

Managing Spreadsheets

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Fast facts

Spreadsheets represent one of the most popular applications on the planet. This is because they are the reporting and analysis tool of choice for many professionals and because they support collaboration and information sharing. Moreover, this is not going to change, not just in terms of existing business people but, as our children are being taught how to use spreadsheets in school, this popularity is likely to continue for many years to come: spreadsheets are ubiquitous and will remain so.

However, no matter the popularity of spreadsheets they also, used improperly or incorrectly, or without sufficient control, pose a greater threat to your business than almost anything you can imagine. They can give rise to compliance issues because changes to data are not audited. They can also be used to aid and abet fraud, because security is not applied to conventional spreadsheets and, again, because there is no control over the ability to change data values. Further, it is easy to make mistakes in spreadsheets (for example, by entering an incorrect formula) that can mislead decision makers, the results of which can be very expensive. HM Customs & Excise in its *Methodology for the Audit of Spreadsheet Models* says that “the complexity and functionality of spreadsheets has reached levels of sophistication that few could have imagined ... the consequent threat posed to businesses by such powerful ‘end user’ applications, mainly in the hands of untrained users, is immense”.

A major cause of these problems is that spreadsheets are not treated as an enterprise resource. For example, although there are (limited) security and auditing facilities in Microsoft Excel these are not usually enforced. Indeed, many users will not be aware that such facilities even exist. In the main, this is because spreadsheets are not perceived to be an IT resource but are seen to lie within the business domain. As a result, corporate security standards are not implemented for spreadsheets. On the other hand, the business is not aware of the potential dangers that the uncontrolled use of spreadsheets can cause. A major focus of this paper is therefore to make business users aware of these dangers so that they can push the task of managing spreadsheets in to the hands of the IT department. In particular, it discusses the need for spreadsheet management, precisely in order to prevent, or at least minimise, the issues just mentioned.

Having established the need for spreadsheet management solutions, this paper goes on to discuss what such a solution might look like. In fact, there are different approaches that may be taken, ranging from complete control (that is, you absolutely prevent people from doing what you don’t want them to) to complete monitoring with no control (that is, you monitor all changes but do not actively prevent any of them—rather like closed circuit TV). We will discuss the relative merits of these positions and when each of these might be most suitable (which will depend upon how spreadsheets are used and for what purpose). Unfortunately, at present there are very few vendors offering relevant solutions. However, there are many vendors promising (but not delivering) relevant solutions and we will discuss the sorts of facilities that any potential solution should provide.

However, as we shall see, there are no complete solutions available today and we will also, therefore, consider how organisations can optimally manage their



spreadsheet solutions, both in terms of the management procedures that need to be implemented and with the respect to those tools that are available.

One final point is that there is an inevitable congruity between the concept of spreadsheets on the one hand and Microsoft Excel on the other. Excel is, after all, the epitome of a spreadsheet application, and it is by far the most widely used. In general, where Excel is referred to in this paper it can be taken as a synonym for spreadsheet.



Spreadsheet problems

There are five major problems with spreadsheets: the potential for errors, lack of security, the absence of an audit trail, the misperception that spreadsheets are not an enterprise resource, and productivity issues. We will consider each of these in turn, before considering some other management issues related to spreadsheets.

■ Error potential

The following paragraph is excerpted from a PricewaterhouseCoopers (PwC) report published on the use of spreadsheets and the Sarbanes-Oxley Act, in July 2004:

“An article in the May 24, 2004 issue of *Computer World* indicated that, “Anecdotal evidence suggests that 20% to 40% of spreadsheets have errors, but recent audits of 54 spreadsheets found that 49 (or 91%) had errors, according to research by Raymond R. Panko, a professor at the University of Hawaii.” *The Journal of Property Management* on July 1, 2002 stated, “30 to 90 percent of all spreadsheets suffer from at least one major user error. The range in error rates depends on the complexity of the spreadsheet being tested. In addition, none of the tests included spreadsheets with more than 200 line items where the probability of error approaches 100 percent.” Perform an online search for *spreadsheet errors or spreadsheet audit*, and you will find a number of major failures attributed to spreadsheet inaccuracies that hit the press in the past year alone.”

This is not the first time that PwC has reported on the errors inherent in spreadsheets. In earlier work, the company reported that in a survey of large client spreadsheets it found that 90 per cent contained significant errors. KPMG Consulting, more recently, has reported that 95% of the financial models that it reviews contain material errors.

