International Journal of Forecasting 29 (2013) 322–336

Contents lists available at SciVerse ScienceDirect

International Journal of Forecasting

journal homepage: www.elsevier.com/locate/ijforecast

Forecasting support systems technologies-in-practice: A model of adoption and use for product forecasting

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ARTICLE INFO

Keywords:
Forecasting support systems
Forecasting practice
Product forecasting
Software
Adoption factors

ABSTRACT

This paper examines the critical factors for the effective adoption and use of forecasting support systems (FSS) in product forecasting. The adoption of FSS has proved slow and difficult, and their use ineffective. In this paper, using the technologies-in-practice model developed by Orlikowski, and based on evidence from professional designers, users and organizational documents, we found that FSS adoption and use depend on certain situational factors, such as organizational protocols, communication among stakeholders, and product knowledge availability. At the adoption level, analysis shows that FSS are mostly seen as a means of communicating the forecasts effectively, and their outputs can be used as springboard for organizational actions. The findings provide foundations for an enhanced model of adoption and use for the practical development of FSS designs and services.

1. Introduction

Forecasting support systems (FSS) have recently generated a considerable amount of interest in both academia and industry. FSS, a specialized type of decision support systems (DSS), are designed to help forecast analysts, demand planners and other stakeholders to achieve accurate forecasts (Armstrong, 2001; Fildes, Goodwin, & Lawrence, 2006; Makridakis, Wheelwright, & Hyndman, 1998), especially as the business issues being negotiated become more complex. Though a large number of studies have touted the technology features and capabilities (e.g. Fildes et al., 2006; Fildes, Goodwin, Lawrence, & Nikolopoulos, 2009; Goodwin, Fildes, Lawrence, & Nikolopoulos, 2007; Küsters, McCullogh, & Bell, 2006; Sanders & Manrodt, 1994, 2003), an organizational perspective that explains the ineffective use and limited FSS adoption is missing from the forecasting literature. In addition, the adoption of such systems involves significant changes to organizations' cultures, business relationship structures and working practices (e.g. Dahlbom, Hanseth, & Ljunberg, 2001; Lindberg & Zackrisson, 1991). A number of commercial FSS packages promoting advanced statistical methods, increased forecast accuracy, and usable interfaces are available (e.g. Rycroft, 1999; Tashman & Hoover, 2001; Yurkiewicz, 2006, 2010; for a comprehensive review see Küsters et al., 2006). However, the practical usage and adoption of FSS beyond Excel has been minimal (Davis & Mentzer, 2007; Fildes et al., 2006; Goodwin, Lee, Fildes, Nikolopoulos, & Lawrence, 2006; Lawrence, 2000; McCarthy, Davis, Golicic, & Mentzer, 2006; Sanders & Manrodt, 1994, 2003; Smith & Mentzer, 2010; Webby, O'Connor, & Edmundson, 2005; Yusof, Aziz, & Davis, 2011).

Longitudinal reviews of the forecasting literature (e.g. Lawrence, Goodwin, O'Connor, & Onkal, 2006; Winklhofer, Diamantopoulos, & Witt, 1996) reveal that there is a paucity of studies explaining FSS adoption and use. Researchers have alluded to the importance of technical features such as forecast accuracy, the generation of confidence intervals, and facilities for user adjustments, but

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doi:10.1016/j.ijforecast.2012.11.004

no empirical evidence has been gathered explaining interactions among FSS users, the stakeholders involved in forecasting, and the organizational context. This gap in the literature has motivated this study, which aims to identify use factors which affect FSS adoption in product forecasting. The study examines the individual beliefs of two adoption stakeholders: FSS designers and users. We also collected and reviewed organizational documents used during the forecasting process, to examine their impact on FSS adoption. Various researchers (e.g. Chau & Tam, 1997; Cooper & Zmud, 1990; Fichman & Kemerer, 1993; Rai & Howard, 1993) who have studied information technology (IT) adoption suggest that resources, strategies, approaches to evaluating performance and tacit assumptions all affect IT adoption. In Information Systems (IS) research on user behaviour, intention models from social psychology have frequently been used as the theoretical foundation for determining user behaviour (e.g. Christie, 1981; Swanson, 1982). Among these theories are: the Theory of Planned Behaviour (TPB, Ajzen, 1991, 2002) and the Technology Acceptance Model (TAM, Davis, 1986; Legris, Ingham, & Collerette, 2003). Indeed, the TAM model has since been employed by Smith and Mentzer (2010) as an explanatory mechanism for evaluating performance, systems quality and the forecasting task.

The current paper takes a qualitative approach, using Orlikowski's technology-in-practice model (2000) as a theoretical basis to explain FSS adoption and use. This model is an adaptation of Gidden's (1993) theory of structuration, which positions IT at the centre of a process which structures organizational interactions (including human actors and information systems). The important point is that 'it is only when the technology is used in recurrent social practices that it can be seen to structure users' actions' (Orlikowski, 2000, p. 408), a structuration process of co-evolution of the material (e.g. the IS tool) and the social context of technology use. For example, in the case of modifiable, off-the-shelf technologies such as manufacturing resource planning (MRP), enterprise resource planning (ERP), and other similar systems, an organization typically purchases a core technology then employs either in-house developers or vendors to modify the technology for the organization's specific use. Because the developers and users of modifiable, off-the-shelf technologies tend to be closely tied, cycles of feedback between use and redesign should occur relatively quickly and be relatively easy to trace.

The structuration process posits that the process of technology development will reveal a considerable degree of openness and social contestation over the design, character and meaning of the technological artifact. Thus, technologies are seen to be characterized by 'interpretive flexibility', and various relevant 'social groups' articulate and promote particular interpretations of the technology. Giddens (1984) proposed the notion of structure (or structural properties of social systems) as the set of enacted rules and resources that mediate social action through three dimensions or modalities: facilities, norms, and interpretive schemes. The process of using technology involves users interacting with 'facilities' (such as the properties of the technological artifact, e.g. an MRP system), 'norms' (such as protocols of using the technology), and 'interpretive schemes' (such as the skills, knowledge and assumptions about the technology possessed by the user). Technologies-in-practice are the results of this interaction. The technologies-in-practice-model offers a focus on the human perspective to the study of technology 'in use' as distinct from technology as an artifact, an object, or an innovation (innovation-decision model, Rogers, 1995). The problems to be addressed are captured by the following research question: what FSS use factors lead to a more effective adoption for product forecasting?

The paper is organized as follows. Firstly, an overview of the background literature relevant to FSS for product forecasting is followed by a brief description of the research context and the study procedure. Next, we present a review of Orlikowski's technologies-in-practice-model and its main aspects and compare it with other adoption models offered in the IS literature. We then present the research design, followed by an analysis of the interview data and organizational documents' evidence through the concepts of the technologies-in-practice model. Finally, the findings are summarized and presented, and their significance and implications are discussed.

