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An Effective Decision-Support Framework for Implementing Enterprise Integrated Systems within SMEs

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ABSTRACT

Small-and-medium enterprises (SMEs) are the backbone of the economy in most countries. With the opening up of the economy, it is crucial that SMEs continuously improve their competitiveness to assert themselves in the global market. There is also a greater need for information integration in SMEs that lack the financial resources and business resilience of large enterprises. This research paper presents the development process of an effective decision-support framework for adopting integrated information systems within SMEs. The methodology comprises eleven steps, such as identifying information systems related business problems, forming a project team, and assessing legacy systems and software vendors. The development process of the decision-support methodology has passed through four major stages: identifying the required specification of the methodology, selection and justification of the most suitable delivery medium, creating and evaluating a pilot version of the methodology, and developing the final decision-support methodology and the workbook in which it is embodied. An evaluation of the methodology concluded that it would help to improve the outcome of an integrated systems project by providing motivation, saving time, reducing risks, and assisting with decision making.

Keywords: Enterprise Information Systems; Implementation; SMEs; Decision Support.

1. Introduction

It is widely recognised that today's manufacturing organisations are increasingly confronting new markets, new competition, and greater customer expectations. There is a need to lower total costs throughout the supply chain and to reduce stock levels to

a minimum, while providing more reliable delivery dates, improved customer service, an enlarged product assortment, and improved product quality. Manufacturers are also finding that product development and design cycle times are becoming more compressed, while the products themselves are becoming increasingly complex.

Since the early 1990s, many organisations have attempted to meet the rapidly changing business environment by replacing their stand-alone information systems (IS) with a single integrated system such as enterprise resource planning (ERP). Integrated systems offered the promise of information passing seamlessly between business departments, and also had the potential to deliver business benefits such as standardising production processes across multiple business units (Koch *et al*., 2002), reducing costs (Papiernik, 2001), and providing a consistent information base that was accessible across the entire organisation (Lozinsky, 1998). Companies also benefited from operational improvements, including reductions in time to market (Konicki, 2000), cycle times (Shang and Seddon, 2000), and product development times (Port *et al*., 1990), while reaction times to competitive pressures and market opportunities were improved (Bingi *et al*., 1999). Shehab *et al.* (2004) indicate that SMEs have to tap the power of IT and an integrated IS to stay competitive and customer oriented.

Replacing their stand-alone systems with a single integrated system might help to minimise some of the business problems affecting SMEs. However, the SMEs also suffer from other problems, including a general lack of personnel. The SMEs typically employ only one or two information technology (IT) professionals or prefer to hire in IT expertise when required, which means that it is sometimes difficult to make well-informed and reliable decisions regarding IS investments. The SMEs also have fewer financial resources and smaller budgets than larger companies, while recent crises such as foot and mouth disease have affected the confidence of the industry. The lack of personnel, IT expertise, and the confidence to make IT related decisions means that the SMEs are finding it difficult to invest what could be significant levels of time and capital into an integrated systems project of which they might have little or no understanding. Therefore, they require assistance when decisions need to be made regarding IT investments. This is particularly the case for those SMEs that might be considering replacing their stand-alone systems with a highly complex integrated system.

This research work was carried out in collaboration between the School of Industrial and Manufacturing Science, Cranfield University, UK and small-to-medium sized enterprises (SMEs) operating within the Agricultural Engineering Industry in the UK. Other than the products they manufacture, Agricultural Engineering SMEs are similar to SMEs operating within other industries. For the purposes of this research, an Agricultural Engineering SME has a financial turnover of up to £15 million and employ up to 200 people. However this research project was conducted with an Agricultural Engineering SMEs, findings of research are applicable to other manufacturing industry sectors.

SMEs have typically implemented stand-alone IS, which has resulted in business problems such as high stock levels that are expensive to keep, a lack of information sharing between departments so that products sometimes fail to meet market requirements, stock-outs of spare parts, and the production of too much paperwork as a result of having to re-enter identical data into numerous systems. Therefore time and resources are wested.

The remainder of this research paper is organised as follows. Section 2 provides a comprehensive survey of previous work in various areas related to this research area. The research methodology used to carry out the research is outlined in Section 3. Section 4 describes the various stages of the decision-support methodology (DSM) development process and the methodology scenario. The overall benefits of employing the developed methodology with its implementation medium are discussed in Section 5. The conclusions are explored in Section 6.

2. Literature Review and Research Scope

Companies are increasingly turning towards integrated systems to help them compete more effectively in today's rapidly changing business environment. One of the initial objectives of this research was to identify the main issues that the SMEs need to consider prior to deciding on whether or not to integrate their IS. It was also important to identify the resources and factors that are likely to have an impact on the level of integration selected by an SME. A comprehensive literature review concerning this area of research was carried out to achieve this objective.

Bradford and Roberts (2001) state that, prior to deciding on whether or not to implement an integrated system, senior management must identify the business benefits that will result from an integrated systems project, and then ensure that every project-related action is directed toward achieving those benefits. Markus and Tanis (1999) offer a similar view, stating that it is important to consider the implementation in business and organisational terms, rather than as the installation of a new software technology. Davenport (1998) argues that companies should consider how an integrated system might strengthen or weaken competitive advantages, how it will affect the company and its culture, whether the system should be customised, and whether a more suitable system for information management can be implemented.

A study of twelve manufacturing companies and six consulting firms identified replacing fragmented legacy systems, reducing the costs associated with IS, obtaining accurate real-time information, process and operational improvements, system simplification and improvement, and competitive pressures were the main reasons for integrating IS (Mabert *et al*, 2003).

