

## Using Expert Systems for Coaching and Mentoring ICT Project Managers

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**Abstract—** Several risks, dynamics and challenges, including lack of skilled and experienced personnel, mobility associated with project management experts and tough economic conditions are just some of many issues that information and communications technology (ICT) organizations in the 21<sup>st</sup> century have to deal with. Furthermore, these organizations are under constant pressure to improve project success rate which are unacceptably very low. Project managers who are ineffective in project leadership due to poor project skills pose a serious risk to project success. Some research studies indicate that the demand for ICT project managers with proper knowledge and expertise is ever increasing and the supply is nowhere near close in meeting the demand. As part of providing a solution to the abovementioned challenges and help equip ICT project managers with correct skills through mentoring and coaching, this research study is proposing the use of expert systems (ES). This proposal is a response to calls that have been made by other studies in project management that new approaches of developing project managers must be pursued. The use of expert systems to equip ICT project managers with the right skills and expertise will help advance and improve their software project management expertise. Just like ‘intelligent organizations’ that use expert systems to improve their decision-making processes in order to advance business efficiency and competitiveness so should expert systems be used to coach and mentor less experienced project managers. This research paper argues that the use of ES for coaching and mentoring yield many benefits for organizations.

**Keywords-** expert system; intelligence system; project managers; coaching; mentoring; skills.

### I. INTRODUCTION

Several risks, dynamics and challenges, such as, lack of skilled and experienced personnel, volatility of human experts [1] and tough economic conditions create a challenge for many information and communications technology (ICT) organizations in the 21<sup>st</sup> century. These ICT organizations are under constant pressure to improve project success rate through, amongst other things, the use of experienced project managers who have great influence on project success [2] to run their projects. These are some of the challenges that organizations in the ICT sector have to contend with in their quest to deliver value to both stakeholders and shareholders.

According to Schwalbe [3] the project management framework consists of nine knowledge areas, which describe the key competencies that project managers should possess in all the nine knowledge areas in order to deliver on projects’ mandates. However, a study by Hans et al. [4]

shows that ICT project managers in South Africa lack some key project management competencies, and these include problem-solving and leadership expertise. Project managers who are ineffective in project leadership due to poor project skills pose a serious risk to project success [5][6]. Project managers may lack appropriate expertise due to a number of reasons. They may lack skills because of not being properly trained or mentored and were just appointed based on their previous excellent performance in their former positions.

The above-mentioned challenges make it necessary for ICT organizations to rethink their business practices of training and mentoring their project managers. Moreover, talent development for project and program managers remains a top concern in organizations. This comes as no surprise given that research studies indicate that experience and project management expertise are key in delivering successful projects [3][7][8]. Metaxiotis [9] indicates that the demand for ICT project managers with proper knowledge and expertise is ever increasing and its supply is nowhere near close in meeting the demand. As part of providing a solution in equipping ICT project managers with appropriate skills through mentoring and coaching, this research study is proposing the use of expert systems. The proposed solution will result in project managers improving their software project management expertise. The use of the proposed ES would further address the skewed supply-demand ratio of knowledge-based resources – the supply of skilled project managers will be improved. It will also enable the training of project managers in the real-world project environment as requested by Ramazani et al. [10]. The use of the proposed ES will also relieve project management experts from the duties of mentoring and coaching which they sometimes do reluctantly [11]. Ramazani et al. [10] are calling for fresh approaches in the development of project managers, and this paper’s proposal intends to fill that gap by proposing a new approach in training, coaching, mentoring and development of project managers through the use of expert systems. Even though expert systems have been used in other areas of the project management discipline, to the best knowledge of the authors of this paper expert systems have not been used for the development of project managers. Therefore, this research paper proposes a novel approach to use expert systems to provide the above mentioned services and thus address the challenges which are plaguing the project management discipline.

The remainder of this research paper proceeds as follows. Section II presents a research methodology used in this

study. Section III discusses expert systems and their application. Section IV presents a discussion on using expert systems for coaching and mentoring ICT project managers. Section V presents the architectural structure of the proposed ES, while Section VI discusses value add which is derived from using expert systems for such initiatives. Finally, conclusions, limitations of this research study, and directions for future studies are presented.

## II. RESEARCH METHODOLOGY USED

As pointed out previously, ICT project managers in South Africa lack some key project management competencies. This is a research problem which this study seeks to address. A research question which will assist in finding a suitable solution to the abovementioned problem is the following:

*Can expert systems be used for equipping ICT project managers with appropriate skills?*

An approach used by this research study to answer the abovementioned research question is through the exploration of relevant literature with the aim of establishing similar cases where expert systems have been successfully used. There is therefore neither data collection nor data analysis performed in this research study.