Of course, spreadsheet errors may be more or less important, depending on the spreadsheet in which they appear and the purpose for which the spreadsheet has been created. However, research has been done to establish the impact of errors in spreadsheets on decision making. The cost of these mistakes, according to a 1996 report, is within the range of \$10,000 to \$100,000 per decision per month.

There are four types of potential errors in spreadsheets:

1. Errors in the data—these can occur through:
 - a. Incorrect data entry—keyboard entry of data is to be avoided if at all possible: there are well-established error rates for keying errors, which are inevitable if data is to be entered manually.
 - b. Incorrect specification—for example, you want data in a particular cell to reflect a database field called “cust1” but have inadvertently



entered “cust2”. Similarly, if working with a front-end environment that supports Excel, you might have selected the wrong option for a drop-down list of relevant data sources. Of course, this is similar to incorrect data entry but it cannot be entirely eliminated.

- c. Incorrect definition—similar to incorrect specification, this occurs when you specify the wrong format for a field. For example, you define it as text when it should be a currency field.
 - d. Incorrect placement—this differs from incorrect specification in that the data you have defined is correct, but you have put it in the wrong place, as opposed to the wrong data in the right place. Note that incorrect placement is not limited to single instances. You may reuse a particular value in multiple places within a spreadsheet or across spreadsheets and the data may be in the right place in some instances and wrong in others.
 - e. Incorrect access—in spreadsheet reporting applications (as opposed to things like budgeting applications) it is often the case that data is loaded into the spreadsheet in some sort of automated way, either via an export to a CSV (comma separated value) file or, more directly, from a query environment. In these cases there is the potential to address the wrong data source, or to perform an invalid transformation as the data is loaded into the spreadsheet.
2. Formulaic errors—that is, where a formula is incorrectly expressed. For example, you might have “x” instead of “+”, with appropriately disproportionate results, or you might have added (or multiplied) the wrong columns. In the case of formulae there are basically three types of error: formulae that have been incorrectly worked out in the first place, formulae that are inaccurate because of keying errors and problems with cloned formulae. In the last case, for example, it is all too easy to clone a formula designed to sum 10 cells and put it at the bottom of a column with 15 cells. Some errors, but by no means all, may be detected by the spreadsheet software. Microsoft Excel, for example, will display (if appropriately set up) a small green triangle (with a pop-up comment) if it suspects a formulaic error.
 3. Macro errors—many spreadsheet users do not use macros but for those that do, this represents another major potential source of errors. Macros are, in effect, mini-programs and we all know how bug-ridden and error prone programs can be. While there is less scope for errors in macros, that remains a possibility that must be catered for.

There are, of course, a variety of other mistakes that you can make when using a spreadsheet. You can position columns inappropriately, it is possible to use inappropriate graphical methods for particular data sets, and so on, but these are mistakes rather than errors. What is important about errors is that they give you misleading information that can lead to poor decision making which, in turn, costs money: often lots of it.



Security

There is not a lot to discuss about spreadsheet security because there isn't any. Actually, that isn't quite true: Microsoft Excel does, in fact, have a password facility though it is honoured more in the breach than the observance. In practice, anyone can open up a spreadsheet, change the data to their heart's content and amend formulae. Anyone of malicious intent can deliberately induce errors in spreadsheets either because they have a grudge against the company or in order to support any fraudulent activity that they may be indulging in, or simply to gild the lily with respect to their own performance.

To take a simple example, you cannot go into your company's General Ledger and gaily change the figures therein: the software and its security will not let you do that. However, you can extract the data from the General Ledger into Excel and then you can change that data as much as you like. We cannot believe that such a *laissez faire* attitude to corporate data makes sense.

The other big problem with spreadsheet security is that there is no user-level access control. At present, even if you are one of the rare few that use passwords, once data is in a spreadsheet you can see all the data that is in it: you cannot then limit who sees what information within a given spreadsheet. This would not be acceptable almost anywhere else within your business. For example, you may let a manager see details of his department's total salary expenditure but you wouldn't let him or her see the salary information for each individual employee, but that is exactly what you can do using spreadsheets. You can, of course, hide data but then it is hidden from everybody (an invitation to fraud if ever there was one) but that doesn't get you further forward since what you need to be able to do is to allow visibility to what individuals are allowed to, or need to, see but not what they are not permitted to see. In other words, what is needed is full role-based security so that people can only see what they have the right to see.