Published literature highlights a number of issues that companies need to consider prior to deciding on whether or not to integrate their systems. Typical issues include the need to form a suitable project team (Cliffe, 1999; Al-Mashari *et al*, 2003), assess different software vendors and the packages they offer (Hecht, 1997; Butler, 1999; Rao, 2000; Bernroider and Koch, 2001; Wei and Wang, 2004), and assess the impact that integrated systems are likely to have on the company once they have been implemented (Laughlin, 1999; Al-Mudimigh *et al*, 2001). Despite various authors discussing specific issues, Lee (1998) states that few attempts have been made to compile them into a structured methodology that could be used to guide companies through the steps they need to take prior to making a decision on whether or not to integrate their systems. A further problem with published literature is that it usually informs a company of what needs to be done, but fails to state why it is being done, how it should be done, the risks involved, and the likely outcome.

Although published literature suggests that integrated systems have not always lived up to expectations, it is possible that they could help to minimise some of the business problems affecting SMEs. However, the SMEs have a lack of both financial and

personnel resources, and so they might find it difficult to implement and support an integrated system. Moreover, the lack of IT expertise within certain SMEs means that it is difficult for them to make well-informed and reliable decisions on whether or not to integrate their systems. Therefore, the SMEs require support when making IT-related decisions.

One approach for supporting decision making would be to identify the main issues that need to be considered prior to integration. Identifying these issues would enable the SMEs to assess their own readiness for undergoing an integrated systems project, and so they would be in a better position to make better-informed and more reliable decisions. The risk of implementing a system that could seriously undermine the business would thus be reduced. Identifying the resources and factors likely to have an impact on the selected level of integration could provide further assistance to the SMEs (Loh and Koh, 2004). Identifying these resources and factors would enable an SME to select a level of integration that both helps to minimise its business problems and that it is able to support. As a result, the SMEs would be less likely to encounter many of the problems that tend to arise from integrated systems projects.

The literature review presented above established that there were two gaps in the knowledge that required further research. The gaps led to the development of the research aim, which was to develop a methodology that can guide SMEs through the decisions that need to be taken when considering whether or not to integrate their IS. The methodology also needed to include the issues that would enable each SME to establish an appropriate level of integration. In order to achieve this aim, information needed to be gathered from sources such as literature, case studies, consultancy reports, and the SMEs themselves.

The focus of this research is to: (1) Develop a specification and structure for the DSM; (2) Develop a methodology that outlines the decisions that need to be taken by SMEs that are considering integrating their information systems; (3) Evaluate and refine the DSM through practical evaluation in an industrial setting. The methods that have been deployed in order to achieve the research goals are discussed in the next section.

3. Research Methodology

As stated in section 1, this is a collaborative research project between Agricultural Engineering SMEs and Cranfield University. Therefore any work carried out must be relevant to an industrial setting. A research methodology that satisfies the demands of both academia and industry has been selected. The methodology was divided into four stages, each of which covers an area of the research.

The first stage was to carry out a review of published literature, focusing on a number of different areas related to the integration of IS (the review was presented in section 2). Published literature was reviewed to identify any gaps in the knowledge for which further research is required. The literature review was also used to identify those issues that companies need to consider prior to making a decision on whether or not to integrate their systems. The resources and factors most likely to have an impact on the level of integration selected by a company have been identified. This phase was carried out using a computer search of databases of the published literature and conference proceedings in the University Learning Resources area.

The second stage was to investigate Agricultural Engineering SMEs to gain an overall understanding of the environment in which they are operating and to identify their business and IS requirements. The primary focus was on their size and structure, the business pressures affecting the industry, the type of IS currently in use within the industry, and the business problems that have arisen as a result of the systems. Based on the relative strengths and weaknesses of each of the interview approaches, a combination of the semi-structured and unstructured techniques has been employed.

The third stage involved specifying the requirements and structure of a Decision-Support Methodology (DSM). The specification was derived from information obtained by completing both the first and second phases. The fourth stage involved the development and evaluation of a DSM that can be used by SMEs operating within the Agricultural Engineering Industry.

4. Development of the Decision-Support Methodology (DSM)

The development process of the DSM went through four stages: Identifying the required specification of the methodology; selection and justification of the most suitable delivery medium; creating and evaluating a pilot version of the methodology; and developing the final DSM. The various stages of the methodology will be discussed in the following sections. More details of the developed methodology can be obtained from Blackwell (2003).

4.1 Overall Specification of the Methodology

The specification of the DSM was based on issues that arose from the literature review presented in section 2 and from feedback obtained from visits to six Agricultural Engineering SMEs. The literature review and the company visits helped to identify the contents to be included within a DSM for integrated systems projects.

It was emphasised that the DSM should begin by enabling a company to develop a sound business case for integrated systems by identifying the likely benefits that would result from the project. It was also important to form a cross-functional team that consisted of the company's best people, and to have an appropriate balance of technical and business expertise. Each member needed to have a clear understanding of his or her roles and responsibilities within the team for the duration of the project.

The methodology needed to outline the resources required for an integrated systems project, particularly those associated with cost and time, and to highlight their impact as the level of integration increased. Companies also needed to be aware of the factors that were likely to have an impact on resources as the level of integration increased. The main factors were the flexibility/obsolescence of current systems, the need for business process re-engineering (BPR) and/or software customisation, change management issues, software compatibility, risk of implementing a system that adversely affects the business, and the need to develop interfaces.

