutionalizing.

This occurs through relationships and interactions of the four kinds of knowledge domains: cognitive domain, behavioral domain, organizing/cybernetic domain, and the domain of ontology (Davenport et al. 2000). Error! Reference source not found. explains the knowledge creation domains in the organisational levels.

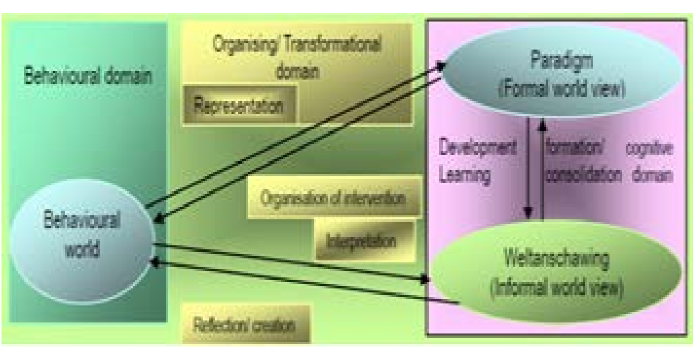


Fig.1, The knowledge creation domains (Yolles 2000).

Therefore firms are propelled towards a grafting of the new capabilities at the organisations' current knowledge base in order to develop the processes of manufacturing. At the same time in mature industries there is a fast-changing business reality due to environmental changes, including how to deal with the environment agency to avoid experiencing difficulties. Knowledge inertia creates a time lag between important changes in the EP, and organisational awareness of those changes.

However, Gorry et al. (1971) confirmed that decision support emphasizes the primary focus-decision making (DM) in problem situations, rather than simply information retrieval, processing, or reporting. Support; clarifies the computer's role in aiding rather than replacing the decision maker.

Thus including those decision situations with sufficient "structure" to permit computer support, but in which managerial judgment is still an essential element. We can observe the role of KSs in the EDMS process and this is shown schematically in Error! Reference source not found.. The complication of environmental issues makes it essential to develop and apply new tools which are proficient in processing not only numerical aspects, but also experience from experts and wide public participation. These are all needed in the decision-making process (DMP).

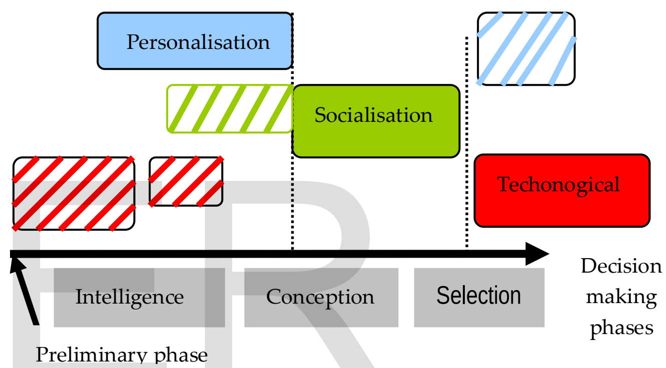


Fig. 2, **The role of KS in the decision making process (Nicolas 2004).**

For that reason, EDSSs are considered to be one of the most promising methods to confront this complexity (Poch et al. 2004). These different tools may be categorized into the following types; (1) GDSS. Parker et al. (1993) classified GDSS through the level of support provided to the members of the group, in this way: "The first level offers the technological DSSs that enables group members to communicate electronically with each other.

On a second level: EDSSs provide support for members of the group in the DMP. The third level presents a GDSS with all the possibilities of the second level. (2) ES: Liebowitz (1998) upholds that this is one of the key programs to aid the emergence of KSs, where KSs involves four functions: securing, creating, retrieving/combining, and distributing knowledge.

Consequently, as firms move towards the knowledge acquisition stage of an ESs this can capture and secure the knowledge left unused. Embryonic knowledge repositories for KSs activities can be tracked to knowledge demonstration methodologies and knowledge encoding techniques in the ESs. (3) ESS: an ESS "is an interactive computer system that provides industry executives with the capability to obtain easy access to internal and external information relevant to EDMSs and other executive actions".This is because an ESS is; "A)

Clearly geared for the top management. B) Used by senior managers without technical support from the medium level. C) Require the greatest amount of information from outside the project or industry. D) Include both structured and unstructured data. E) Uses various communication technologies such as texts, graphics ...etc. (Laudon et al.1994). Furthermore, Performance is a vital subject to firms on two levels, the organisational level and individual level (Williams 1998).

This is because the roles of knowledge and understanding of EP have become clearer. Consequently, the integrating of systematic and systematised learning to sustain competitive advantage and KSs can be a vehicle for achieving the desired results for organisations (Rajad Kasim 2008).

In this context, Sasson et al. (2006) propose a design model including three major repositories of knowledge. The first repository is a performance analysis repository which is used to store analysis information. Before information is transferred to the repository for storage, users enter data through a performance analysis user interface.

In view of that, considered environmental KSs are vital. This is because, it help companies to gather knowledge about the environment through different procedures, and that knowledge can be used to come up with an effective environmental policy for the organisation. Then, those companies develop a proper strategy for their organisation.

According to Boiral (2002) the implicit knowledge if it is taken into account could be significantly useful in three master areas of EM; (1) the identification of pollution sources. (2) The management of emergency situations. (3) The development of preventive solutions. This is because, environmental innovation comprises of new or amended processes, techniques, practices systems and products to avoid or reduce environmental harm (Kemp et al. 2000).