2. FSS overview for product forecasting: theoretical foundations

While FSS are primarily seen as a special type of DSS, the use of a FSS usually involves two stages (Fildes et al., 2006). The first stage involves the derivation of statistical forecasts, and the second stage involves various user adjustments that lead to the final forecasts. Primarily, existing research studies treat user adjustments as a *structural part* of the goal of producing accurate forecasts. Experimental evidence generally suggests that forecasters often make 'unnecessary' judgemental adjustments to statistical forecasts (Lawrence et al., 2006; Lawrence, O'Connor, & Edmundson, 2000). Lim and O'Connor (1996) found that forecasters were making damaging-to-accuracy adjustments (despite a computer display showing them that they were reducing the accuracy). However, when an adjustment is made on the basis of events which are not reflected in the statistical forecast (e.g. forthcoming sales promotions), the user adjustments are likely to improve accuracy as long as the information about the event is reliable.

Recent observations of forecasting systems in use (Fildes et al., 2009) have confirmed the importance of user adjustments in organizational forecasting. Specifically, the following issues have been highlighted: (i) users adjusted either the parameters of the forecasting method or its components (e.g. seasonal factors) in order to improve the method's forecasts of the underlying time series; and (ii) users often selected default parameter values or sub-optimal statistical methods. Fildes et al. (2009) also suggested that many organizations would improve their forecast accuracy if they followed basic principles such as limiting judgmental adjustments of quantitative forecasts, requiring managers to justify their adjustments in writing, and assessing the results of their judgmental interventions. Experimental evidence from Goodwin et al. (2007) also suggests that users adopted a wide variety of strategies when choosing a statistical method and applying adjustments (e.g. they often did not choose the forecasting method that provided the best fit to historical data, and made large judgemental adjustments to the statistical forecasts). Based on findings from the DSS literature (e.g. Sauter, 1997), Goodwin et al. (2007) argue that forecasting system designers should consider the ways in which individuals use their systems to produce forecasts. This is due to the fact that a mismatch between the software designer's model of how a system will be used and the actual use is likely to affect the system's functionality.

Smith and Mentzer (2010) argue that there is a dynamic relationship between the development of an organizationally-based FSS, the procedures that guide forecast development, and their fit with the capabilities of FSS users. The study by Smith and Mentzer is perhaps one of the few studies that places the role of FSS at the heart of organizational processes. Their study builds on the theory of Task-Technology Fit (TTF, Goodhue, 1995, Goodhue & Thomson, 1995) to evaluate the relationship between the skills/abilities of the individuals involved in forecasting, the task and system characteristics that support forecast creation, and the resulting forecast accuracy. Their model of forecasting task-technology fit (FTTF) supports a positive relationship between the system user's perceptions of the quality of, and their access to, the procedures that guide the forecasting task (user actions in relation to historical demand, and information related to product and market characteristics). For example, wholesale and retail forecasting tasks will be more focused on collecting historical demand data, whereas consumer product forecasting might focus on methods for collecting more specific demand data concerned with the influence of promotion and competitive pricing activities. Smith and Mentzer (2010) argue that the access to defined procedures and the perceived quality of those procedures are related to forecaster assessments of how the FSS supports their forecasting efforts.

Despite the positive results and better forecast performances obtained with FSS, widespread adoption has not been observed (e.g. Sanders & Manrodt, 1994, 2003). Based on survey data from 240 US organizations evaluating practitioners' use/satisfaction and their perceived performance of their forecasting software, Sanders and Manrodt (2003) found that: (a) 48% of practitioners used spreadsheets to develop forecasts; (b) 60% were dissatisfied with the current software and reported ease-of-use and easily understandable results as the most important software features; (c) 61% regularly adjusted the forecasts produced with software; and (d) commercial forecasting software users obtained improved and more consistent forecasts. Moreover, in many cases the adoption and use of FSS has to overcome various barriers such as insufficient knowledge of the use of FSS, a lack of training in forecasting methods, low support from senior management, and problems in integrating the software with enterprise resource planning (ERP) and other IT systems in the organization (Sanders & Manrodt, 1994; Sanders & Premus, 2002). For example, users – at an early stage of the current study – reported that they had to remember and recall knowledge about the products for which they were making the forecasts during regular use of their FSS: the product's stage in the lifecycle, price changes, upcoming promotions and events, and competitors' activities. This often results in an inability to analyze and use the information in the system meaningfully, an observation likely to lead to a reduction in forecast accuracy.

Overall, the literature review revealed that top management support, forecasting accuracy, effective adjustment capabilities, and integration with other IT systems are the main concerns for FSS adoption and use (see also Mentzer & Bienstock, 1998; Mentzer & Moon, 2005; Mentzer & Schroeter, 1994; Moon, Mentzer, & Smith, 2003). Social and organizational issues come second. This paper contributes to the existing literature by expanding on the factors that are postulated to enhance/inhibit FSS use. It does this by presenting new factors that augment our current FSS adoption for product forecasting.

3. Models of human interactions with technology in organizations

The past decade has seen the development of a number of structurational models of technology, which have generated numerous insights into the role and influence of technologies in organizations (Barley, 1986; Orlikowski, 1992, 1993; Orlikowski & Robey, 1991; Poole & DeSanctis, 1990; Walsham, 1993; Walsham & Han, 1991). These models posit technology as embodying structures (built in by designers during technology development), which are then appropriated by users during their use of the technology. Human action is a central aspect of these models, particularly, the actions associated with embedding structures within a technology during its development, and the actions associated with appropriating those structures during the use of technology. A number of researchers have proposed the further theoretical development of a structurational perspective on technology, suggesting that it may have considerable analytic advantages in explaining the consequences associated with the use of new and reconfigurable technologies (e.g. Roberts & Grabowski, 1995; Sproull & Goodman, 1990; Weick, 1990). For example, adaptive structuration theory (AST) examines how the structures that are imposed by technology recursively shape and in turn are shaped by interactions with users of that technology within a socio-technical environment (Poole & DeSanctis, 1990).

The technologies-in-practice model by Orlikowski (2000) which forms the conceptual framework of this paper is based on the duality of structure based on structuration theory, a social theory formulated by Giddens (1984). Orlikowski (1992) initially developed the structurational model of technology as an extension of Giddens' duality of structure (1984) to reconceptualise the nature and role of technology in organizations and for analyzing the interpretive flexibility of technology, where technology is both a product and a medium of human action. Drawing on the structurational model of technology, Orlikowski (1992) and Orlikowski and Robey (1991) constructed a conceptual framework to illustrate the recursive nature of technology design and use. In this paper, the focus is on the use mode of the FSS technology. According to Orlikowski (1992, p. 410), in the use mode:

'Human agents appropriate technology by assigning shared meanings to it, which influence their appropriation of the interpretive schemes (rules which reflect knowledge of the work being automated), facilities (resources to accomplish that work), and norms (rules that define the organizationally sanctioned way of executing that work) designed into the technology, thus allowing those elements to influence their task execution.'