Auditing

The third major issue with spreadsheets is with respect to auditing. However, like security, there is not much to discuss because again, while there is some capability, it is rarely used. In practice, you can log changes to a spreadsheet into a separate worksheet but this only applies on an individual spreadsheet basis rather than across the whole spreadsheet environment.

In other words, in most instances, not only can you not prevent someone from changing the data in a spreadsheet, for whatever purpose, but you also have no way of knowing who changed the data, when he or she changed it, or what the change consisted of. Indeed, you can't even tell that a change has been made at all!

In a way, this is much more serious than a lack of security (though the two go hand-in-hand in encouraging fraud) because it undermines any compliance or governance regulations that may be in place. As a general statement it would be fair to say that:



Any company that is subject to Sarbanes-Oxley or similar regulation, which uses spreadsheets for any purpose beyond very limited reporting, but does not use spreadsheet management, will be unable to comply with the strictures of those laws.

This is a pretty strong statement. But Sarbanes-Oxley requires companies to be able to justify what has happened to the data it presents in its corporate accounts and how it got there. If a spreadsheet is involved at any point in that process then, unless appropriate controls are in place (spreadsheet management), you will have a breakdown in the data chain where you cannot certify what has happened to the data. Note that it is by no means impossible to use spreadsheets within a compliant environment—but it requires management. Microsoft, for example, makes extensive use of Excel spreadsheets in its own internal compliance procedures. However, the key point is that Microsoft does use the management facilities in Excel and they are surrounded by appropriate additional procedures.

In fact, the issue is even worse than this. Spreadsheets are often passed from one user to another and the latter may well use the information in the original spreadsheet as a data source for spreadsheets of their own. Again, there is no way to track that this has happened. You can, in fact, prevent it from happening (you can lock the spreadsheet so that it cannot be forwarded, edited or even printed) by using Information Rights Management software but this doesn't help you to monitor what happens subsequently if you actually want to enable this sort of functionality.

Finally, Excel allows data to be consolidated from a number of sources into a worksheet. By default, it shows results but no formulae, with the consolidation taking place in memory. From an auditing and compliance perspective, this default setting should never be used as the data cannot be tracked and there is a high risk of error.

Spreadsheets as an enterprise resource

It should be clear that spreadsheets, or at least some of them, are vital to organisational wellbeing. In particular, those spreadsheets that are used to inform important decision making processes, or which are used for financial and other corporate reporting, or which are to be used in customer or other third-party presentations, need to be treated just like any other corporate asset. In particular, just as you would not implement a new application without testing that it did what it was supposed to do, all corporate (if not personal) spreadsheets should be tested prior to deployment. That is, sets of figures should be run through the spreadsheet to ensure that there are no formulaic, macro, placement, access or specification errors anywhere within the spreadsheet.

In other words, if it is accepted that spreadsheets represent a corporate resource, then all spreadsheets that do anything more than very simple reporting, should be subject to a quality control process to ensure accuracy. If, on top of that quality control, you can implement spreadsheet management procedures (especially simplified data access) then you will be going a long way towards eliminating costly mistakes from your spreadsheets.



The main reasons why spreadsheets are not recognized as being a corporate resource are varied. In the first instance, they are often simply dismissed as not really being a critical asset or as not suitable for investment (for user training or process assurance). In our view this is clearly a mistake, at least some of the time.

The second problem is that spreadsheets are used in different ways and by different people. For example, there are what we might term 'data collection' activities such as budgeting, which is driven by the finance department in this particular case, or by other relevant departments for different applications of this sort. Secondly, we have 'spreadsheet reporting', which is owned by operational groups. In effect, spreadsheets are treated as siloed applications, each of which is owned by its own clique, none of which relate to the IT department. This leads in turn to a third problem, which we might characterise by saying that while there is a technology gap in the sense that there is an inadequate environment provided for managing spreadsheets, there is also a cultural gap which means that users do not even employ what security and auditing capabilities are provided.

The bottom line is that there is a lack of ownership of spreadsheets as a whole, with no-one in the organisation being seen to be responsible for their use within the corporate structure. This needs to change if spreadsheets are going to be properly managed.