For that reason, industrial enterprises must challenge the predominance of formal knowledge in the management of environmental problems. Then, promote a climate of learning that encourages the recognition and sharing of employees' experiences. That means, companies' environmental programmes are required to learn new practices and knowledge and introduce clean technologies (Porter & Van Der Linde1995).

Mining data in the quality control system is mining knowledge. This is because the data mining utilises search algorithms (patterns, similarities, correlations or text matching). For this reason, data results are visually presented to the user, which creates better understanding and improved judgments about the manufacturing processes (Head 2007).

Tests, checks and management revisions are supporting processes that implement improvement actions to correct or prevent non-conformities as contained in the techniques of KSs. This means, acquisition of cutting edge technology to develop a reliable product before going to market with clean technologies by use of some kind of quality system "ISO 14001etc" (Al-dujaili 2011).

Accordingly, the companies have to take into account the following dimensions when using knowledge; knowledge type, knowledge orientation, knowledge availability, and knowledge inertia (Chi et al. 2008). Table 1 explains the previous case studies which have investigated this relationship, but according to a different perspective to the current study, because they are not studies that have collected these variables comprehensively.

Table 1
Summarising the relationship between KS, DSS and OP according to some authors

Factors \ Author	Wen et al, 2008	Baeshen, 2008	Avouris, N 1995	Vinodh et al, 2011	Boiral, 2002	Al-dujaili 2012
DSS	KM, multi-agent technology	Artificial intelligence	Cooperating knowledge-based system (CKBS) techniques	Technologies determine the market dynamism	Tacit knowledge	Supporting EDMSs
Sector	General mobile agencies	Industry	Industry	Industry	Industry	Industry
Methodology	Survey	Application	Application	Application	Application	Application
Country & sample size	Taiwan	Kingdom of Saudi Arabia		Indian	US	Iraq
Analysis approach	Programming , Visual Basic, sum of square error, linear transformation	discipline called Environmental Informatics integrates environmental science with computer	Existing environmental are discussed, with special emphasis on a typical example, the distributed chemical Emergencies manager	Analysis of SBP subcomponents & evaluation of proposed projects	Case studies	Case studies
Theory	KBV	Case-based reasoning	KBS	Evaluation of strategies is a multicriteria- D-M	presents a framework for the analysis of the creation, transfer and retention of tacit knowledge that is not limited to environmental KM.	This research aims to harness the concept of KSs as an essential element in the dissemination of an organisation's knowledge to support planning, analysis and EDMS that could improve some types of environmental systems. This is because when the companies effectively gain leverage of KS this assists with rapid EDMSs with fewer oversights or errors. This will enhance the EOP.
Results	Improve quality of D-M, reduce the number of professional managers and maintain the effective management of an enterprise	Artificial intelligence technologies can be useful to solve problems in environmental application areas and sectors	The study explained that used knowledge acquisition technique helps architecture of the developed system are also described in environmental decision support	The contemporary business organisations recognize sustainability as an important concept for survival and ISO 14000 requirements, which enabled the selection of the best alternative which guided the decisions makers to implement certain actions from the perspective of environmental improvement	This study presents that firms must challenge the predominance of formal knowledge in the management of environmental problems of through create a climate of learning that encourages the recognition and sharing of employees' experiences	The study however identified high correlation between KSs & EOP. Also, a computer based relationship between EDMS & EOP was developed

ISSN 2229-5518

3 Research Methodology

This research seeks to highlight the concept of KSs as an essential element, in supporting EDSS to enhance the EP. This is because it consists of essential elements which are critical to an enterprises manufacturing know how and understanding of environmental regulations within the manufacturing decision making context, especially for the industry sector. Industry requires creative thinking to generate innovation, learning and excellence in knowledge cognition and knowledge inertia, as well as spending in three types of DSS: GDSS, ESS and ES. In other words, this research aimed to investigate the issues and factors which affect the utilization of KSs as a tool for effective EDMS.

Therefore, decision models and DSSs which enhance effective utilization of this approach are investigated. A DSSs which demonstrates an empirical application of KSs will be developed through adopting the following objectives: (1) To investigate the role of knowledge systems in effectively supporting EDMSs. (2) To develop a model of KSs and other factors leading into effective EDMSs. (3) To test the model for significant decision factors. (4) To develop a guideline for establishing KSs for effective EDMSs.

4 Research Method

This study has used mixed methods to conduct the research. A preliminary research model has been developed based on a comprehensive literature review. A schematic of this research model is presented in Figure.3.

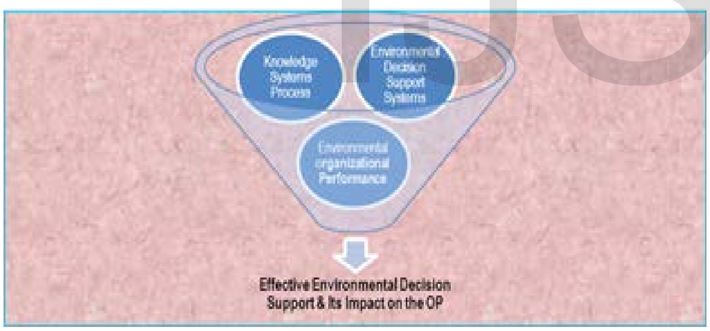


Fig.3. A schematic of the research model

Additionally, In order to fulfill the study objectives, a model was developed of KSP in the organisations. The model is outlined in the study model (Appendix). The literature shed light on various "KSP" and other "decision factors" as shown in the study model (Appendix). Interviews were conducted with various manufacturing enterprises to fine tune the research model.