While the notions of *embodied structure* and *user appropriation* have been extremely valuable in explaining the various outcomes associated with the use of given technologies in different contexts, they are less able to account effectively for ongoing changes in both technologies and their use. Orlikowski (2000) has extended the structurational perspective on technology by taking a more practice-oriented perspective. This complements the notion of embodied structure with that of emergent structure, and the notion of appropriation with that of enactment. While technology appropriation is defined as the use of cognitive and physical resources by individuals in their daily practices (e.g., it involves acquiring the necessary skills or developing competence in using the tool), enactment is the way in which knowledge and personal engagement are put into action (recognizing needs, articulating problems, contributing to solutions and analyzing the consequences) through social engagement. The enactment, in turn, changes the situation in such a way that new potentials are able to be constituted.

Orlikowski (2000, p. 406) argues that "assumptions of technological stability, completeness and predictability…are inappropriate in the context of the dynamically reconfigurable, user-programmable, and highly internetworked technologies being developed and used today". According to Orlikowski (2000, p. 410), this comes about because people "draw on their skills, power, knowledge, assumptions, and expectations about the technology and its use, influenced typically by training, communication and previous experiences". According to Orlikowski (2000), these structures are 'emergent' rather than 'embodied' in the technology and are studied as 'technologies-in-practice', that is, 'in use', to be distinguished from technology as a technological artifact. Orlikowski's theory (2000) regarding the practice perspective was extended in studies of an online health insurance company by Schultze and Orlikowski (2004), who found that technical features were appropriated by end-users for both intended and unintended purposes (p. 87). Moreover, Boudreau and Robey (2005), in their study of an ERP system implementation in a large governmental institution, found that improvised learning by end-users occurred when technology was in use, which they described as working 'around system constraints in unintended ways (reinvention)' (p. 3).

The emerging paradigm of understanding FSS adoption as a *process* often involves theory-building approaches that lead to the discovery of relevant social processes during the use of technologies. However, what is more relevant is that this approach accounts for the changes in working practices as theoretical mechanisms that explain the interactions between people and technological artifacts in a specific setting. We intend to capitalize on this approach in order to study FSS technology in context. This means that forecasting is seen as a socially constructed process that is used to legitimate certain organizational actions.

4. Research data and study process

We collected data from supply chain organizations using a combination of semi-structured interviews, and observations of actual FSS use. The data collected consist of audio recordings, user forecast reports, training documentation, and reviews of commercial FSS marketing brochures. The study was based on a total of 20 interviews (10 forecasters and 10 systems designers) with users having an average of 13.3 years of experience in using FSS. Thus, to ensure a rich data set and for purposes of comparative analysis, a range of informed forecasting professionals were consulted for their perceptions of FSS adoption and use. The people interviewed filled the roles of forecast analysts, finance analysts, and supply chain manager within their organization, while the designers have been responsible for designing and marketing their FSS. The users' organizations were located in the following five sectors: household goods, baby food products, pharmaceutical, medical technology suppliers, and consumer foods. As professionals, all of these participants had an extensive knowledge of FSS through development, usage, research or teaching. The data collected from the interviews were also enriched with a forty-five minute follow up demonstration of the way in which the particular FSS was employed by the users to address working requirements. The documents provided a source of secondary data for comparative analysis.

The interview guide was partially adapted from Mentzer et al.'s (1999) forecasting audit protocol to address issues of organizational forecasting, but this was further enhanced with questions applying to FSS specifically. Mentzer, Bienstock, and Kahn (1999) based their framework on the work of Armstrong (1987), Fildes and Hastings (1994), and Schultz (1984), as well as the findings from a 15-year, three-phase research program in forecasting management. To provide face validity, the questionnaire was reviewed and pre-tested with three senior academics in the area of forecasting to ensure that the questions were understandable and were presented in a proper manner. Any comments were used to improve the wording and flow of the items in the questionnaire.

In order to preserve the quality of the primary data, notes on each interview were written up and interviews were transcribed as soon as possible. This then formed the raw material for a detailed analysis of the users' and designers' working practices, following on the main tenets of the 'technologies-in-practice' model, and informed by the existing literature on forecasting. The results of this analysis are reported in the following section.

5. Findings for FSS technologies: technologies-in-practice and the adoption model

This section reports the designers' perceptions of the way in which the FSS were used in practice, the users' perception of how they used the tool, and the actual usage patterns that were observed. Also reported are the types of anticipated and emergent changes noted in the core organizations. Extracts of quotations from interviewees' accounts and extracts from organizational documents are provided as evidence. The analysis proceeds at two levels: we argue that the designers have two main beliefs as to the ways in which the FSS are used in practice, and follow this up with descriptions from users of five distinctive technologies-in-practice that they realize in the use of FSS.

5.1. Designers' technologies in practice: FSS as enablers for individual and collaborative use

Most of the FSS designers in our study had technical backgrounds, having worked as programmers, computer support staff, and forecasters for much of their careers. The FSS development was thus influenced by their strong views about demand forecasting and operational control, efficiency and accuracy, and their motivation to create a computer tool to support accurate forecasts. In that respect, the software designers were inscribing these properties into the FSS artifact. Their enactment of a technology-in-practice for individual use in order to achieve accurate forecasts thus modified aspects of the technology itself (through the addition or improvement of various features, such as user adjustments or customization of the databases), and strengthened the developers' belief in the value (both for themselves and users) of accuracy and the FSS role in facilitating collaboration between forecasters and managers. The following designer reported that the forecasting software offers the functionality not only to provide accurate forecasts, but also to effectively support organizational processes, meaning that the software becomes 'the enabler':

> 'The software helps you because it speeds up the process, automates the process, and it allows people to collaborate and share within the process, and allows you to do large volumes, analyze large volumes of information, so the systems is really the enabler.'

When focusing on the FSS adoption process, designers reported some problems of a technical nature, such as FSS integration with other IS in the organization, database productivity and configurable data management. The example below, noted by an experienced software designer, illustrates this FSS development practice:

> 'Probably the greatest influence (in FSS development) is that especially larger companies have a more professional IT department and they put a much greater investment in large corporate databases and that has forced us to spend most of our development time not thinking about forecasting at all but thinking about database productivity.'

However, the majority of the factors affecting FSS development had less technical sources. In particular, designers consistently reported the need for flexible and customizable reporting and effective user adjustments, as the following two interview extracts demonstrate:

> 'The one that is interesting from a design point of view are usually when people want more in the way of reports or different formatting of reports. Reports seem to be more important than a statistician would think they are.'

> 'Second step is to exert (produce) the forecast, and that could be model and overrides and all the work (that people have to do to produce accurate results). We always teach them that it's the statistics plus the judgment, never one or the other, and the software integrates that and there are all the tools to make that possible.'

While accurate forecasts shape the FSS technology-in-practice model of designers, this factor is seen within a context of the need to support parallel user activities, group forecasting and collaboration. In particular, there seems to be a close relationship between forecasts and business plans, where conversation and communication among stakeholders in the organization play a key role in forecast creation. For example, the following designer describes such a technology-in-practice:

> 'If, for example, the forecast department presents the forecasts and these are different from what the current plan (is), (or) if they are above, that's when the conversation comes into play, if they (the forecasts) are above the current plan. Does the company want to raise the plan, often they don't, because then they set the bar higher so they have to keep it at this higher level. If the forecast comes from the lower plan then management is nervous because now they start to look bad because the forecast is lower than what they previously committed.'