The methodology should enable a company to assess its legacy IS. If the legacy systems were found to be both compatible and to offer the desired functionality and/or flexibility, then a company has the option of integrating them. Alternatively, a

company might want to purchase an integrated system; if so, the methodology would have to outline how any potential software vendors could be assessed, thereby helping to identify the one(s) most likely to supply a suitable system. The different integration options available (single system single vendor and best of breed) also needed to be included. Finally, the methodology should enable a company to regularly re-evaluate, re-structure or even abandon an integrated systems project if required.

4.1.1 Structuring the Methodology

Sakthivel (1992) states that a methodology should be easy to use and be teachable with minimum efforts; its documentation should be readable, complete, consistent and accurate, while the rules and procedures should be well defined without being rigid or contrived. Maniace (1995) argues that a methodology should be sufficiently flexible and robust to support the design, development, and delivery of change. The methodology should be easy to understand, with the clear potential for knowledge transfer to the client; it should also provide roles and responsibilities for participants.

Avison and Fitzgerald (1995) suggest that a methodology should provide a systematic method that consists of a collection of procedures, tools, and techniques so that progress can be effectively monitored. The methodology should be divided into phases or steps that guide its users in their choice of the techniques that might be appropriate at each stage of the project, and also help them plan, manage, control, and evaluate the project. Fitzgerald (1996) states that providing a phased approach will help to improve project management and control because some visibility is afforded into the progress made. That is, following the conclusion of each phase, an opportunity is provided to review progress and to monitor the actual costs and benefits. Redundant, irrational and counter-productive activities can therefore be eliminated, while the grouping of activities improves efficiency by ensuring that necessary work is completed without oversight.

4.2 Selection of the most suitable Delivery Medium

Flowcharts, Structured English, decision trees/decision tables, quality function deployment, knowledge-based systems, expert systems, and workbooks are the main decision-making tools and techniques. Data flow diagrams were rejected as a possible

delivery medium because they do not include the symbols required for expressing decision points and sequences in which tasks must be carried out (Alter, 2002). Table 1 provides an overview of the various strengths and weaknesses offered by the different decision-support delivery mediums.

According to Gagne *et al*. (1988), the selection of a delivery medium should be based on the availability of resources and personnel within the environment in which the methodology will be used, feasibility, and cost effectiveness. The delivery medium should also be convenient, flexible, and durable (Dick and Carey, 1990).

Based on the relative strengths and weaknesses of the different tools and techniques, workbooks represent the most suitable delivery medium. Workbooks have been used in practical business settings and as the basis for various methodologies, and also meet many of the suggested criteria as to how an IS-related methodology should be presented. They establish 'how to do' something as well as 'why' something is being done, and provide a practical approach to analysing and improving a company's business position; they are convenient for presentation, dissemination, and delivery. Workbooks are capable of meeting the ideal characteristics for a methodology outlined in section 4.1. In addition to encouraging project participants to communicate, disseminate and exchange knowledge, they are readable, easy to use, consistent, and well defined without appearing rigid or contrived.

Technique	**Strengths**	**Weaknesses**
Flowcharts	1. Easy to understand and follow 2. Indicate actions to be followed 3. Facilitate communication 4. Can represent decision points	1. Declining in popularity 2. Logic difficult to unravel 3. Time consuming to alter
Structured English	1. Concise, precise, readable 2. Unambiguous 3. Relatively easy to understand 4. Indicates actions to be followed	1. Time required to build writing skills 2. Processes are difficult to follow
Decision trees	1. Indicate actions to be followed 2. Unlimited decision points 3. Validation procedures	1. Rule based 2. Complexity increases with number of decision points
Decision tables	1. Handle large number of actions 2. Facilitate communications 3. Documentation easily updated 4. Validation procedures 5. Unambiguous	1. No indication of sequence of actions to be followed 2. Rule based 3. Complexity increases with number of conditions

QFD	1. Handles a range of problems 2. Facilitates communication 3. Reduces implementation time	1. Increased complexity requires development of more matrices 2. Cumbersome
KBS	1. Evaluates all possibilities 2. Allows 'how'/'why' questions	1. Time, tools, training required for development 2. Expensive to develop 3. Difficult to document and test 4. Requirements change often
Expert systems	1. Make decisions 2. Consistent outputs	1. Rule based 2. Difficult to develop, test, implement, and maintain 3. Documentation problems 4. Level of resources required 5. Need to understand language
Workbooks	1. Wide industrial application 2. Used to deliver methodologies 3. State 'how' to do something 4. Divided into distinct phases 5. Convenient	1. Assumes sequential approach

Table 1: Strengths and weaknesses of decision-support delivery mediums

4.3 Developing a Pilot Version of the Methodology

The objective of this phase of the research project involved the development and evaluation of a methodology that outlines the issues and decisions that Agricultural Engineering SMEs will need to consider prior to integrating their IS. Four stages were used to achieve the objective. Stage one involved the development of a pilot version of the DSM based on information presented in sections 4.1 and 4.2.

Stage two consisted of identifying people who had experience of either managing large IS projects or of developing and using a DSM. Six people were identified and a one-page letter was written and forwarded to them. All six people stated that they would be willing to evaluate the methodology; four of the respondents were employed at Agricultural Engineering SMEs.

The pilot methodology was forwarded to the six respondents and a list of questions was prepared. Using both unstructured and semi-structured approaches, each of the respondents was interviewed for a time period lasting approximately one hour. Any

feedback obtained from the interviews was assessed and validated through comparisons made with published literature; once validated, the feedback was incorporated into the methodology. The amended version of the methodology was then forwarded to the respondents and the process repeated. As recommended by the Delphi technique (Alexander and Serfass, 1998), the process was again repeated, and so feedback was obtained on three versions of the pilot methodology. Once the pilot version had been evaluated three times, the research team sought to obtain a more thorough evaluation through expert opinion and industrial-based case studies.