The study relied on personal interviews with officials and knowledge workers at the manufacturing enterprises. This was in addition to the use of a survey to collect cross sectional data, which was distributed to random samples in these firms. The researcher gathered information over a period. This data was analysed by statistical procedures to find the significant factors of effective EDS in these companies.

The values of the statistical variables and the standards used to measure models for DSS and EP (Yi) indicated the chosen optimal model (cubic model). This model exceeded each of the statistical tests and all of the standards. Multiple-regression analysis checking has been adopted in the hypotheses of the study. For each hypothesis, models were run separately for each of the independent variables, KSs and its enablers and the dependent variables DSS, EP and their variable enablers.

A. The relationship between the KSs processes and KSs enablers:

- $KSP = \alpha + \beta_1 LEA + \beta_2 INN + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $LEA = \alpha + \beta_1 INN + \beta_2 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $INN = \alpha + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$

B. Between DSSs and KSs processes and DSSs enablers:

- KSs enablers $= \alpha + \beta_1 KSP + \varepsilon$
- $DSS = \alpha + \beta_1 KSP + \varepsilon$
- $KSP = \alpha + \beta_1 GDSS + \beta_2 ESS + \beta_3 ES + \varepsilon$
- $DSS = \alpha + \beta_1 LEA + \beta_2 INN + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $GDSS = \alpha + \beta_1 LEA + \beta_2 INN + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $ESS = \alpha + \beta_1 LEA + \beta_2 INN + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $ES = \alpha + \beta_1 LEA + \beta_2 INN + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$

C. The relationship between the KSs processes, KS enablers and EP:

- $EP = \alpha + \beta 1\ KSP + \varepsilon$
- $KSP = \alpha + \beta_1 EIM + \beta_2 JFW + \beta_3 OFIOF + \varepsilon$
- $EP = \alpha + \beta_1 LEA + \beta_2 INN + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $LEA = \alpha + \beta_1 EIM + \beta_2 JFW + \beta_3 OEIOFW + \varepsilon$
- $INN = \alpha + \beta_1 EIM + \beta_2 JFW + \beta_3 OEIOFW + \varepsilon$
- $EIM = \alpha + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $JFW = \alpha + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$
- $OFIOF = \alpha + \beta_3 RES + \beta_4 COG + \beta_5 INE + \beta_6 UTI + \beta_7 ACQ + \varepsilon$

D. Between EP and DSSs:

- $EP = \alpha + \beta_1 DSSs + \varepsilon$
- $EP = \alpha + \beta_1 GDSS + \beta_2 ESS + \beta_3 ES + \varepsilon$
- $EP = \alpha + \beta_1 EIM + \beta_2 JFW + \beta_3 OEIOFW + \varepsilon$

This study set out the regression equations above to identify the relationship among knowledge systems process, environmental decision support systems and environmental performance, as explained in the study model in appendix.

5 Results Analysis and Discussion

This study aims to assess the reality of KSs in companies as a field of study, through the identification of factors that affect KSs in the selected companies. 55 forms (survey) were sent to each one of the three companies, and acceptance was 35% for the Textile Industry, 31% for the Southern Cement State Company and 33% for the State Company for the Garment Industries. This means that a total of 165 forms were sent and acceptance was 32% a good percentage of responses of the sample in these companies to which the survey was supplied.

The forms were sent to a range of knowledge workers (engineers and technicians) within these companies including the top leadership in production and other depts. This form contains nine of main variables about KSs which included (innovation, learning, and knowledge inertia), EDSS(group decision support systems, executive support systems and the expert systems) and EP. In probability theory and statistics, the standard deviation of a statistical population, a data set, or a probability distribution, is the square root of its variance. Standard deviation is a widely used measure of the variability or dispersion. It is algebraically more tractable though practically less robust than the expected deviation or average absolute deviation, and is as defined in equation (1) (Yadolah 2003).

$$\delta N = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{X})^2} \qquad (1)$$

Table 2:
One-sample statistics for the three companies

Variable	Mean	Std. Deviation	Std. Error Mean
KSs	1.7944	.37938	.05163
EDSSs	2.0062	.60128	.08182
EOP	1.8981	.68406	.09309
Lea	1.7474	.39483	.05373
Inn	1.8356	.42273	.05753
KR	1.6019	.41070	.05589
KI	1.8426	.57931	.07883
KC	1.9414	.54864	.07466
GDSSs	2.0625	.69140	.09409
ESSs	1.9753	.63478	.08638
ES	1.9683	.67216	.09147

A question is validated for its reliability, where its standard deviation is found as explained in Error! Reference source not found. and Error! Reference source not found. for the sample (N = 54). Therefore, these values enabled further analysis in these research areas, as the reliability of the questions is very high.