Designers have also been very specific on the factors that enable collaboration and group forecasting activities. In particular, most of the designers described such a technology-in-practice for FSS. Here follows an example from a major FSS development organization:

> 'First of all the forecast is not just looking at seasonality and trend. It is also to be able to incorporate all the key business drivers into the forecasting process. These can be price, advertising, sales, promotions, special events, regional demographics in the area, weather, and all those kind of things that add value to the forecast to be more accurate. That's how the real world operates.'

Overall, designers were concerned with the quality of the decision-making process, of which forecasting forms a key part, as well as with an integrated FSS that increases the transparency of information and eases effective forecast analysis. We have also noted that designers in our study described FSS reporting and user adjustments as capabilities for *individual* use. While the designers were indeed aware of developing FSS for both individual and collaborative technologies-in-practice, the politics surrounding the forecasting review meetings taking place within the organizations were not part of their FSS development concerns.

5.2. Users' technologies-in practice

Users expanded on a fundamental set of technologies-in-practice by including in their forecasting task design obtaining information from their customers and market knowledge from sales people, and their hesitancy to use advanced statistical models and FSS features (relying on the ones most commonly used within the organization). Also identified was the reluctance of some users to spend time in forecast modeling for products that were not important for the organization and their reliance on 'gut feelings' and accumulated market knowledge for creating their forecasts. Many of these issues were of a social and organizational origin, rather than being associated with the FSS technology alone.

5.2.1. Adapting FSS reports of technology-in-practice for use in organizational review meetings

Users had given some thought as to how they would like to adapt the FSS so that more complete records of their activities and colleagues' and clients' participation in the forecasting process could be kept for the forecasting meetings (a typical report is shown in Fig. 1). They explained that, in the forecast reports produced outside the FSS, they can record what is recommended to the company by clients, which products have had major forecast inaccuracies in the previous months, the assumptions used, the product price, the adjustments made, and the actions (marketing, advertising) that should be followed based on the forecasts. Interestingly, the forecast reports were also used to capture the participation or absence of various stakeholders in the meetings, a working practice with important implications for the final forecasts.

In this way, the users could maintain more complete records of the forecasting process and the assumptions embedded in the forecasts. For example, one of the users noted that the FSS reports were not product-specific and that the forecast assumptions (information from the market used) could not be recorded. This was led to the discovery that several users were initially unaware that the reports available with from FSS could not be modified in order to be used in subsequent meetings during the forecasting process (as the extract below highlights). In particular, the users listed four main reporting needs: information on the forecast assumptions, the advice obtained by colleagues, information from sales people and clients, and proposed organizational actions.

> 'What else would I like? I think I have a bit more of a problem with the way you can report from it (FSS). I don't think you can produce flexible reports, some sort of report designer I would like so that you can design your own reports.'

Some users valued the forecasting models embedded within the FSS, while others used FSS as a tool for learning about their products, market assumptions and other aspects of responsible forecasting management. For example, one of the users (a mathematics and business graduate) had been using the FSS intensively and with confidence. However, he considered the FSS statistical models to be often unreliable, since the information/advice he was gathering from sales people who had a local knowledge of the market was often very different. In summary, users felt that credible forecasts and forecast reports are very much dependent on reliable advice and information from sales people and their clients. Importantly, the FSS could play an important role in capturing these sources of knowledge prior the forecasting cycle. This evidence from individual users suggests an expanded technologies-in-practice, compared to that implemented by the designers, a technology which embraces effective product management, the capturing of colleagues' advice, and the use of market knowledge in organizational meetings (described by designers in Section 5.1).

5.2.2. Collective problem-solving technology-in-practice: the one consensus forecast

Forecasters used the FSS for coordinating and scheduling their forecasting activities, as well as maintained a variety of electronic reports within FSS databases. Most of the users frequently exchanged information about forecast problems, solutions, and new events that may influence their next forecasts. Some had also created their own lists of products and annotated significant events, using features that allowed the customization of report templates. Moreover, forecasters used many of the features of their FSS to promote collective forecasting work, embed local knowledge into their forecasts, and cooperate with each other. They also modified the technology over time as they created or customized these product databases. In this recurrent practice of technology use, the users drew on their detailed knowledge of products, and used this local market knowledge to interact with FSS by making adjustments, editing forecasts and sales history, and customizing reports or designing their own reports (outside the FSS).

This recurrent user activity enacted a set of rules and resources which structured users' work in terms of cooperative troubleshooting and forecasting knowledge sharing, while modifying the technology itself (by adding content, creating new product databases that were meaningful to users, and customizing report templates). In turn, this technology-in-practice of collective problem-solving reaffirmed the value of cooperation within the organization and reinforced (together with the planned forecasting review meetings) their established cooperative work practices and norms, further encouraging the users to continue using the FSS to maintain a functional organizational forecasting process. The following user summarized this technology-in-practice very concisely:

> 'Yeah, I mean there are occasions when we sit together for an hour and at the end of it we decide to change nothing. We still, however, have gone through the discussion, and most of the time we feel that's a benefit.'

In particular, users promoted a collective problem-solving forecasting process, where knowledge sharing and advice is extensive. As such, the FSS played a key role in shaping a shared forecasting meaning and in fostering social interactions among relevant stakeholders involved in the forecasting process. This is reflected in the outcome described by the following user:

> 'We are almost ending up with one forecast now, which is in turn the latest thinking.'

The final FSS forecast is designed to achieve organizational consensus through processes of negotiation, persuasion and debate. Moreover, FSS users repeatedly reported using the default forecasting method (see Fildes et al., 2006) or the one usually applied by the organization

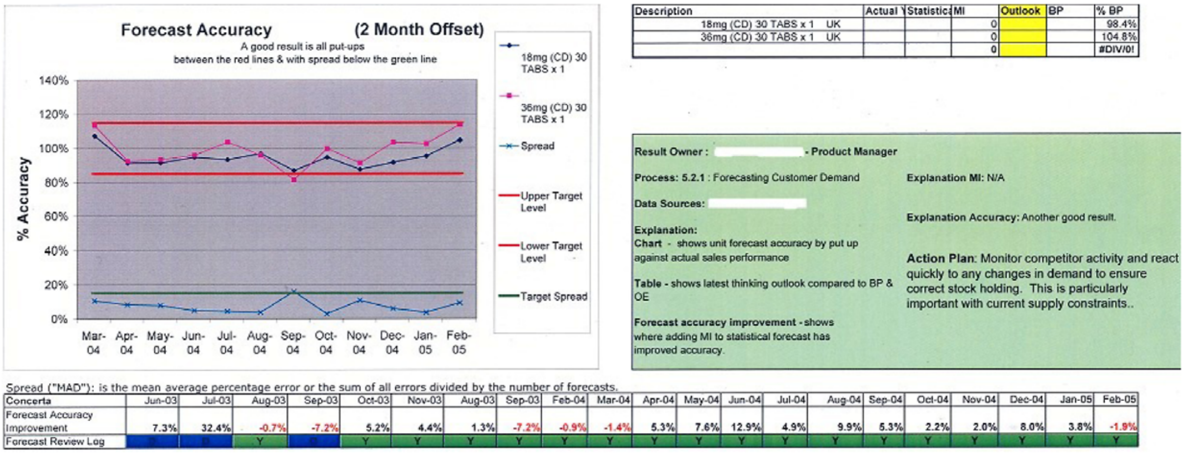

Fig. 1. Actual report used in forecasting review meetings (made anonymous).