## III. EXPERT SYSTEMS: THEORY AND PRACTICE

Organizations are continuously searching for innovative methods of reducing costs, improving decision making processes and automating or simplifying routine tasks. Therefore, organizational survival depends on finding ways and practices of adapting to the continuous changing competitive environment. Expert systems (ES) or intelligent systems are one type of IT tools that organizations turned to for addressing such challenges [12]. Avram [13] defines expert systems as:

*"Systems that use knowledge-based techniques to support human decision-making, learning and action."*

ES contains knowledge and experience of experts in a specific domain that anyone can use in solving problems [14]. Expert systems are a branch or subset of artificial intelligence [15][16]. Intelligent systems are considered 'intelligent' because they can solve a problem in a way similar to a human expert [17].

Expert systems have found application in a wide range of fields, such as manufacturing, business, finance, airline, law, computer science, geology, education, mathematics and medicine [16][18][19][20]. With each field, expert systems have been used to solve different range of problems. For example, some companies have implemented expert systems to assist in performance appraisal processes [21]. Others have used artificial intelligent systems for tutoring undergraduate auditing and engineering students at various universities [22]. Jenicke [17] cites three business organizations, namely, Digital Equipment Corporation, General Electric and Coopers & Lybrand that have developed and are using expert systems in their respective business domains. Digital Equipment Corporation uses its expert system called XCON [23] for configuring VAX

systems which handle customer orders. XCON has resulted in an improved customer order processing for the company. General Electric uses an expert system called DELTA for diagnosing and repairing the company's diesel-electric vehicles which are used for railroad maintenance [17]. On the other hand, Coopers & Lybrand uses its expert system called ExpertTAX [17] for providing expert advice to the organization's accountants so that they may in turn respond intelligently to clients' tax related questions. The system acts as an intelligent advisor to the company's employees who seek its guidance for decision making. ExpertTAX stores the expertise of the company's experienced accountants in its knowledge base component. Metaxiotis [9] also makes mention of organizations, such as Singular and the Portuguese Railways that have successfully implemented expert systems in their business operations. The discussion above illustrates that an ES may be used to position an organization in a better strategic position in the marketplace.

The literature has many research studies which cite the usefulness of expert systems in assisting in decision making. Expert systems may also play an important role in retaining competitive project management knowledge which may be transferred to less experienced project managers. This assertion is also supported by Jenicke [17] who states that expert systems are suitable for dissemination of knowledge and expertise within their areas of application. The use of intelligent systems for coaching and mentoring purposes has become imperative because the supply of experienced project managers with correct expertise is in short supply [24] and some project managers lack some key project management competencies. The use of expert systems for equipping ICT project managers with appropriate skills would help improve the supply of project managers with the right skills set. Moreover, this proposal is also in line with what other previous studies have established in terms of using computer-based training for enriching employees, as well as learners with much needed knowledge [5][22].

The proposed approach in developing ICT project managers is in accordance with the Guide to the Project Management Body of Knowledge [25] framework for managing project human resources. The PMBOK Guide (2012:105) states:

*"Individual development (managerial and technical) is the foundation necessary to develop the team."*

Such development includes enhancing skills, knowledge and capabilities of team members through, for example, computer-based training [25]. Furthermore, according to the PMBOK Guide (2012) one of the primary functions of a project management office (PMO) is to ensure coaching, training and mentoring of project managers. This research paper is therefore in direct support of PMO functions.

Notwithstanding the differences in the role that a project manager plays under PRINCE2 and PMBOK [26] a project manager is still a key project stakeholder whose primary responsibility is to steer a project to success. Such an expectation therefore requires that a project manager be properly skilled and this is the aim of this research study.

#### IV. USING EXPERT SYSTEMS TO COACH AND MENTOR ICT PROJECT MANAGERS

The failure rate of projects is still unacceptably high and several studies have highlighted these cases of failed projects. On the other hand, Schwalbe [3] indicates that 97% of successful projects were carried out by experienced project managers who have correct project management skills. However, as mentioned above the sad part is that such project managers are in short supply [24] and therefore, these findings further back the call made by this paper for the use of expert systems to improve the situation.