Table 3:
One-sample test for the three companies

Variable	t	Mean difference	95% Confidence interval of the difference (Test value = 0)	
			Lower	Upper
KS	34.758	1.79444	1.6909	1.8980
EDSSs	24.518	2.00617	1.8421	2.1703
EOP	20.391	1.89815	1.7114	2.0849
Lea	32.521	1.74735	1.6396	1.8551
Inn	31.910	1.83565	1.7203	1.9510
KR	28.661	1.60185	1.4898	1.7140
KI	23.373	1.84259	1.6845	2.0007
KC	26.003	1.94136	1.7916	2.0911
GDSSs	21.921	2.06250	1.8738	2.2512
ESS	22.867	1.97531	1.8020	2.1486
ES	21.518	1.96825	1.7848	2.1517

Moreover, Cronbach's Alpha test is widely believed to indirectly indicate the degree to which a set of items measures a single unidimensional latent construct. Accordingly, the test results' for all the variables was found to be: 0.90 to the sample = 54 according to equation (2) (Devellis 1991), either with respect to each variable as in Table 4.

$$\alpha = \frac{k}{k-1}\left(1-\frac{\sum_{i=1}^{k}\sigma^2_{Y_i}}{\sigma^2 x}\right) \qquad (2)$$

While, Revelle et al. (2006) have shown that α can take on quite high values even when the set of items measures several unrelated latent constructs. Therefore as a result, Alpha is most appropriately used when the items measure different substantive areas within a single construct. When, the set of items measures more than one construct, the coefficient omega-hierarchical is more appropriate (Zinbarg et al. 2005). Consequently, Cronbach's Alpha test has explained to us that the question is validated for its reliability, when Cronbach's Alpha results found are as shown in Table 4.

Table 4
Reliability statistics for the companies

Variable 1	Variable 2	Cronbach's α
KSs	EDSSs	.62
KSs	EOP	.62
EDSSs	EOP	.84
Lea	Inn	.83
Lea	EDSSs	.65
Inn	EDSSs	.73
KR	EDSSs	.67
KI	EDSSs	.65
KC	EDSSs	.75
Inn	EOP	.64
Lea	EOP	.77
KR	EOP	.79
KC	EOP	.68
KI	EOP	.79
EDSSs	EOP	.84
GDSSs	EOP	.78
ESSs	EOP	.76
ESs	EOP	.83

These values enabled work to proceed further in this research area. As they result in the reliability of the questions being very high, with an average valid percentage for each relationship of 69.2%. Subsequently, Mood et al. (1997) the Chi-Square Test is one of the statistical probability theories. This is widely used in the distributions of inferential statistics; for example, in assumptions testing over and above construction of confidence intervals to the data. In accordance with that, the method is defined as in the two equations 3 and 4. If $X_1 \ldots X_k$ are independent standard normal random variables, then the sum of their squares;

$$Q = \sum_{i=1}^{k} Xi^2 \quad (3)$$

It is distributed according to the chi-square distribution with k degrees of freedom. This is usually denoted as:

$$Q \sim X^2(K) or Q \sim X^2{}_k \quad (4)$$

Thus, the chi-square distribution has one parameter: k-a positive integer that specifies the number of degrees freedom, i.e. the number of X_i's. Consequently, this study has used this test to measure the homogeneity of the sample data as explained by the results in Table 5.

Table 5

Chi-Square test statistics

Component	Chi-Square	df	Asymp. Sig.
KS	12.370a	27	0.993
EDSS	20.630b	30	0.899
EOP	33.222c	14	0.676
LEA	23.333d	17	0.871
INN	15.852e	22	0.823
KR	15.815f	12	0.99
INE	32.111c	14	0.863
COG	35.556f	12	0.82
GDSS	29.741g	18	0.74
ESS	19.630h	13	0.838
ES	32.667d	17	0.692

On the other hand, the study determines degrees of freedom (df). Degrees of freedom are calculated as the number of responses in the problem minus 1. The study has determined a relative standard to serve as the basis for accepting or rejecting the hypothesis. The study used the relative standard in the research of $p > 0.05$. The p-value is the probability that the deviation of the observed from that expected is due to chance alone (no other forces acting). In this case, using $p > 0.05$, the study expects any deviation to be due to chance alone 5% of the time or less.

Table 5 gives the chi-square distribution. Using the appropriate degrees of 'freedom, locate the value closest to your calculated chi-square in Table 5. Determine the closest p (probability) value associated with your chi-square and degrees of freedom. In this case, the p value is about 0.10, which means that there is a 10% probability that any deviation from expected results is due to chance only. Based on our standard $p > 0.05$, this is within the range of acceptable deviation. In terms of the study hypothesis for this search, the observed chi-square is not significantly different from expected. The observed numbers are consistent with those expected under Mendel's law. This indicates proceeding further within the research areas.

As well, Factor analysis is a statistical method used to describe variability among observed variables in terms of a potentially lower number of unobserved variables called 'factors'. In other words, it is possible, for example, that variations in three or four observed variables mainly reflect the variations in a single unobserved variable (Hatcher 1994). Factor analysis of the companies of the study domain found that all the employees confirmed to the first variable in inviting the identification of KSs, and creating a knowledge depository.

This is because one of key factors in sustainable processes strategies or technologies determine the market dynamism so as to withstand competitiveness (Vinodh et al. 2011). Analysis obtained a percentage (98%) for other variables, as is explained for the communalities of the factor analysis in Table 6. Where, the value of a contribution ranging from 0-1 reflects the square-multiple-correlation coefficient to a variable of KSs with the factors. By and large, we note that the common factors explain a high percentage of the variables variance. The variable of knowledge resources was found to be less dependent (55%).

Table 6

Total variance to the variables

Component	Initial Eigenvalues			Extraction sums of squared loadings		
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
KSs	5.926	53.876	53.876	5.926	53.876	53.876
EDSS	2.915	26.503	80.379	2.915	26.503	80.379
EOP	0.714	6.494	86.873			
Lea	0.456	4.149	91.021			
Inn	0.41	3.726	94.747			
KR	0.315	2.861	97.608			
KI	0.178	1.617	99.226			
KC	0.085	0.774	100			
GDSS	5.48E-16	4.98E-15	100			
ESS	2.71E-16	2.47E-15	100			
ES	4.85E-18	4.41E-17	100			

Error! Reference source not found. highlights the latent roots of the matrix correlations (the components' variance), and its total is equal to the rank of the matrix, which is an equal variable to the number of variables.