Productivity issues

Finally, another major issue is the time taken to manage existing spreadsheets. Even today, when these are not recognised as important enterprise resources, individual users have a considerable management effort involved in managing their own spreadsheets—they may need to discover the location of relevant source data, they may need to extract information from previous versions of a spreadsheet and perform reconciliation procedures, they may need to distribute their spreadsheets to colleagues (which raises the possibility of errors in distribution lists), and they will (we hope) be taking back-ups on a regular basis. We are also aware of environments where people have simply stopped using spreadsheets and moved to statistical packages because of the difficulty of managing complex spreadsheets.

Moreover, note that we are not talking cheap people here. The people who use spreadsheets are typically line managers on the one hand, and business analysts on the other. These are expensive personnel and it is wasteful for them to have to do these routines when such processes could be automated.

Other management issues

While the issues discussed above represent the main reasons for implementing a spreadsheet management application, there are, potentially, a number of other management issues surrounding the use of spreadsheets, which it would be useful to be able to handle. For example, it is often the case that spreadsheets exist within hierarchies and it would be useful if it was possible to easily view and maintain those hierarchies.



Another issue that commonly arises is that spreadsheets are used to extract data automatically from a source database, but that what you actually want is to combine data from various data sources. Management issues around this sort of scenario would be greatly simplified if you could access multiple data sources from a single spreadsheet, as you can with e.Spreadsheet from Actuate (www.actuate.com) for example.

A further complication is that most large organisations have probably thousands, if not tens of thousands, of spreadsheets distributed across the enterprise. Not only are these uncontrolled, they are unknown and not automated. Moreover, it is inevitable that much of the functionality embedded in these spreadsheets is duplicated which, in itself, is wasteful. A tool that can discover existing spreadsheets and bring some or all (according to user preference) of these into a single management structure will be especially useful for ongoing administration. Indeed, it is arguable that a product that only supports the management of new spreadsheets and has no facilities for bringing old spreadsheets into the new environment is only doing half the job, if that.

Finally, it would be useful to have comparison capabilities through which you could automatically compare different spreadsheets to ascertain where you have duplications or near duplications. In the latter case, a visual comparison or difference facility would be useful (similar to those provided in application development and change management environments) along with a merge facility.



Spreadsheet management options

Third party vendors relate to Microsoft Excel in a variety of different ways. At the lowest level, suppliers simply provide the facility to export data into a spreadsheet or, a slightly more advanced offering, the ability to print a formatted, static spreadsheet, where data values and formats are saved as an Excel file. In either case, this is usually done for one of two reasons: either to rectify some deficiency in the vendor's offering (such as a lack of graphical capability), or simply because customers like to be able to play around with the data in Excel. In either case, while there is some sort of guarantee that the data was accurate when it was initially loaded into the spreadsheet, all bets are off once the data has been exported (including, potentially, the introduction of new errors).

A more sophisticated approach is adopted by some vendors, which offer an Excel plug-in. The intention here is to lock-down data values sourced from the business intelligence or other vendor, so that these are dynamically related back to the source, and cannot be changed. However, this does not prevent specification or placement errors and it does not provide either security or auditing within the spreadsheet environment. Moreover, it is always possible to copy the data from the spreadsheet into another one (on a laptop, say), amend the data and then create a new spreadsheet on the main system. Similarly, you can also e-mail a spreadsheet to a colleague and, again, there is no control over what he or she can do with the data. In other words, this sort of solution has only limited value and does not prevent abuse.

An alternative adopted by some suppliers is to encapsulate spreadsheet capability into their own environment. This may be based on the fact that they have duplicated the Excel environment within their own system, or they may have licensed Excel and embedded it. In either case, the effect is that the spreadsheet is plugged into the vendor's application as opposed to plugging the application into Excel, as discussed above. The advantage is that the whole environment is as well controlled as any other facility provided by that supplier. In addition, these sorts of products often provide a facility to automatically manufacture and distribute spreadsheets to consumers, which improves productivity and reduces construction and distribution errors. It also introduces the opportunity to deliver personalised views of the data within the spreadsheet.

However, Excel is likely to be much more widely used in any organisation than any business intelligence product. In other words, the approaches just discussed only address that tiny corner of the spreadsheet problem that is pertinent to the business intelligence provider's solution and it does not cover anything else.

What is needed is a solution that spans all corporate spreadsheet resources. However, there are two elements in such a solution: one is with respect to spreadsheet management in general and the other is more focused on the detection and correction of errors. We will discuss each of these in turn.