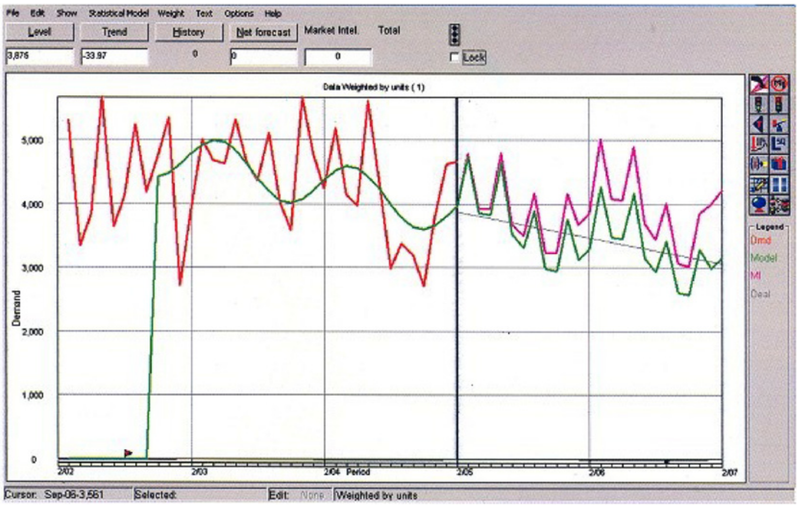

Fig. 2. Limited use of FSS for data display—screenshot.

to forecast the products, while not using the many other FSS design features that were not familiar (see Fig. 2).

In other words, the users focused on the elements they needed to get their forecasting task done and ignored the majority of other FSS capabilities. Interestingly, the 'forecasting task' included elements of the organizational forecasting process, rather than just the development of the statistical forecast itself.

As such, this FSS technology-in-practice was previously described by the software designers (see Section 5.1). It was a structure where the FSS was an 'enabler', supporting the forecast analysis and collaboration, and this was both shaping and shaped by the forecasting process. FSS users thought that the technology was useful for problem-solving forecasting, but very limited in providing an extensive framework for an organized integrated forecasting activity. We will now proceed with user reports and our observations of three enacted distinct technologies-in-practice that further clarify the individual and collaborative aspects of FSS adoption and use.

5.2.3. Limited-use technology-in-practice: user training and standardized organizational processes

The most common technology-in-practice we observed with the users in this study involved a limited use of the FSS (see also Goodwin et al., 2006), and was enacted by users at various different levels of the organizations. Such use of FSS was minimal, even perfunctory, and involved opening the forecasting program a few times a week, rarely or never checking the forecasting models and the assumptions, and only occasionally accessing the decisions of previous review meetings or downloading information from the web (e.g. related to the weather or other factors that could potentially affect the next forecasts). More often, the FSS was used as a data storage tool and its use was limited to projecting 'base-line' statistical forecasts. Equally, FSS advanced features (e.g. causal models, different ways of visualizing the data and forecasts) were not used and most of the users did not experiment with them at all. The following user describes such a process which clarifies this technology-in-practice:

> 'Yeah, so you can have slam charts and you can have the main units, or cash. You can group them together so you have got a number of products together there are things like that you can have a bar chart, but we never use any of these graphs that you can get here because we have very specific requirements.'

Our data and analysis suggest that this technology-in-practice was enacted for at least two reasons. First, some users mentioned that the people who participated in the forecasting process had different expectations and interests in the forecasts. Second, the design of the organizational forecasting process itself imposed specific requirements of the final forecasts. Some of these users based their skepticism on the view that the FSS primarily facilitated a statistical forecast, while their work was effective management of the organizational forecasting process. Interestingly, the organizational requirement was to deliver a reliable forecast, as the following user extract reveals:

> 'Everyone wanted something different, so we then decided as long as you have a process, and whether or not you use a piece of software is up to you but we need you to deliver a reliable forecast to use in production and that was really the challenge that they put on us.'

The skepticism felt by these users was exacerbated by their limited knowledge of and experience in using FSS functionality. The training sessions they had experienced about their FSS dealt with the mechanics of using the software and were abstract and fragmented, as the following user comment suggests:

> 'I learnt by the student. I took over from her. Basically she showed me the basics sort of whirlwind two or three weeks where she had to show me everything else as well. And then by picking up five minutes with Lyn ten minutes from Geoff, just picking up bit by bit.'

The collaborative aspects of FSS were not highlighted and there was little or no illustration of how FSS could be used in the organizational forecasting process. Moreover, as Goodwin et al. (2006) highlighted in their interpretive study, the decision to adopt a FSS was based on market pressures, while the selection criteria were mostly focused on the FSS capabilities of each package, rather than, for example, usability and user experience, or integration with other collaboration tools in the organization (see Asimakopoulos, 2012).

Thus, the training in and use of FSS were very limited, and, in retrospect, users remained skeptical and unmotivated to spend much time learning the technology, beyond the requirement to produce a 'base-line' forecast and a forecast report. The users we interviewed/observed also accessed FSS for a limited time every week, usually just to check whether there had been any changes to the business plan or any event that significantly affected sales demand. In this case, face-to-face interactions with product managers were preferred for discussing these changes. In this recurrent practice of technology use, the users drew on their organization's focus on the most *important/highly valued products* and *effective alignment* with the latest business plan. The limited knowledge of FSS, and their view of it as 'simply a tool for solving a forecasting problem' enacted a set of minimal rules and resources which barely influenced their existing work practices and did not alter the use of FSS technology.

In turn, this limited-use technology-in-practice, because it provided the users with little value, strengthened the users' assumptions and experiences of FSS as less than useful for their forecasting work practices, and reinforced the organization's orientation to wider supply chain management issues. In this recurrent practice of technology use, users drew on their knowledge of organizational institutional practices (in particular, the norm of a standardized forecasting procedure), and their limited ability to use FSS features and database properties, to enact a set of minimal rules of interaction with the FSS, which had little influence on their existing work practices.

5.2.4. Individual user productivity technology-in-practice: adjusting and communicating the forecasts

While the limited-use technology-in-practice was predominant among some users, another technology-in-practice emphasizing individual productivity was also evident in the practices of a different set of users. This set of users viewed their FSS as an opportunity to enhance their own individual effectiveness by speeding up existing ways of doing things, such as producing forecasts using different forecasting models, or adjusting the forecasts based on market knowledge and their own expectations. One typical user who worked as a supply chain analyst described their use as follows:

> 'Then I look at it and say the last time you only sold 25.000 and justify why they think they are going to put 40.000 and then we usually ring up the customer and if the customer sometimes say ah yes I want to do this then we put our own interpretations on it we will plan what they say and then in the first week if it's not been taken off like that to what they said we will adjust the forecast. Sales people also give me information about promotion and anything that drives sales for new and existing products.'