Table 7

Communalities for the factor analysis

Factors	Initial	extraction
KS	1.00	0.980
EDSS	1.00	0.976
EOP	1.00	0.672
LEA	1.00	0.888
INN	1.00	0.806
KR	1.00	0.556
INE	1.00	0.817
COG	1.00	0.725
GDSS	1.00	0.811
ESS	1.00	0.743
ES	1.00	0.867

The first main component has the largest latent root (the component variance), equals 5.926 and explains 53.876 of the total variance for variables of KSs. Also, the second component is 26.503 of variance. The rest of the components are neglected since the latent roots are less than one. Fig.5 depicts a scree plot. The inflexion point on the curve has occurred after two

ISSN 2229-5518

factors explained in Table 6 as the total variances for variables of KSs. This is because it has more than one root. All of the other factors are neglected by the program because the latent roots are less than one. The ramifications of components 1 and 2 have been explained in previous analysis, where the ramifications represent a simple correlation of coefficients among the components.

Analysis of the results highlighted that the most powerful variables are correlated with the first factor and are variables of learning and creativity. The percentages of both variables were 0.833 and 0.83 respectively. The variable of ESS is 0.768. The weakest variable of correlation with the first variable is ES 0.578. From the factor analysis results, it appears that there is major concern by the employees about identification of appropriate knowledge resources for their work, and how these are learned within the corporation.

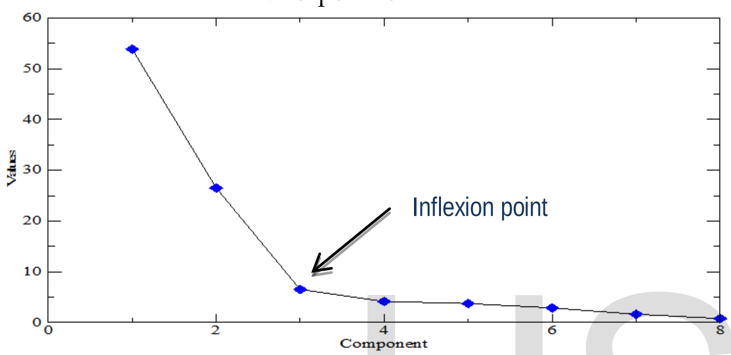


Fig. 4, Scree plot to the inflexion point in the curve (Table 6)

Additionally, this is the test implemented by researchers to investigate the quality of assessments on the data gathered. For instance, as criteria for a validity study, or as performance measures for selection or promotional purposes (Fleenor et al.1996). By and large, interrater reliability is defined as an index of consistency, which represents consistency of variance among raters (Kozlowski et al. 2000). While contrary agreement is explained as the exchange-capacity among raters, which addresses the extent to which raters make essentially the same ratings (James et al.1993). The two techniques used for an evaluation of the relationship between the scores provided by multiple raters are interrater reliability and interrater agreement. This is because they take into account social, political, and organisational factors that impact on the system to system performance (Liao et al. 2010).Accordingly, the interrater reliability has been evaluated by utilizing the interclass correlation coefficient (ICC) in Error! Reference source not found..

Table 8:

Results of interrater reliability and agreement

Variables	indexes	CC(1,K)	$r_{wg(J)}$
KSP	LEA	0.889	0.941
	INN	0.952	0.975
	RE	0.572	0.727
KS enablers	CO	0.789	0.882
	IN	0.752	0.858
	UT	0.885	0.939
EDSS	GDSS	0.543	0.704
	ESS	0.659	0.794
	ES	0.787	0.881
EOP	EIM	0.613	0.760
	JFW	0.247	0.397
	OEIOFW	0.295	0.455
	Practical experience	0.605	0.812

This is because each company has been evaluated using a different rater and their evaluations have been averaged, ICC (1, K) being suitable. ICC (1, K) is calculated by using a one-way ANOVA in SPSS software version 16.1 (Doros et al. 2010). According to James et al. (1984), they have updated indexes for the limitation of reliable consensus with the composition model. As a consequence, they have created indexes suitable to (ensure-group agreement). Thus, appreciating a single target with a single item ($r_{wg(J)}$) or multiple-item scale ($r_{wg(J)}$). This study has adopted ($r_{wg(J)}$) because assessment of multiple-aims is required for the analysis. Error! Reference source not found. highlights the results summary of interrater reliability and agreement. In this case there are many studies which indicate a good value of ICC in the range of 0.512-0.99. While ($r_{wg(J)}$) is ranging from 0.69-0.96 (James et al. 1993, Druskat 1994) which is suitable. Consequently, the results in this study are dependable according to the ICC and $r_{wg(J)}$ ranges. This means, the interrater reliability and agreement. The values for JFW and OEIOF however were low and these mean these two factors must be excluded.