Stage three ran concurrently with stage four, and involved evaluating the pilot DSM through expert opinion. Based on information provided by Cranfield University, fourteen individuals who had acquired extensive experience in such roles as project management and IS development were identified. Based on contacts made by the research team, senior personnel at six Agricultural Engineering SMEs were also identified; each person had either undergone an integrated systems project within their companies or had extensive experience of such projects. Selecting the experts on the basis of their experience also helped to minimise the problem of validity, which was a concern expressed by Rossi and Freeman (1993).

Stage four involved a case study evaluation of the pilot DSM in an industrial setting. Nine SMEs were identified and a one-page letter was written and forwarded to them. Four SMEs stated that they were willing to participate in a case study, and so the methodology was forwarded and visits were arranged. Two of the case studies were carried out following the expert's initial evaluation (described in stage three, above), and two followed their second evaluation. Section 5 presents one of the case studies. Therefore, five different versions of the pilot DSM were evaluated in three stages. The sixth version represents the final DSM, an overview of which will be presented in Section 4.4.

4.3.1 Overview and structure of the pilot methodology

The pilot methodology consisted of nine steps. Since all nine steps were included in the final DSM, they will not be described in detail here; rather they will be described in Section 4.4. The nine steps were as follows:

1. Identify information systems related business problems
2. Establish if integrated systems can minimise the problems
3. Establish if integrated systems can be supported
4. Outline a preliminary case for integration
5. Establish the level of integration required
6. Assess current information systems
7. Assess software vendors
8. Decide to purchase or develop an integrated system
9. Develop business case

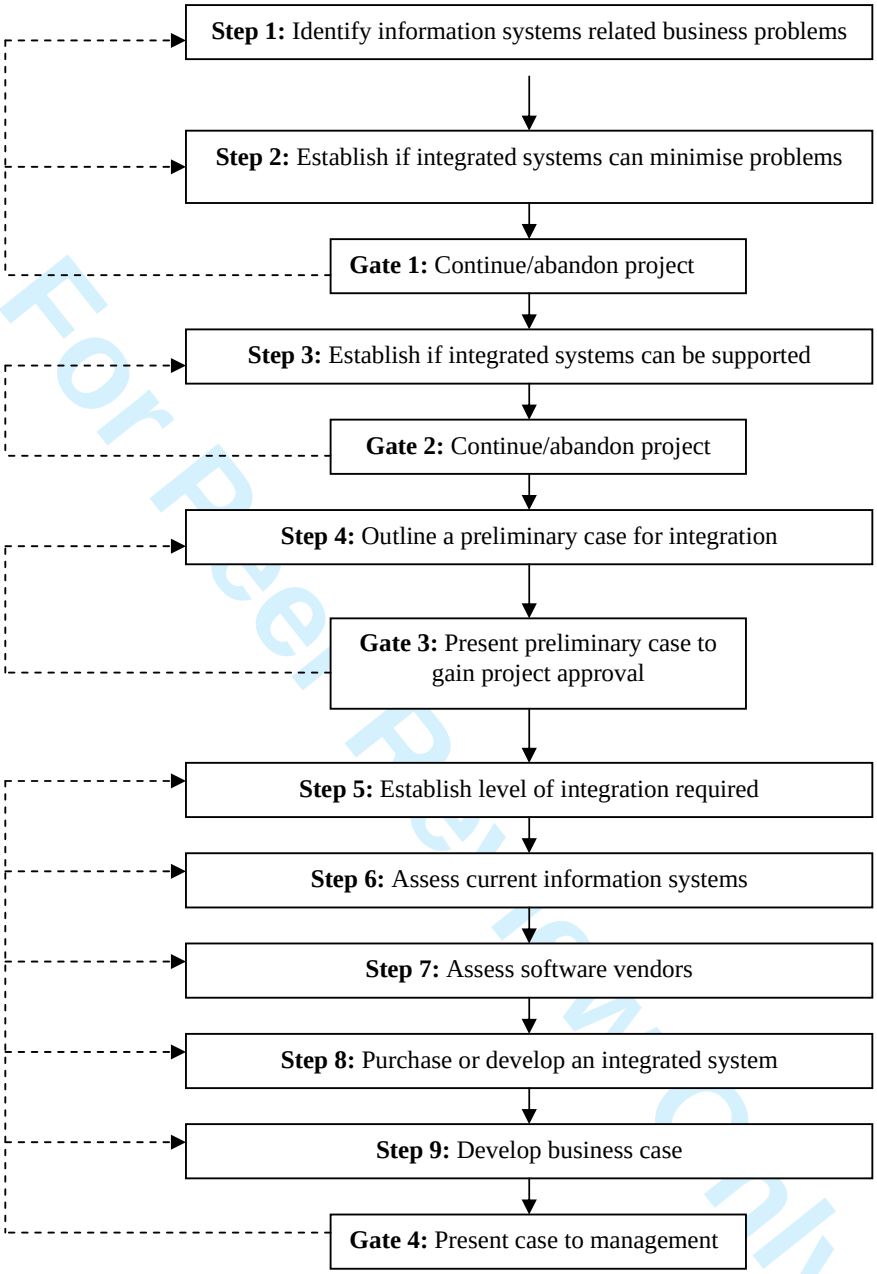
Figure 1 illustrates the nine steps of the pilot methodology. As will be described in section 4.4, many of the steps contained tools and techniques to assist the user in completing the methodology. As suggested by Sakthivel (1992), each of the nine steps had a consistent structure, which was as follows:

- Aim – The aim of the step
- Why – Why the step is being carried out
- Outcome – The outcome of the step
- Risks – The risks involved with failing to carry out the step correctly
- How – How the step should be carried out

Therefore the research team avoided the problem identified by Boahene and Bowles (1999), who criticise many methodologies for over-emphasising what needs to be done rather than focusing on why it is being done and how it is to be done.