Thus, a few forecasters used their FSS regularly to perform activities which were previously only possible on paper or with other media. Some users also used FSS to access customers' databases and obtain product information, which were previously available on paper. This technology-in-practice involves other stakeholders and is mediated by FSS use, as this user account indicates:

> 'We speak to the customers as well the information we usually get is from the customer (and making it available for analysis to the system database), the important customers put the orders on, the week before promotion, how much do you think they are going to order, they usually have an idea of what they going to sell, sometimes they are completely wrong, we have to use or own judgments on that.'

Because these uses of FSS may automate established practices and lead to increased efficiency, they do not violate institutional norms, and they do establish users' professional positions within the organization. Indeed, these users believed that their use of FSS enhanced their personal productivity, while enabling them to produce *credible* and *reliable* forecasts.

In this recurrent practice, users drew on their knowledge of organizational culture and their moderate knowledge of FSS functionality, and engaged specific features of the FSS (databases, parameters and promotional information) to enact a set of rules and employ resources, which increased their individual productivity and incrementally modified the technology (via customizations of the system content). The following user provides an example of the way in which she was using the FSS 'edit promotion' feature not only to include promotional effects in the forecasts (the original purpose of use) but also for product phasing:

> 'The first week the orders are massive so we are trying to get it through the supply chain but I can't put that in, I can't put buying orders.'
>
> Researcher question: How do you deal with this situation?
>
> 'With the edit promotion, but this bit is only supposed to be for promotions, but we are using it also for phasing.'

In turn, such a technology-in-practice of individual productivity, because it provided demonstrable improvements in forecast effectiveness and efficiency, supported these users' view of FSS as an effective tool for personal productivity gains, while reinforcing the communicative and collaborative aspects of the organizational forecasting process (in user terms, to change the forecasts and make everybody aware of the revised forecasts in the supply chain).

5.2.5. Forecasting process support technology-in-practice

Users' initial use of FSS enacted a technology-in-practice of organizational forecasting process support. Such a recurrent practice of technology use involved three primary activities: effective transmission of organizational protocols and requirements, use of available product knowledge, and organizational actions based on the forecasts. As was described in Section 5.2, users reported problems due to the protocols that had to be followed during the forecasting process. This often caused users to face difficulties in documenting their work process, and entering all information they received about potential problems when interacting with the FSS to produce their forecasts. Fig. 3 presents an organizational training document which highlights the linear and ordered steps when using FSS and the forecasting protocols that designers expected users to follow.

Even worse, users were often unable to maintain a complete trace for issues which might have had impact on the forecasts, and thus distinguish product knowledge that could be helpful in resolving these issues. The following two examples from an experienced FSS user highlight both the issue and the difficulties of using the FSS to resolve it:

> 'I think the other issue we have is we've mentioned many times is the cross border trade element where the business is growing but it's being counted offset by business coming in from elsewhere.'
>
> 'We could forecast the growth of cross border if we play around with (the FSS) enough, just treat it as a different SKU, but that's not easy to do (due to the heavily standardized forecasting procedure).'

As product managers, the members of the organization were knowledgeable about the market conditions in general, as well as the FSS capabilities in particular. Moreover, the use of FSS for documenting and capturing important forecasting problems was not supported by other users/departments in the organization, which were often not willing to share knowledge during the forecasting process. The following user vividly describes this aspect of FSS use, which has significant implications for effective adoption:

> 'This previous information tells me nothing about where this forecasting should be going from my point of view just looking at it visually. And I don't have the marketing expertise to know about the market conditions, how heavily the product is promoted, in order for me to make a judgment about where this product should be going. Would be nice if we had in the background some sort of indication (from other users and in particular the marketing department) as to where this product is.'

Users' ongoing enactment of the organizational process-support was further reinforced by actionable points which redefined the criteria used to assess forecasting performances and the meetings' outputs. The user in the following extract demonstrates a potential FSS improvement considered through better support of this technology-in-practice:

> 'I'd like to have a button where you can say show reports, what do you want to include on the report, and you can say history, for example, of the last two months. And the same with the forecast going forward for one year, two years, or three years.'
>
> Researcher question: Maybe if you can write some basic notes, type in some information, too?
>
> 'Yeah, so in the report you have some text, yes, that would be very useful.'
>
> Researcher question: So you will have the graph, the market intelligence and then you deliver it to the people for the meeting.
>
> 'Everything you have here is fixed, you can't change it at all, you have that report but you know, very good point. If there was just a text box there you could type in your text to back that up.'

Users modified the reports to include the use of FSS for the entry and documentation of events and promotions, ensuring the quality of the decision-making process, and the reuse of previous actions based on the forecasts. The following example illustrates the way in which scripts enabled the user to automate different forecasting tasks, and thus effectively support the organizational process:

> 'I'm sure this (FSS feature) produces some summaries but it doesn't produce them how I want them to look and I want to be able to do them myself. And one thing it does which is really good is automated scripts so you can write scripts and then you can put them together

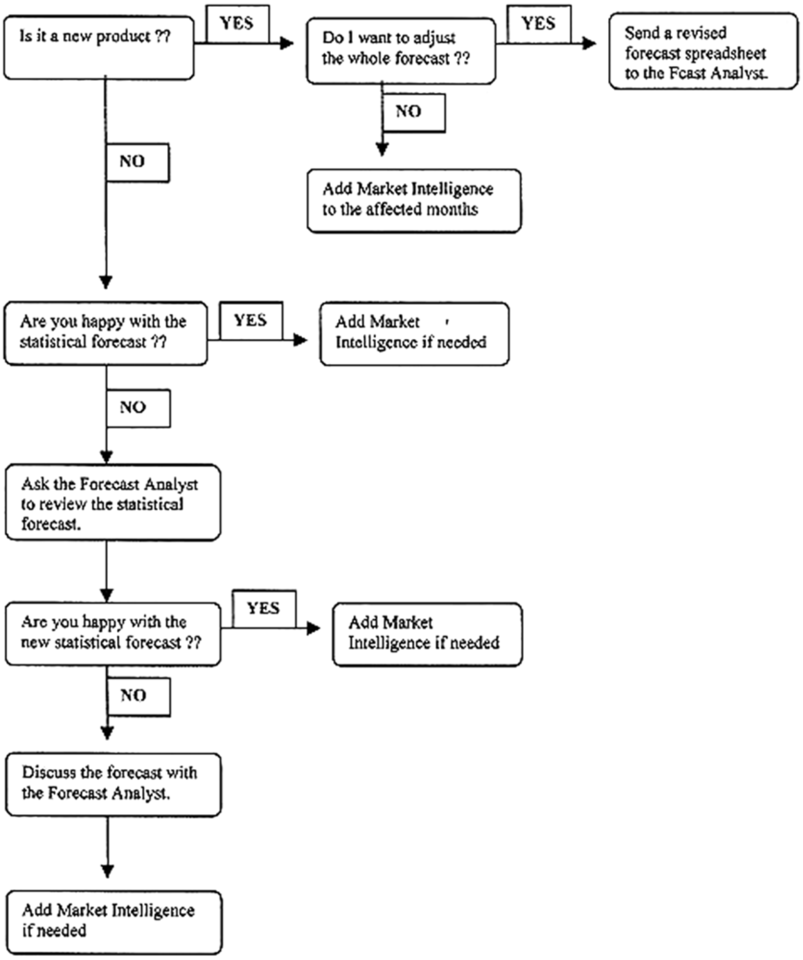

Fig. 3. Organizational document used for FSS training and application.

into batch jobs and it runs a lot of jobs together. How we use this at the month end. I wrote a number of scripts for Geoff and put them into two jobs which was sort of two or three hours off the monthly process, because you can just hit a button. I mean that's useful but it's not everything in there that we want to do so I would like there to have more ability to write scripts.'