Initially the study undertook a check of random sample responses to the test. This indicates responses to the test which were distributed using the questionnaire to accurately present the answers to the checklist. The proportion of the stability coefficient was (68%) and the veracity coefficient (82%). This means that if re-evaluation of the performance of the company were done it should produce the same accuracy of results, and the answers veracity in the checklists. The Eq. resulting (5, 6) show the results of the analysis. In this study, we will use the coefficient of stability analysis and the veracity. The stability analysis and the veracity analysis refers to the consistency and stability of the questions. Where the variables that have a stability coefficient and veracity coefficient above 0.70, this indicates high reliability (Anastasi1968, and Nunnally 1978), as in the two Eq. 5 and 6.

$$1 - \frac{\text{The variance of difference}}{\text{The degrees of variance test}} = 0.68 \qquad (5)$$

$$\text{Veracity coefficient} = \sqrt{0.68} = 0.82 \qquad (6)$$

However, this proves that the process of evaluation of factors of the KSs to the DSSs and the EP in the firms of study enjoys a high degree of stability and veracity, where the ratio has a value of 0.82. As well as this, it defines the relationship that can be adopted in the study model. This section focuses on the determination of the type of relationship (correlation) and its strength between independent study variables (X_i) KSs, and the dependent study variables. These dependent variables are represented by DSSS and EP (Y_i) and determine the type and strength of the relationship between any of the various indicators of DSSS and EP (Y_i) variables and all independent variables in the study (X_i).

ISSN 2229-5518

The study relies on the simple correlation coefficient (Pearson), which has the symbol (r_{xy}). This uses the statistical program, Excel and Labview software to elicit (R^2) using a polynomial method. Table 9 outlines all the results. To get the best multiple-regression model between the models that were used in the study, which includes a number of the independent variables (X_i), and explain as much as possible the changes in the dependent variables (Y_1, Y_2), the study used a backward elimination procedure method that is based on the use of the full equation of the model. Then one variable is eliminated at each stage that has little influence in the model on the dependent variable (Y).

Table 9:

The results of the statistical analysis

Relations	R	D-W	R^2	T-Test Cal. value	T-Test Tab. value	F- Test Cal. value	F- Test Tab. value	r_{xy}
KSs &EDSS	0.70	2.14	0.70	4.535	2.457	12.294	2.49	0.74**
LEA &INN	0.73	1.87	0.59	3.985	2.650	9.252	2.31	0.65**
LEA & EDSS	0.76	1.93	0.66	4.625	2.624	10.911	2.39	0.75**
INN & EDSS	0.69	1.86	0.52	5.883	2.567	15.095	2.33	0.61**
KI & EDSS	0.80	2.01	0.67	3.715	2.896	8.620	3.44	0.67**
KC & EDSS	0.54	2.02	0.50	2.471	1.943	8.620	3.87	0.51*
KSs & EOP	0.89	1.88	0.84	7.749	1.697	30.281	2.33	0.88*
INN & E OP	0.80	1.98	0.73	4.664	2.583	13.951	2.74	0.75**
LEA & EOP	0.87	2.03	0.79	7.063	2.624	24.364	2.85	0.86**
KC & EOP	0.51	1.97	0.51	2.159	1.943	4.661	4.28	0.50*
KI & EOP	0.87	2.11	0.70	3.591	2.821	15.209	3.58	0.66**
DSS & EOP	0.81	2.10	0.69	5.304	2.518	34.948	2.57	0.79**
GDSS & EOP	0.64	2.09	0.50	2.437	1.860	3.438	3.58	0.51*
ESS & EOP	0.77	2.01	0.81	4.654	3.143	31.435	4.28	0.75**
ES & EOP	0.88	2.06	0.79	6.972	2.998	66.487	3.87	0.86**
EXP & KSs	0.60	1.86	0.99	2.906	1.829	2.768	2.07	0.51*
EXP &EDSS	0.76	2.11	0.99	2.465	1.729	6.840	2.11	0.52*
EXP & EOP	0.57	2.02	0.62	2.227	1.729	2.381	2.63	0.50*
KR & EDSS	0.60	1.85	1	3.047	2.896	4.500	3.12	0.60**
KR & EOP	0.81	2.10	1	5.367	2.896	15.480	3.58	0.79**

In other words, we delete one variable at each stage based on its small contribution thereby reducing the sum of squares of errors $(\sum Ui^2)$ for all variables. In comparison, the values of the statistical variables and the standards to estimated models for Y_1 and Y_2 in Table 9 indicate the chosen optimal model is a cubic model. This is because it exceeded all of the statistical tests and the entire standards. Figure 6 explains the relationship among the variables based on the results that are displayed in Table 9. For each it displays the regression and the coefficient of determination R^2, and it represents the statistical model of the study. The computerised statistical analysis of the simple correlation coefficient (r_{xy}), DSSs (Y) and the factors influencing it the independent variables,(X_i) generated the following conclusions. The simple correlation coefficient (r_{xy}) between Y and the KS (X_1) (0.74**) means that there is a very strong and direct correlation between Y and X_1. This means that any increase in X_1 will lead to a significant increase in Y_1, and vice versa. It is also observed that the simple correlation coefficient (r_{xy} = 0.74**) is at the moral level statistically (0.01).