It was mentioned above that expert systems have been used for tutoring students and therefore, using them for mentoring and coaching project managers would not be a wrong concept. Expert systems may either use rule-based (theory-based) or case-based (experienced-based) form of reasoning in solving problems [22]. Expert systems which make use of both rule-based and case-based techniques would prove useful in training ICT project managers. This assertion is based on the fact that people solve problems by either using prior cases or rules depending on the task being solved [22].

The use of ES for coaching and mentoring initiatives would be beneficial to an organization and to the mentored individuals in many ways. Firstly, it would ensure that valuable expert knowledge is kept and preserved in the knowledge base of an expert system for future use. Such practical real-world knowledge from experts provides aspiring ICT project managers with valuable learning experiences [27]. In the case of project management, such knowledge would pertain to project areas, such as [3][28]:

- knowledge in performing trade-off amongst project triple constraint [3],
- knowledge in project risk management,
- knowledge in scope management, as well as
- knowledge in other areas that pertain to the eleven knowledge areas of project management [28].

Furthermore, the knowledge base of the ES would also include expert knowledge in project management areas in which South African project managers were found to be lacking key expertise as identified by Hans et al. [4].

The lack of project management expertise by project managers in the abovementioned areas [5] have contributed to the failure of ICT projects [29]. For, instance, a study by Standish Group [30] indicates that less than a third of projects finish on time and within budget. This indicates that project managers have problems in dealing with two of the three project constraints. Another study by Ibbs et al. [28] shows that organizations in the ICT industry are struggling in managing project risks. Although this has been a well-known problem, little has been done by organizations to address it [3]. Therefore, the use of an expert system for mentoring and coaching project managers in this knowledge area will go a long way in addressing this issue. Project scope management is another key area that needs project managers to pay attention to. Schwalbe [3] indicates that proper project scope management is a contributing factor to project success. The

discussion above justifies the inclusion of project knowledge on the stipulated areas above in the knowledge base of the ES expert system.

Secondly, once the desired knowledge has been kept in the ES knowledge base it can then be used to train, coach and mentor both inexperienced and aspiring project managers that an organization wants to groom. When an inexperienced project manager uses an expert system, he/she is able to learn (infer) how the system arrived at a particular correct decision. Through such interactions with an ES, a project manager is able to gain valuable real-world knowledge and experience. Furthermore, such knowledge transfer forms part of organizational culture transfer to 'new' project managers. The initiative of using ES to train, coach and mentor novice project managers would be playing a critical and imperative role of grooming new project managers in-house and thus ensuring and perpetuating consistency in the way an organization manages its projects. Previous research studies show that organizations which groom project managers internally are amongst those that run successful projects [3]. Therefore, expert systems would be playing a role of transferring knowledge and the problem-solving strategies of experts to less experienced project managers [22].

#### V. ARCHITECTURE OF THE PROPOSED EXPERT SYSTEM

According to Metaxiotis [9] and Jenicke [17], expert systems have the following three basic main components:

- **Knowledge base** – The knowledge base contains the knowledge needed for solving a specific problem. In order for ES to solve human problems, human expert knowledge should be captured in a knowledge base [16]. In this case an ICT expert project manager's knowledge will be captured into the knowledge base of the proposed ES. The previous section mentioned some project management knowledge that should form part of this component. The knowledge base may be in various forms, such as, facts, theories, heuristics or relationships. Typically, the knowledge base is implemented in IF-THEN rules [16]. The development of this component of an expert system is the most challenging one [14].
- **Inference engine** – This component takes the input that has been entered by the user through user interface and then manipulates knowledge base using the inference control procedure [17]. The control procedure determines the order in which the knowledge base will be searched [9]. It may start with a set of conditions and then establish a conclusion or it may start with a conclusion and then search the knowledge base for conditions that meet the conclusion [9][16][17].
- **User interface** – Through this component a novice project manager is able to interact with the expert system. He/she is able to ask the ES to test some conclusions or enter information which the system will use to find conclusions related to the entered

information [16]. In return, the expert system is able to present its results and possibly prompt the user for additional information via the same user interface. An expert project manager also uses this user interface to capture project management knowledge into the knowledge base.

Figure 1 depicts the components of the architecture of the proposed expert system, as discussed above.

VI. THE VALUE OF USING ES TO COACH AND MENTOR ICT PROJECT MANAGERS

Information technology has become an indispensable factor for every organization [31]. ES as an integral part of IT provides an organization with an excellent opportunity of managing knowledge in project management and also of enabling knowledge transfer to inexperienced project managers. Metaxiotis [9] stresses the importance of using information technology by organizations in order to gain a competitive advantage. Therefore, an organization can obtain a competitive advantage from the use of ES through knowledge retention (knowledge captured in ES) and knowledge transfer (through using ES to coach and mentor inexperienced project managers). A number of authors have noted some benefits of using expert systems for training human resources, and such benefits include:

- **Continuous availability of services** – services provided by expert systems are always available anywhere, unlike when such services are offered by a human expert which might not be available or their availability may be confined to a specific location [16].