Management solutions

The first possible approach to a full spreadsheet management application is what we might call “the complete control solution”. The idea behind this sort of approach is that you will fully control everything that is done within the spreadsheet environment. Using a role-based security system, you will apply locking down to cell-level, so that only authorized personnel can change data, and that is audited and logged when it occurs. Similar strictures can be applied to formulae and other facilities within the spreadsheet environment.

The alternative approach is the so-called “closed circuit TV (CCTV)” option as provided, for instance by ClusterSeven (www.clusterseven.com). In this approach, everything that you do is logged, every change to a macro or a formula, every change to the data, who did it and when. However, no attempt is made to prevent anybody from making such a change. In other words, this is auditing without security.

There are products in both of these areas though the latter are more mature than the former. This is not surprising, since auditing is not as onerous as security and auditing. On the other hand, because the CCTV approach is more mature, there tends to be more advanced features offered, such as automated spreadsheet discovery, macro management and so forth, which vendors of complete control solutions have not got around to yet. In particular, CCTV is able to discover and manage all existing spreadsheet resources. It can do this because it is non-intrusive, whereas complete control solutions have more work to do when encompassing existing spreadsheets.

Which approach to take will depend on individual preference but it seems likely that in the longer term most companies will want to have both security and auditing, rather than just the latter. Indeed, the CCTV market is primarily intended for users that deploy very advanced spreadsheet applications for mission-critical purposes (for example, in financial trading: if this stock moves by this much, then buy/sell). In these sorts of environments, spreadsheets are already recognised as a vital corporate resource, are fully tested prior to deployment, and are maintained and developed by qualified personnel only, so it is arguable that security is less of an issue in these sorts of environments.

Requirements for a solution

The table on page 11 shows the major features that we would like to see vendors provide in spreadsheet management solutions. We have divided these into ‘must-have’ and ‘advanced’ facilities, where the former are essential and the latter would be nice to have.

Dealing with errors

As we have noted, management solutions are one thing but dealing with errors is another. There are a variety of applications available for detecting and correcting



Must have features	Advanced Features
Role-based security down to the cell level	Federated availability for heterogeneous data source access
Locking: at the spreadsheet level, for data down to the cell level, and for objects including formulae and macros	Version control: comparison, difference and merge capabilities
Full audit trail for all changes, including macros	
Discovery capability	
Management and control of distribution	
Spreadsheet hierarchy management	
Support for IT-based testing of formulae and procedures	
Where-used capabilities so that you can track the use of data across spreadsheets	

Table 1: Features we would like to see provided in spreadsheet management solutions

errors in spreadsheets (for example, XLSpell from Sheetware, see www.sheetware.com). However, as with all software applications, it is much more efficient (and less expensive) to prevent errors rather than to attempt to detect them after the event. Indeed, HM Customs and Excise states in its *Methodology for the Audit of Spreadsheet Models* that “detailed testing can be extremely laborious” even when using the software that it supplies for this purpose (SpACE, see www.lexisnexis.co.uk/space)—and remember that you pay for this auditor’s time.

It is worth going into some detail with respect to this HM Customs and Excise report. It suggests that the auditor start by assessing the risk that is associated with each spreadsheet and to concentrate upon the spreadsheets that have the greatest implications for the business. This only makes sense. It then goes on to recommend that the auditor assess the degree of risk associated with each spreadsheet. It is worth reporting what the methodology has to say with respect to this:

- “If the developer does not fully understand the business, there is a **high** risk of errors in the logic and design of the spreadsheet.”
- “Are the areas for input of raw data segregated from the computational areas?”
- “Is there a separate sheet containing a table of contents and a description of the purpose of the model?”
- “What evidence of testing and other documentation exists?”
- “If testing was thorough, the risk of undetected error is **lower**. If testing of the initial model and/or subsequent amendments was sketchy or non-existent, the risk of error is much **higher**.”
- “You must consider the adequacy as well as the mere fact of testing as evidence that the model or application presents a low risk of error.”



- “Has the developer documented the spreadsheet, to make clear: what it’s for; what it does; how it does it; what assumptions were made in its design; what constants are used and where they are held; who developed it; when; when and how it has been changed since being brought into use; the presence and purpose of any macros?”
- “The better the documentation, the less scope there is for error or misunderstanding between the developer and the user.”
- “A good practice in design is to include the documentation as part of the workbook on a separate sheet.”
- “Again, consider the quality as well as the existence of documentation.”