FSS scripting and documentation properties enable the appropriation of a set of resources which provided support for users' work, and ultimately for the organizational process. In this recurrent practice of technology use, FSS users drew on their knowledge of the organizational norms, the need to transmit specific organizational protocols effectively, and the importance of some products for both the organization and their clients.

5.3. Summary of the findings

Taken together, these empirical illustrations show that users enact different technologies-in-practice using FSS technologies across various organizational processes. We have seen that they do so in response to various technological visions, and opportunities embraced by the designers, influenced by specific interpretations and particular organizational requirements, and shaped by a diversity of practices for collaborating, solving forecast problems, improving individual productivity and effectiveness, and supporting forecasting work processes. These technologies-in-practice are structures which are enacted through the recurrent use of a technology. They are not embodied within the technology; rather, they emerge from the ongoing and situated interactions that users have with the technology at hand (Orlikowski, 2000). The FSS adoption model (see Fig. 4) emphasizes that the 'integration with other IS systems or database productivity' does not seem to be the main stimulus to FSS adoption, while the 'effective communicative structures' and 'forecasting process support' are the main factors that influence FSS adoption. Fig. 4 summarizes the model that has emerged from our study of users' and designers' reported facilities, norms, interpretive schemes and the general FSS adoption/use model.

Thus, in the case of FSS designers, we see that they drew on their earlier experiences of different technologies, their visions about the prospective use of FSS, and their knowledge of software design and programming, to

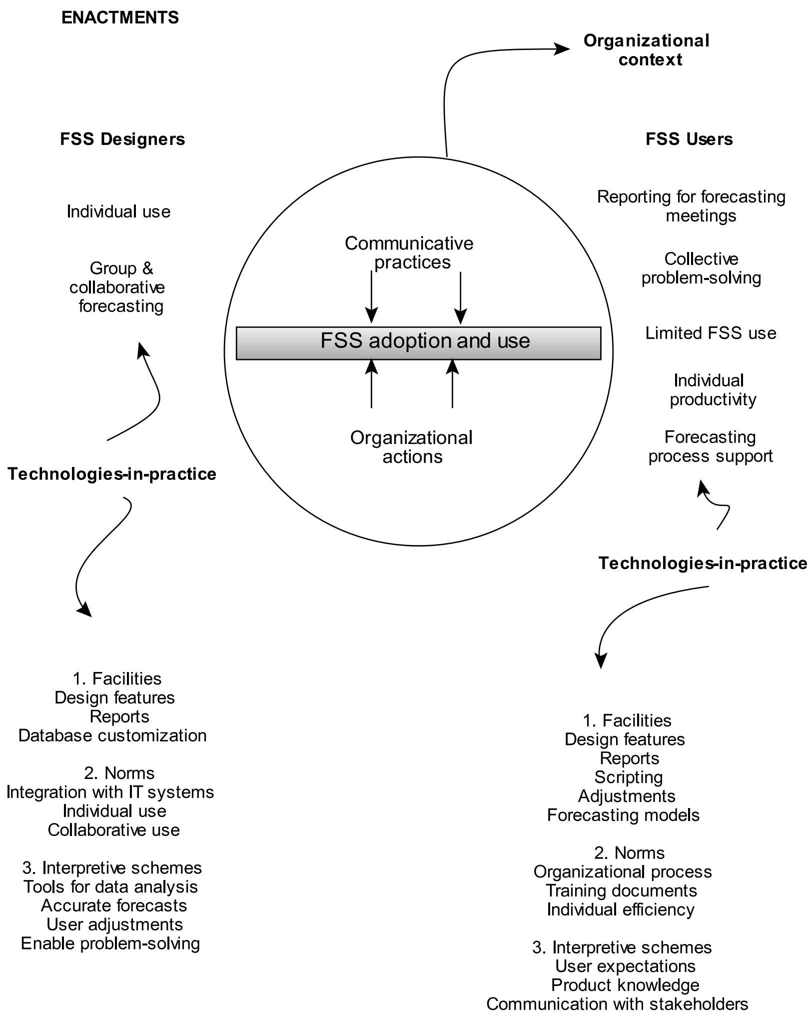

Fig. 4. Summary of the FSS adoption and use model.

enact an individual/collaborative optimum technology-in-practice as rules and resources for their FSS development efforts. In return, users influenced by an organizational context that supported individual productivity in forecasting, recurrently enacted a technology-in-practice that engaged many of the collaborative and design properties of FSS as rules and resources for efficient problem solving. Interestingly, some users recurrently enacted technologies-in-practice that engaged very few of the FSS design features as rules and resources for either limited use (see also Goodwin et al., 2006) or individual productivity gains. Finally, another set of users endorsed a view of a FSS that supports the organizational process and is guided by products' importance for the organization. These recurrently enacted technologies-in-practice included many of the collaborative properties of a FSS for effective forecasting process support. Based on the adoption model advanced in this study, it could be argued that the technologies-in-practice are shaped to a large extent by various user communicative practices and can be used as a resource for organizational actions.

6. Discussion and implications

The current paper outlines a technologies-in-practice model for FSS adoption and use based on evidence from FSS designers and users working in different supply chain organizations. The findings have suggested specific technologies-in-practice regarding FSS use and adoption, and a forecasting process which is contingent on organizational actions. The study provides several theoretical contributions to the existing body of FSS research. First, our findings indicate that the relative advantage of FSS is determined by the enhanced availability of the technology for different communicative practices employed by users during the forecasting process, a unified technology that enables different stakeholders to communicate their views on forecasts and agree on specific actions. FSS are also place and information dependent, since different customers, business partners and sales people are continuously proposing new information and forecasts based on local market knowledge.

Our findings thus suggest a need to conceptualize technologies-in-practice in order to capture the specific forecasting knowledge exchanged for communicative purposes when FSS are adopted and used. This need is supported by Orlikowski and Iacono (2001), who propose a shift from general adoption models to theories that capture the distinctive characteristics of specific technologies. To guide future development regarding the knowledge of FSS for specific communicative practices, we propose the following research question:

Q1: Is the forecasting socio-contextual knowledge (e.g. competitors' activities) construct a powerful factor in predicting FSS adoption in addition to forecasting accuracy and integration with other IS systems in the organization?