- **Costs savings.** The maintenance of human expert knowledge through the conventional way (for example, training a new project manager) may be more expensive. Therefore, the use of ES for training, mentoring and coaching would result in costs savings for organizations, a view also supported by both [17] and [24]. The usage of ES reduces the training and knowledge transfer cycle amongst staff members [9].
- **Consistency** - expert systems apply reasoning consistently without any biasness unlike human beings. This would ensure that consistency is 'transferred' to mentored managers. That is, ES teaches project managers consistency in their reasoning process [9].
- **Keeping lessons learned and updating knowledge base** – with case-based expert systems current decisions and incidents may be stored for statistical and future case-based reasoning [14].
- **Actively creating intellectual capital** – the use of ES creates organizational knowledge which will enable the business to compete effectively. It facilitates the continuous training of new project managers for an organization. This contributes to the continuous availability of human resource reserves [32].
- **Promoting a learning culture in an organization and empowering project managers** – by adopting ES an organization does not only remain in the cycle of knowledge creation and knowledge sharing [17][32] but also becomes a learning organization and at the same time empowering its project managers.

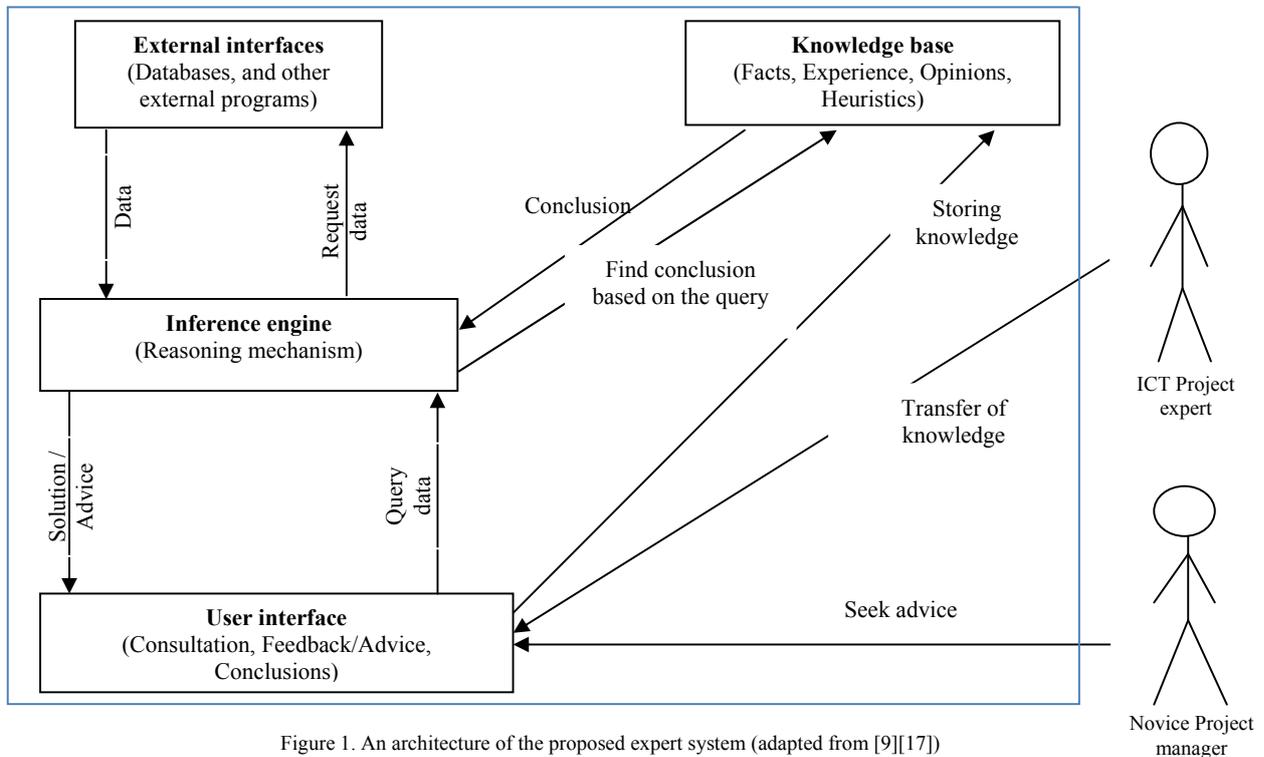


Figure 1. An architecture of the proposed expert system (adapted from [9][17])