While the nine steps assumed a linear progression from Step 1 to Step 9, loops were included that enabled previous steps to be revisited if necessary. Each of the loops occurred at the four decision points or gates included in the pilot methodology. The gates satisfy the arguments of Fitzgerald (1996) by enabling a decision to be made as to whether or to proceed to the next step or return to one or more of the previous steps. The gates followed steps two, three, four, and nine, and were as follows:

1. Continue or abandon the project (following step two)
2. Continue or abandon the project (following step three)



Note: Feedback loops are represented by the dotted lines (- - - -).

Figure 1 The pilot decision-support methodology

3. Present preliminary case to gain project approval (following step five)
4. Present business case to management (following step nine)

Each of the four gates had a consistent structure, which was as follows:

- Purpose of the gate – The reason(s) for the gate being present
- What is the activity – The issues that the would-be user needed to consider
- Outcome – The next step to be taken depending on whether or not the gate is passed

4.3.2 Evaluation of the pilot methodology

As described earlier, three versions of the pilot DSM were evaluated by interviewing six respondents. In order to maintain confidentiality, the respondents are identified as follows:

- A - Institute of Manufacturing, University of Cambridge
- B - Management Consultant within Empower Interactive Group
- C - Technical Director within an Agricultural Engineering SME
- D - IT/Business Manager within an Agricultural Engineering SME
- E - Technical Director within an Agricultural Engineering SME
- F - Technical Director within an Agricultural Engineering SME

The interviews focused primarily on the strengths and weaknesses of the workbook and the pilot methodology embodied within it. The questions were based on the following areas:

- How easy it was to use and understand
- How well it was structured
- Its length and how it might either be extended or reduced
- Whether sufficient details were provided at each of the steps in order to complete them successfully
- Whether the worksheets and tools included within the methodology helped the would-be user to progress through it
- Problems that might arise when using it in practice

- Any additional comments or areas of concern that needed to be addressed

When considering its strengths, the interviewees (in parenthesis) stated that the pilot methodology:

1. **Was easy to read and understand** (C, E, and F)**.** Respondent C stated that the workbook was relatively easy to use, although he argued that it would be much easier if the would-be user had experience of the problems and key issues affecting the business. Respondents E and F stated that the workbook was straightforward to read and contained the right amount of detail within each step.

2. **Provided a useful framework as to how an integrated systems project should be planned prior to making a decision on whether or not to implement one** (C, D, and E)**.** Respondent E stated that the methodology would point companies in the right direction and that he would be willing to use it in practice. However, he also pointed out that in no way should the methodology be considered as a replacement for experienced decision-making. Respondent C stated that his company had used many steps similar to those contained within the methodology when undertaking its own integrated systems project. The respondent stated that using the workbook might have improved the outcome of the company's project by providing a clear idea as to why the steps were being undertaken and what the long-term outcome would have been. Respondent D argued that the workbook provides guidelines on what needs to be done, although he emphasised that it would only prove useful within companies that had sufficient drive and motivation to undertake an integrated systems project.

3. **Helped companies to focus on their long-term business plans and to make decisions regarding the integration of their systems** (C and D)**.** Respondent C stated that the workbook was useful for long-term planning, in that it enables a company to visualise the future rather than concentrating on its current business environment. The workbook also forced people to consider the business as a whole rather than working in silos. Respondent D stated that the lack of finances within the industry meant that the workbook could be used as a self-assessment tool to establish whether it was worth undertaking an integrated systems project prior to hiring consultants.

4. **Provided a reference document that was logically set out, of reasonable length, with the right amount of detail, and with the tools and worksheets providing useful support** (A, C, and E)**.** Respondent A stated that the workbook was well set out and provided sufficient detail within each step. Respondent C stated that each step was well structured (divided into aim, risks etc.) and that the workbook would provide useful support for companies that were considering integrating their systems. Respondent E stated that the workbook covered all the main issues and that, although nothing should be added, removing parts of it might cause some important issues to be overlooked.

When considering its weaknesses, the interviewees (in parenthesis) stated that the pilot methodology:

1. **Failed to address issues of change management, communication between departments, and team formation** (C and D)**.** Based on his own experiences, respondent C argued that great emphasis should be placed on addressing/resolving change management/communication issues, while pointers should be provided on how to select a suitable team for working through the methodology. Respondent D stated that team formation issues needed to be considered, although he recommended not forming a project team at too early a stage. Rather, a project champion should identify the need for integrated systems and then a team should be formed to carry the project through to its conclusion. The need to address change management and team formation issues is supported by many authors within published literature, including Appleton (1997), Laughlin (1999), Chan (2001) and Cliffe (1999). The researchers decided to include an additional step within the methodology that would help to address issues of team formation, project roles, communication, and change management in general.

2. **Had yet to be evaluated in the form of a case study, and so some companies might find it difficult to understand what needed to be achieved when using it** (C and E)**.** Respondents C and E stated that the methodology would be easier to understand if it could be demonstrated within the real world by conducting a case study. Although in agreement, the researchers argued that the aim of the pilot methodology was to establish how useful it might prove to be within a real world

setting prior to evaluating it more thoroughly through expert opinion and case study. The researchers stated that the time required to carry out a case study within a company meant that the methodology would only be evaluated by this method following several revisions, thus preventing the companies from potentially wasting their time.