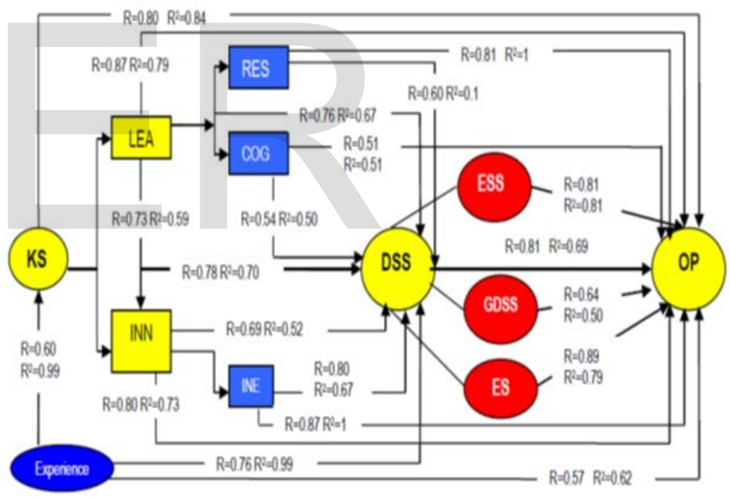


Fig.5, Standardized structural parameters in a KS model and the subindependent variables' with EDSS and EOP (Table 9).

Figure.5 explains the relationship regression among the variables according to a cubic model. The simple correlation coefficients between Y_1 and knowledge resources (X_2), knowledge cognition (X_3), knowledge inertia (X_4) , innovation (X_5), learning (X_6) and experience (X_7) (0.595**, 0.514*,0.669**, 0.609**,0.864**, and 0.523* respectively) indicate a direct and strong correlation between these variables. Therefore, an increase in any of the above variables (or a combination of them) will lead to an increase in Y_1, and vice versa.

The coefficients are moral with levels of (0.05, 0.01). The simple correlation coefficient between Learning (X_6) and innovation (X_5) (0.646**) indicates that the relationship (direct correlation) was medial between these variables. Consequently, any increase in X_6 will lead to an increase in X_5, and vice versa. Also, the coefficient is moral with a level of (0.01). The simple correlation coefficients between Y_2 and KS (X_1), knowledge resources (X_2) , knowledge cognition (X_3), knowledge inertia (X_4) , innovation (X_5),learning (X_6) and experience (X_7) (0.883*, 0.793**, 0.502*, 0.657**, 0.749**, 0.864** and 0.793**, respectively) indicate a direct and strong correlation between these variables.

Thus, an increase in any of the above variables (or a combination of them) will lead to an increase in Y_2, and vice versa. Again, the coefficients are moral with a level of (0.05, 0.01). The simple correlation coefficients between Y_2 and DSSs, GDSS (X_8), ESS (X_9), and ES (X10) (0.789**, 0.51*, 0.748**, and 0.861**, respectively) indicate a direct and strong correlation between these variables. Thus explain the regression relation among dependent variable (Y_2) and the independent variables (X_8, X_9 and X_{10}). That means, the knowledge discovery process requirements need to synchronize adaptive extrapolative investigation with real-time analysis and EDSS (Ganguly et al. 2007). Hence, an increase in any of the above variables (or a combination of them) will lead to an increase in Y_2, and vice versa. Again, the coefficients are moral with a level of (0.05, 0.01).To ensure the statistical morality of the regression coefficients (β) the study used the test (t), to test the following two hypotheses.

H_o: The model is not significant.
Vrs. H_1: The model is significant

Where; it is defined that the calculated values ($F_{cal.}$), when greater than the value of the variables as in Table 9. With the degrees of the freedom in the numerator and denominator (10, 54) and with a level of statistical morality of (0.05 and 0.01).This means that the null hypothesis will be rejected (H_0), and we may accept the alternative hypothesis (H_1). This indicates that the cubic model is highly statistically significant at the level of morality (0.05, 0.01).

Thus, the cubic model is highly efficient in the treatment of the data which we have collected in this study, and can be used for the purposes of forecasting DSSs and EP in the future cases. Also, the study will discover whether the model has multiple problems by testing two hypotheses. According to Montgomery et al. (2001), most regression problems involving time series data exhibit positive autocorrelation, so the hypotheses usually considered in the Durbin-Watson (D-W) test are:

$$H_o : \hat{p} = 0$$
$$H_1 : \hat{p} \neq 0$$

The statistical test is shown in equation (7);

$$d = \frac{\sum_{i=2}^{n} (ei - ei - 1)^2}{\sum_{i=1}^{n} ei^2} \quad (7)$$

Where ei = yi − ˆyi and yi and ˆyi are, respectively, the observed and predicted values of the response variable for individual i. d becomes smaller as the serial correlations increase. Upper and lower critical values, dU and dL, have been tabulated for different values of k (the number of explanatory variables) and n:

If $d < d_L$ reject H_0: p= 0
If $d > d_U$ do not reject H_0: p = 0
If $d_L < d < d_U$ test is inconclusive.

The value of D-W for the cubic model has been calculated for all variables, where the value of D-W for KS and EDSS was calculated at (2.14). Table 9 shown these values as D-W and compares those values with the two limits, the lower (d_L) and the upper (d_U) at a moral level of (0.01 and 0.05). The number of independent variables was (K=10) and the sample size was (54) and the limits were (d_L= 1.02) and (d_U= 1.84). Where the calculated values of D-W fell between (1.02-1.84) it is located within the domain (d_U<D.W. < 4- d_U) that is namely $(1.84 < D.W. < 2.16)$.Therefore, we will accept the null hypothesis (H_o), meaning that the cubic model does not suffer from the problem of self-correlation between the values of random variables (U_i).

6 Conclusions

This research has evaluated the use of KSP as tools for supporting the EDMS and for improving EP. The study was conducted within integrated projects in the manufacturing. The use of this tool should be especially beneficial in pursuing environmental improvements, in avoiding environmental incidents and deviations and in complying with the law. The results analysis shows that KSP plays a fundamental role in encouraging and improving the exchange of experience. Thereby, it helps in improving creativity and environmental performance and removing barriers and obstacles. Where tensions exist in organisations, (e.g. between production and environment), they must be solved by top management and by push and pull processes of knowledge.