- **Enabling on the job training (OJT)** – On the job training is very important for producing highly competent employees [33] and would be employees. In a competitive business environment where organization cannot afford to send away employees for training or they may have no capacity to provide such training [34], the usage of expert systems for training purposes enables such organizations to kill two birds with one stone – allows companies to be productive and also enables them to equip employees with much needed skills.
- **Provide learning anywhere and anytime** – ES enable any employee to learn anytime, and anywhere [35].

The use of expert systems further ensures efficient transfer of knowledge without costing an organization too much money and time. It also offers trainees a hands-on experience rather than being passive learners. This kind of training is consistent and repeatable, and these are the elements which are missing with training offered by human agents.

Over and above of the benefits mentioned on the usage of expert systems, herewith below are some of the specific benefits that accrue from the implementation of the proposed expert system for mentoring and coaching ICT project managers:

- **Improvement of project management efficiency.** Given the short supply of ICT project managers with appropriate and much needed project management skills [9][34], the proposed ES will not only ensure continuous supply of such managers but will also contribute to the better management of ICT projects. The proposed ES will focus on equipping project managers with the identified lacking skills which include problem-solving expertise, critical thinking, leadership, tools expertise, etc. [4][10]. In other words, the proposed ES will be aimed at mentoring and coaching ICT project managers on the identified critical skills gaps in project management.
- **Meeting both the ‘demand and supply sides’ of knowledgeable ICT project managers** - It was indicated earlier in this paper that currently there is a skewed supply-demand ratio of knowledgeable ICT project managers. The use of the proposed ES will seek to balance this unfavorable supply-demand ratio.
- **Facilitation of sharing of specific project management know-how** – Captured ICT expert know-how will be transferred through the proposed ES to new or novice project managers. As indicated before in this paper such project management knowledge is critical to project success and project managers with such knowledge are in short supply and thus the use of the proposed ES for addressing this will be a welcome relief.
- **Equipping project managers in the real-world context** – Project managers will learn project management skills in the real world, as the expert system will be based on real life experiences of project management experts. A study by Ramazani et al. [10]

highlights the need to train project managers in the environment and context they are likely to encounter at work.

- **Assists in overcoming some of the barriers encountered by conventional knowledge sharing** – There are various barriers to knowledge sharing, including lack of socialization among staff members within organizations. Such a barrier inhibits transfer of tacit knowledge between staff members, however the use of the proposed ES would overcome such barriers as knowledge would be residing in the ES system.

Furthermore, the use of the proposed ES to part knowledge to new project managers lessens the approach of learning through trial and error that project managers are sometimes subjected to.

## VII. CONCLUSION AND FUTURE WORK

If organizations hope to address the plight of ICT projects’ poor track record and the lack of skilled project managers, then they need to change their development strategies of project managers. These sentiments have been echoed by [10] who state that new approaches are needed in developing project managers. According to Kilkelly [24],

*“Project management is complex, and so to create good project managers and, subsequently, sound projects, it is critical to get the development right”.*

The use of the proposed expert system for training, mentoring and coaching new inexperienced ICT project managers is one way of getting the development strategy right as well as proposing a new way of training project managers as called by Ramazani et al. [10]. The usage of an expert system enables organizations to promote and maintain excellence through knowledge management, coaching and mentoring of their future project managers with the aim of creating a better future for the stakeholders.

The discussion presented above has attempted to answer the question of whether expert systems can be used to equip ICT project managers with much needed skills in project management. This research paper has argued that the use of expert systems for coaching and mentoring new and novice ICT project managers yields many benefits for ICT organizations, with the main benefit being the enablement of the transference of much needed project management know-how between expert and novice project managers.

This research paper is part of the PhD research work of the first author, where he intends to develop real-time interactive project management intelligence (PMInt) tool which is modelled after business intelligent tools [36]. Once the PMInt tool has been developed, it will then be tested for its effectiveness in improving decision making.

The usefulness of the proposed expert system for coaching and mentoring novice information and communications technology project managers needs to be tested. The first challenge though is getting participation of ICT project management experts when the proposed expert system is developed. The experts might view the system as meant to replace them [37] and this may lead to their lack of participation in the development of the system. Secondly,

the complexity and exorbitant costs associated with the development of expert systems [11] might be a challenge for some organizations.

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