We make no apologies for quoting from this at length as it effectively provides a best practice guide for building spreadsheets and for preventing errors. Moreover, in our view the sort of structured approach that is recommended for developers should be followed even if the developer and user is one and the same person. The guide goes on to suggest that if the spreadsheet passes these criteria then it should need no more than a routine audit rather than the detailed (and extremely laborious) testing mentioned above. In other words, this planned approach substantially reduces the likelihood of error.

Finally, note that Microsoft provides a number of facilities within Excel for helping to identify errors, such as the ability to calculate nested formulae one step at a time, to trace relationships between formulae and cells, and to watch a formula and its result in a cell. In other words, there are some features to support the testing of spreadsheets though one would not say that these were the equivalent to the sort of testing that would be standard for applications developed by the IT department, for example.

What you should do

We said at the beginning we would discuss hybrid solutions. You could argue that there is no such thing as a hybrid: you have security or you don’t, you have auditing or you don’t. However, in practice, companies need to do something about spreadsheet management, either in conjunction with the sort of tools that we have already discussed or as a stand-alone exercise. The steps that organisations need to follow include:

- Identify all the spreadsheets in your organisation: who owns them, what they are for, how widely they are distributed and so on.
- Prioritise these according to their importance to the enterprise both in terms of their impact on corporate strategy and their scope for aiding and abetting fraud.
- High priority spreadsheets should be tested, published and generally managed by the IT department.



- Medium priority spreadsheets should at least be server-based so that there is some form of central control.
- Where feasible store Excel data in XML format, so that you can validate fields and enforce integrity through use of an appropriate XML schema.
- The password and auditing facilities supplied within Excel should be used for all sorts of spreadsheets. Control over the use of macros (digital signatures and the use of trusted publishers) should be encouraged. Default settings that make calculations invisible should be turned off. Hiding of data should be discouraged.
- You may wish to treat older versions of spreadsheets differently from current ones. Clearly, there are fewer user obstacles to be overcome when applying security to the former. Versioning of spreadsheets is also something that you may want to explore.
- Publish best practise guides for users (based on the HM Customs & Excise model above)—there are many features of spreadsheet applications that users are simply not aware of. No doubt there are many users that would implement passwords if they knew about it.
- Consider the implementation of information rights management software so that you can limit the use of published spreadsheets.

This is by no means an exhaustive list and the implementation of these techniques will not take the place of either the management solutions we have discussed or the need for error detection and correction. However, implementing a policy for managing spreadsheet management is the first step that you need to take, and the points above represent some of the basic things that you need to consider.



Conclusion

In an ideal world one might design a new spreadsheet paradigm, based on appropriate industry standards, where all facilities were encapsulated into other query, reporting or planning environments, which provided the necessary security and auditing capabilities. Unfortunately, we do not live in such an idyllic setting: spreadsheets as they currently exist will continue to be used in their millions and any attempt to move users to another environment is doomed to failure. The challenge is therefore to provide reasonable management of spreadsheets without removing the obvious benefits to individuals.

If we accept the arguments outlined above for spreadsheet management (and we believe these to be overwhelming) then security and auditing must be imposed externally, without impacting on the user's ability to use Excel (or whatever) as he or she sees fit. As we have discussed, this can either be done through the provision of auditing on its own (where security is not considered an issue) or by a combination of security and auditing. There are very few such solutions available on the market at present, but we can expect to see more as time goes by. However, the emphasis for any product selection policy should be to ensure cross-functional and cross-application capability: what you don't want is a lot of separate point solutions (one for this BI package, one for that planning application, and so on).

Finally, while it is impossible to remove entirely the possibility of errors occurring in spreadsheets, it is possible to greatly reduce their likelihood. This can be accomplished in two ways: first, by treating spreadsheets as enterprise resources that need to be properly tested and checked prior to deployment and, secondly, by using tools that simplify the spreadsheet environment (particularly with respect to heterogeneous data access)—reduction in complexity should automatically reduce error rates.

To conclude, this is an emerging market and there are vendors that are taking different approaches, which are more or less mature. Which will best suit your company's requirements will depend on your circumstances but what is certain is that you should be considering spreadsheet management as a matter of urgency.

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