3. **Included some statements that the research team either failed to justify or provide evidence for** (A and B)**.** Respondents A and B were concerned that certain statements were made without either explaining what they meant or without providing sufficient details as to where they had come from. The research team responded by including explanations to the statements, although, rather than distracting the would-be user, decided not to include specific references unless quoting survey responses.

4. **Failed to clarify the meaning of the term 'an appropriate level of integration', together with how such a level could be achieved and measured** (B)**.** Although the term 'an appropriate level of integration' was used several times in the methodology, respondent B was concerned because it was neither fully explained, nor was it explained as to how it could be measured. The researchers addressed this issue by including a definition within the glossary, and by emphasising its meaning when reference was made to the term within the methodology. It was also stated that it was not necessary to measure the level of integration, although it could range from 0% (no systems integrated) to 100% (all systems integrated).

5. **Failed to explain why the would-be user should adopt a business rather than a technology approach to an integrated systems project** (B)**.** Although respondent B had a clear understanding as to why a business approach should be adopted, it was suggested that would-be users lacking experience with IS projects might not understand the importance of doing so. The need to adopt a business approach is supported by authors such as Markus and Tanis (1999) and Bradford and Roberts (2001). The research team responded by placing greater emphasis on the reasons for adopting a business approach within the methodology.

4.3.3 Outcome of the evaluation process

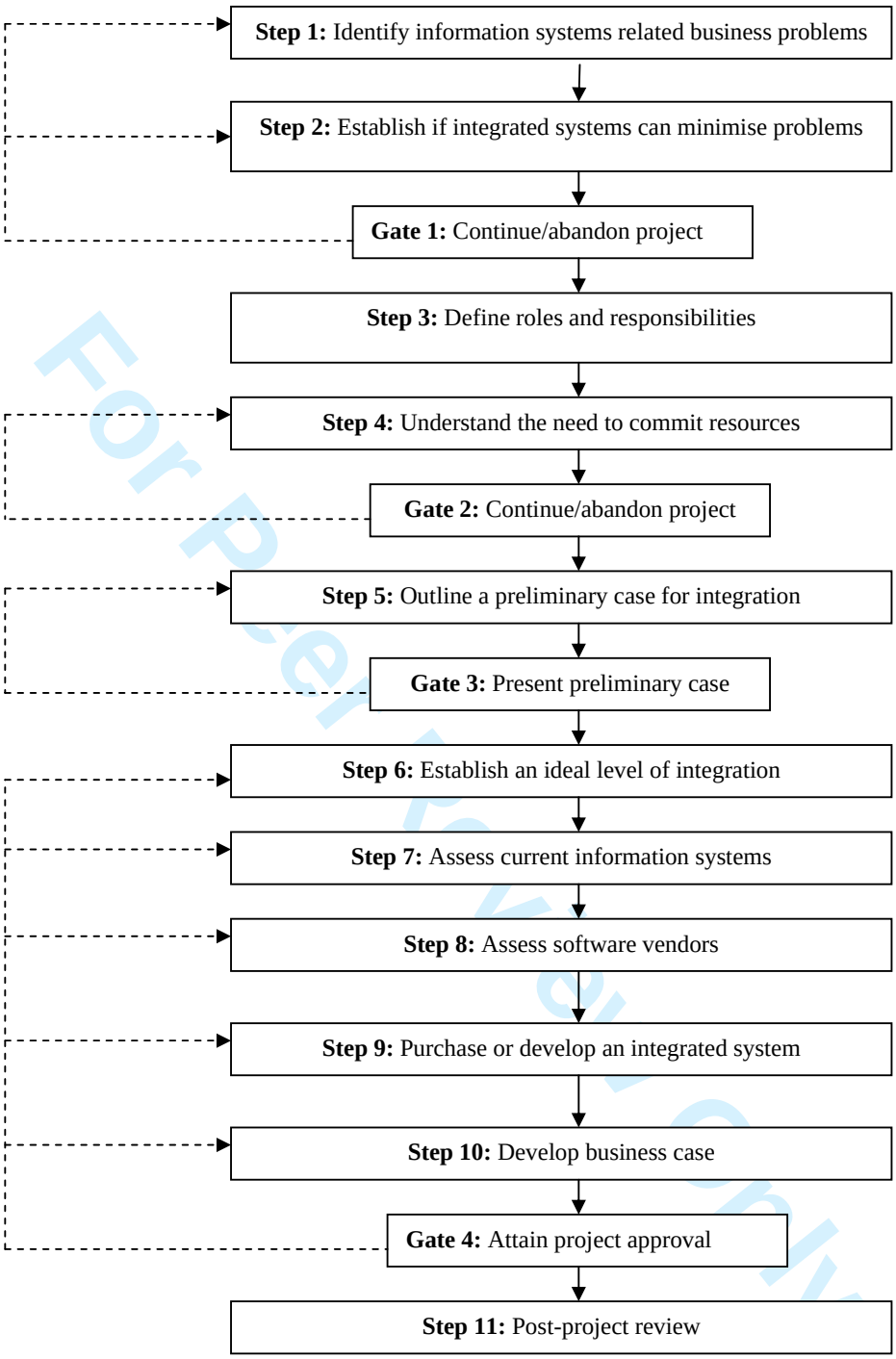
The evaluation process led to a number of alterations being made to the DSM; the most significant alteration involved the inclusion of two extra steps. One step was to define roles and responsibilities, which discussed team formation and the need to address any change management issues that might arise. The second step involved conducting a post-project review. Alterations were also made to a number of the tools and techniques, particularly the worksheets that needed to be completed for the early steps, and the worksheet for vendor assessment (Step 8). Tools and techniques, such as SWOT analysis, risk assessment, and Pareto analysis were also added as a result of the recommendations made by the experts. Other alterations were based on providing more detailed explanations for some of the statements made by the research team.