This requires the development of capabilities by employees (experts) to make cross fertilisation of knowledge much easier among different sectors of the firm. This helps in improving the environmental performance by a commitment to learning, a shared vision and improving cross-pollination of ideas, which are all aided by open-mindedness by employees. With respect to expert systems the data supports the fact that these systems are vital in the firms as a link to avoid the stagnation of knowledge. They also provide a promising opportunity for developing EDSS, which may be a database that would contribute to narrowing the knowledge gap, thereby serving to solve problems in the environmental area.

This is because; An EMS provides the framework to manage the industrial enterprise environmental responsibilities effectively and also helps in assimilating the environmental initiatives into the day to day operations (Puvanasvaran et al. 2012). The data also enhances our understanding that in the manufacturing context KSs should include regular updates at company board level on the progress of the company. As well as other intra company reporting systems at all levels of the management hierarchy. DSSs may include formal teams for specific projects, regular analysis of the companies' previous experience to ensure best practice.

Good control of the quality and environmental performance, preferably using some kind of accredited quality system and environmental systems (ISO 9001, ISO 14001… etc.). In view of that, ISO 14001 has become an administrative tool towards corporate environmental management. It as well helps in reducing insurance and prosecution risks. This is because; ISO 14001 helps in acquisition investor confidence and brings in more ethical investment (Whitelaw, 2004).

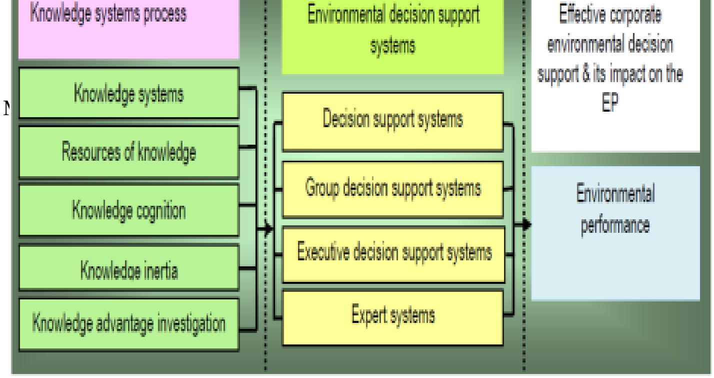
The firms were dependent on ESs for having stable strategies with respect to the environment; this meant an emphasis on long term rather than short term goals and keeping pace with advances in technology. The ultimate goal of dealing well with environmental issues involved bridging the knowledge gap in the firms to ensure increased performance of the processes. The dual technologies of ESs and data mining enable the design of a durable KSs for differing areas and missions. In this case, EDSSs in their different forms could play a master role in the interaction of humans. In the firms systems and ecosystems, they are tools designed to fit with the multidisciplinary nature and high complexity of environmental problems.

7 . Further Research

Further experimental investigations are needed, there being a delimitation of the constitutive reasons for innovation, through adopting the significance of implicit knowledge to creative work. Accordingly, future work should pay close attention to knowledge processes and organisational memory infrastructures. This requires a focus on the workers that are creating and circulating knowledge between company divisions and the employees. This is because almost all of the companies are building knowledge processes, but they ignore the investment within the infrastructure where the knowledge processes stabilise and conversely facilitate knowledge processes, or to the contrary.

More broadly speaking further research is also needed to conduct a survey with a greater number of samples and companies to validate it experimentally. It would be interesting to assess the effects of a new survey in gaining more powerful tools and then follow-up with the analysis of quantitative research findings. This analysis will provide the wide technical knowledge and expertise needed to select and apply the most appropriate knowledge for the organisation. Consequently, through analysis of knowledge gaps the companies could be described with respect to the difference between the enterprise's current capability and the capabilities required for KS. These findings will allow for the development of tangible dimension indices for KSs gaps.

7.1 Appendices



The proposed study model

7.2 Nomenclature of Abbreviations

Acronym	Nomenclature	Acronym	Nomenclature
KS	Knowledge Systems	EIS	Executive Information Systems
RE	Resources	IS	Information Systems
EOP	Environmental organisational Performance	MR	Multiple-Regression
OL	Organisational Learning	r_{xy}	Simple Correlation Coefficient
EDSSs	Environmental Decision Support Systems	LEA	Learning
IT	Information Technology	INN	Innovation
ES	Expert Systems	KI	Knowledge Inertia
ESS	Executive Support Systems	KC	Knowledge Cognition
GDSSs	Group Decision Support Systems	EXP	Experience
D.W.T	Durbin-Watson Test	KR	Knowledge Resources
dU	Domain Upper	OL	Organisational Learning
dL	Domain Lower	D-M	Decision-Making
Ui	Random Variables	df	Degrees of freedom
2-tailed*	Correlation is significant at 0.01 level	2-tailed**	Correlation is significant at the 0.05 level
R^2	Determent Coefficient	F_{cal}.	The calculated values
DSSs	Decision Support Systems	EP	Environmental Performance

Acknowledgment

The author would like to thank all of the knowledge workers from the companies which participated in completing the study. Thanks are also due to Dr. Andrew Campen of Arvia Technology Ltd in the UK for feedback on earlier versions of this paper. The author hereby acknowledges support from his sponsor of Ministry of Higher Education and Scientific Research of Iraq.

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