The following section outlines the workbook and the final DSM embodied within it that was developed as a result of the evaluation process described in section 4.3.2.

4.4 The final decision-support methodology

The final DSM consists of eleven steps, many of which are supported by worksheets and tools. Figure 2 illustrates the overall structure of the final methodology. Each of the eleven steps has an identical structure to that of the pilot methodology outlined in section 4.3.1. Companies might not feel confident of progressing through one or more of the eleven steps of the methodology and so provisions have been made to adopt an iterative approach. In order to assist with the iterative process, loops are provided within the methodology that enables previous steps to be revisited. Each of the loops occur at the four decision points or gates included within the methodology. The gates can be found following steps three, four, five and ten, and are as follows:

1 Continue or abandon the project (following step two)
2 Continue or abandon the project (following step four)
3 Present preliminary case to gain project approval (following step five)
4 Present final business case (following step ten)



Note: Feedback loops are represented by the dotted lines (- - - -).

Figure (3) The final decision-support methodology

Similar to the eleven steps, each of the four gates also has a consistent structure, as follows:

- Purpose of the gate – The reason(s) for the gate being present
- What is the activity – The issues that the would-be user needs to consider
- Outcome – The next step to be taken depending on whether or not the gate is passed

An overview of the eleven steps included within the DSM will be provided in the following sections.

Step 1: Identify systems related business problems

The aim of Step 1 is to identify those business problems that are caused directly by the IS currently in place in the company. Therefore, the methodology immediately ensures that the project will be business driven rather than IT driven. Step 1 consists of three tasks: (i) to identify the business problems, (ii) to identify IS-related reasons for the business problems, and (iii) to relate the business problems to the IS problems. Each task requires the would-be user to complete worksheets by responding to statements concerning the business and its IS.

Step 2: Establish whether integrated systems can minimise the problems

Step 2 ensures that integrated IS are capable of minimising the business problems affecting the SME. The tools provided for this step include a worksheet for identifying any potential business benefits, a SWOT analysis, and a risk assessment. In this step, SWOT analysis and risk assessment is used to highlight the overall benefits and problems that are likely to arise from an integrated systems project.

Step 3: Define roles and responsibilities

Step 3 consists of two tasks: (i) assemble project team and (ii) address change management issues. The purpose of the step is to ensure that all departments likely to be affected by the project are represented on the team, and that the team consists of those employees most capable of carrying out the project successfully. The tools provided include the crucial roles that need to be fulfilled for the duration of the project, such as steering committee and project champion, together with a description

of their main responsibilities and activities, such as empowering the team to make decisions. A checklist is included to help ensure that the crucial roles have been filled, and that the most suitable team members have been selected to carry out the project.

Step 4: Understand the need to commit resources

Step 4 comprises two tasks: (i) to consider the resources required for supporting integrated IS and (ii) to ensure that the project team is aware of the impact that increasing levels of integration is likely to have on resources. The project team is able to consider the financial, human, and IT resources required for supporting integrated IS. Resources to consider include costs for implementation and post-implementation depression, and the time required for carrying out an integrated systems project. It is important to consider such issues since higher levels of integration will require the commitment of higher levels of resources to support the project. Being aware of the resources required is likely to reduce the possibility of the team recommending a level of integration that the SME is unable to support. The tools provided for this step highlight the likely resources that will be needed for integrated systems projects, and the likely impact on resources as the level of integration increases. Step 4 is followed by a decision point, Gate 2: Continue or abandon the project.

Step 5: Outline a preliminary case for integration

This step involves developing a preliminary business case that outlines the reasons for recommending that the SME integrate its IS. It helps to ensure that sufficient business benefits have been identified in the previous four steps to warrant the possible integration of IS. It also ensures that the project team is fully aware of the resources that are likely to be required and the potential risks involved. The tools provided to assist with developing the business case include SWOT analysis and risk assessment. Unlike Step 2, the SWOT analysis and risk assessment tools are used to highlight the impact that increasing levels of integration are likely to have on the SME.

Step 5 is followed by the third decision point, Gate 3: Present the preliminary case to gain project approval. The gate aims to ensure that time and resources are not wasted on a project that is unlikely to add any value to the business. The gate also ensures that the project team has considered any potential advantages and disadvantages that could result from the project.

Step 6: Establish an ideal level of integration

Step 6 ensures that the project team attempts to identify an ideal level of IS integration (a level capable of minimising the problems affecting the business and at which the necessary support in the form of resources can be provided), and so the project team is encouraged to focus only on those IS that when integrated will help to minimise the company's business problems. The tools provided to assist the project team include a worksheet that highlights the business problems of the SME and the systems that need to be integrated. It is also recommended that the project team conduct a Pareto analysis to help identify the systems that are causing the most business problems.

Step 7: Assess current information systems

This step assists the project team to establish whether the company's current IS are capable of being integrated, i.e. whether or not they provide the desired functionality and compatibility. The reason for carrying out the step is that the integration of legacy IS might be a cheaper and less risky option that purchasing an integrated system from one or more software vendors.

Step 8: Assess software vendors

Step 8 enables the identification of a software vendor, or vendors, which can provide an integrated IS capable of meeting the requirements of the business. The assessment process reduces the risk of purchasing a system that the SME is unable to support (Bernroider and Koch, 2001). In order to complete the step, the project team is required to develop a request for proposal that can be used to outline the criteria against which an integrated system purchased from a software vendor can be selected. In order to identify suitable vendors, the project team requires access to resources such as IT publications, management consultants, and competitors within the same industry. The project team is also expected to obtain reference sites from any potential software vendors and to visit those sites so that the software can be viewed in a real world environment.

Step 9: Purchase or develop an integrated system

The purpose of step 9 is to help the project team to recommend whether the SME should develop an integrated system by programming links between its legacy IS or whether it should be purchased from one or more software vendors. The step highlights the three integration options available: integrate the legacy IS, purchase a system from a single software vendor, or purchase a system from more than one software vendor. In order to assist the project team, a purchase or develop tool is included that outlines the potential strengths and weaknesses of each integration option. Based on the relative strengths and weaknesses, the project team is expected to recommend the most suitable integration option for the company.

Step 10: Develop business case

The purpose of Step 10 is to develop a final business case that helps to justify the need for integrated IS within the SME. The business case brings together the information gathered during the previous nine steps. The tool used to assist with the business case is a worksheet containing the key performance indicators that can be used to identify how any potential business benefits will be measured. A computer based performance measurement model in SMEs environment has been discussed by Kueng *et al*. (2000).

The fourth and final decision point, Gate 4, follows step 10: Attain project approval. The purpose of the gate is to help ensure that the project team is able to demonstrate the need for integrated IS to senior management and to outline the business benefits that are likely to be received as a result.

Step 11: Post-project review

This step involves a review of the previous ten steps and the four gates. The purpose of the review is to provide an opportunity for the project team to address any outstanding issues and concerns that senior management and the finance department might still hold about the project. The review also represents a final opportunity to cancel or at least delay the project if any outstanding issues or concerns cannot be resolved. The project team is also able to assess what it did and did not do so well during the course of the project. Team members are therefore able to learn from their

mistakes so that they can be avoided on any future projects that they are involved with. The tool provided for this step enables the project team to outline any outstanding concerns, to nominate the employees who will resolve the concerns, and to provide details of the actions that will be taken in order to do so.

4.5 Methodology Scenario

The would-be user is expected to launch at Step 1 (Identify information systems related business problems) and conclude at Step 11 (Post-project review), particularly if the company has little or no experience with integrated IS projects. Rather than forming a project team from the outset, it is recommended that a nominated project champion carry out the first two steps. The project champion should have a good overall understanding of the business and its requirements. If the champion identifies sufficient business benefits afforded by implementing integrated systems, the project team should be formed at Step 3 (Define roles and responsibilities).

Under certain circumstances, however, it is possible to enter the methodology at different points. For example, pressure exerted by either major customers or major suppliers could force a company to enter at a later step although it is likely that some of the earlier steps will still need to be visited. For example, companies should find it beneficial to have an understanding of how to assemble a team capable of completing the project successfully, and the potential business benefits, resources, and risks associated with integrated systems projects. The methodology has been designed to provide users with the option of either complete the eleven steps or make an exit strategy at four decision points or gates.

5. Methodology Implementation and Benefits

This research project has developed a practical step-by-step methodology embodied in a paper-based workbook that can be used to assist SMEs with the decisions they need to make when considering whether or not to integrate their IS. The workbook is divided into three main sections. The first section provides an overview of integrated systems; the overview is aimed particularly at those companies that have little or no experience of such systems. The second section describes how to use the workbook and outlines the potential benefits of doing so. The third section presents the eleven steps of the DSM. The workbook also includes appendices that cover a number of

issues, including the implementation of integrated systems, handling consultants, and training.

Although the methodology was developed in collaboration with Agricultural Engineering SMEs, companies of similar size operating within other industry sectors should also find it useful. It is proposed that the workbook should serve as a reference guide that enables individual SMEs to make integrated IS-related decisions that are both well informed and reliable; it aims to support rather than replace decisions based on experience. It is anticipated that the would-be users of the workbook gain the following business benefits:

- Increased business awareness by providing an indication as to the type of questions that should be asked in order to improve the business position
- Reduced costs as a result of being able to undergo a self-assessment of the business without the need to hire external expertise
- Improved teamwork between departments
- Reduced risk through an improved understanding of integrated systems projects
- Establishing a level of integration that helps to minimise any business problems and which can be supported
- A possible quicker return on investment through the speeding up of the process of business assessment prior to undergoing the implementation of an integrated system
- Possible improved business performance as a result of identifying the information systems that need to be integrated.

6. Conclusions

Organisations continue to implement integrated systems, despite evidence suggesting that they might not always be appropriate for the business. Moreover, it is usually suggested that organisations should either consider integrating all of their IS or none of them. Therefore, an organisation's specific business problems and its level of available resources are rarely considered.

This paper described the development of a DSM for integrating IS within SMEs. The developed framework is composed of eleven steps that include identifying IS-related

business problems, forming a project team, assessing legacy IS and software vendors, and developing a business case that outlines the need for integrated systems within the company. The methodology brings together information gathered from published literature, SMEs operating within a number of different industrial sectors, and experts who have considerable experience of managing integrated systems projects.

The major benefit of the developed methodology is that it helps to overcome these problems by enabling companies to undergo a self-assessment process prior to making a decision on whether or not to integrate their IS. The self-assessment process also allows an organisation to select a level of integration that is most appropriate to the business. Therefore, it is possible that many of the problems arising from integrated systems projects can either be managed more effectively or avoided altogether.

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