Second, the results of this study suggest that organizational and situational factors impact the decision to adopt and use FSS. The findings of this study, as well as evidence from previous research, suggest that situational factors may be important determinants of FSS adoption and use (e.g. Asimakopoulos, Dix, & Fildes, 2011; Asimakopoulos, Fildes, & Dix, 2009). Regarding the conceptualization of use situations, some of the situational factors found in this study, such as the lack of training, low managerial support, and limited FSS use, fir with the findings of Fildes et al. (2006), Goodwin et al. (2006) and Sanders and Manrodt (2003), and thus confirm the importance of these factors for product forecasting. From a methodological perspective, our experiences indicate that the technology-in-practice model can be used to explain FSS use situations for product forecasting. A research questions could be:

Q2: What are the effects of different situational factors on FSS adoption compared with other IT adoption determinants?

Forecasting systems for product forecasting pose several challenges to human–computer interaction (HCI) research, from the complexity of issues in the supply chain context and the organizational aspects of using forecasting information and knowledge, to the more common user interface aspects of designing effective visualizations and embedding relevant knowledge into designs. For example, events/price changes in the context of forecasting are particularly important pieces of knowledge, as they represent activities of special significance for both users and organizations. Therefore, not only the recognition but also the effective use of events contributing to the forecasts is of the utmost importance (see also Fildes et al., 2006, Fildes et al., 2009). In that respect, the adoption of FSS technologies that integrate mobile and internet computing applications should be able to support a set of forecasting goals. This study proposes the design of FSS that align closely with the user's communicative work practices in order to increase their usefulness for long-term organizational actions.

6.1. Practical implications

This study provides important strategic guidelines both for organizations which are considering adopting FSSs and for practitioners who are developing FSS. Regarding organizations' decisions as to investing in a FSS, we expect that the applications which are most likely to succeed are those that are compatible with existing *user communicative working practices* and *organizational actions*. Regarding development strategies for FSS, our findings suggest that more attention should be paid to the communicative aspects of the systems that are consistent with anticipated or emerged technologies-in-practice which are evident in the organizational context of use. Similarly, users disliked FSS solutions that have complex and non-customizable adjustment and reporting procedures. The fact that usability and user interface design problems have been major issues (see Küsters et al., 2006) suggests that more effort needs to be made to design easy-to-use FSS that effectively support the actual forecasting process.

The lack of reliable product knowledge mechanisms/features emerged as a major barrier to effective FSS use in the present study. One viable strategy for practitioners when designing knowledge and advice mechanisms is to launch a new FSS prototype initially in an organization where there is a large base of established but *diverse* users in terms of roles and expertise, and then design features by gradually incorporating advice from different people into the FSS. In addition, FSS providers need to clearly communicate the benefits of FSS in terms of providing a tool for increased communication inside and outside the organization. While our intention in this paper is not to suggest specific FSS design features, we could see value in designing simple visualizations—such as note-taking—that highlight the different elements of the forecasts and help users to relate different sources of knowledge. Technological enhancements such as Web-enabled, multi-functional, and mobile FSS might be designed to better address users' technologies-in-practice. This would mean that users could pursue advantages over traditional methods of communicating with customers or suppliers, or disseminating product information through the FSS.

For designers, the model indicates that they should be aware of the different uses of FSS that may hinder the successful adoption of new FSS, or the effective use of the current one. They should encourage active participation in the design process from users and other reference groups (see Asimakopoulos, 2012) who play critical roles in influencing the working practices and organizational actions that arise from the forecasts. Similarly, FSS designers should actively seek out these referent groups and create an awareness of the collaboration opportunities that the FSS might offer.

6.2. Limitations and suggestions for further research

As with any empirical research, this study has its limitations. The types of enactments and technologies-in-practices discussed in this study all involved the use of a particular technology, the FSS, a specific context, product forecasting in supply chain organizations, and a particular organizational culture. Exploring different cultural (e.g. Mady, 2000) and institutional (e.g., governmental, educational) forecasting contexts to those studied here would also expand our understanding of the way in which users recurrently structure their use of technologies in different circumstances. Another limitation of this study is that the data were collected between the years 2005 and 2007. Substantial changes in the commercial environment, and a long-lasting period of economic crisis and financial insecurity for many organizations, have, however, taken place since the data collection, which might have implications for the model. Still, we believe that the theoretical constructs and the model postulated in this study remain valid predictors for FSS adoption and use. Future research is needed, however, to test the proposed adoption and use mechanisms with new technologies in this evolving area.

In further studies, we wish to expand particularly on the ways in which FSS improvisational use might arise through stakeholders' communication and collaboration on specific events (see Orlikowski, 2000). The aim is to enhance collaboration (face-to-face or collegial) in forecasting problems (such as cross border trade) through the use of FSS. The focus of these studies would not be on users learning new skills per se, but rather on users learning how to improve their communicative practices while improvising more effectively when using FSS. To this extent, we will also focus on the ways in which social influence mechanisms and organizational political pressures (see Galbraith & Merrill, 1996) on users enable or inhibit effective FSS adoption and use.

The comparison of the conditions and consequences associated with whether and how actors use technological artifacts to enact different technologies-in-use suggests that three clusters of enactment may be observed (Orlikowski, 2000, p. 421). These clusters depend on observable changes in process, technological artifacts, and/or structure. The first type of enactment is inertia, i.e. the technology-in-use does not change, but actors choose to use the technology to retain the status quo. In the second type, application, actors choose to use new technological artifacts to refine present technology-in-use. In the last type, change, actors choose to substantially alter their technology-in-use, and thereby dramatically change their ways of doing things. This study has focused on describing the technologies-in-practice and its implications for FSS adoption and use. At the micro-level, we provide evidence of FSS adoption and use, adding to the forecasting body of knowledge.

Our study has some similarities to the Sales Forecasting Benchmarking Model (SFBM, Moon et al., 2003), with reference to the need for functional integration (the need for collaboration, communication and coordination) and the systems (hardware and software) that support the forecasting process. However, the focus of this study is on users' working practices and 'technologies-in-practice' as important aspects that impact FSS adoption and use, rather than organizational performance and accurate forecasts. As technology evolves into more interactive modes of work and communication, FSS to support these working practices should be given greater significance.

7. Conclusion

Our research has focused on the development of a model of FSS adoption/use based on Orlikowski's conceptual lens. This effort makes a novel contribution to the study of FSS adoption, and particularly to 'use structures' that impact adoption. The model indicates that adoption in practice is mainly caused by user communicative practices and actions which are implementable at the organizational level. The technologies-in-practice presented in this study, specifically the limited use of FSS, individual user productivity, and forecasting process support, are presented as technologies-in-practice that moderate the relationship between communicative practices and organizational action. The methodological significance of the study stems from its socio-technical and interpretive nature on the adoption and use of FSS. The practical implications of the study from the insights gained are expected to include the provisions of a set of technologies-in-practice and directions for effective future FSS design adoption, especially when applied to product forecasting in supply chain organizations.

Acknowledgments

We would like to thank all FSS users and designers who participated in this research. Many thanks also to the co-editors of this special issue, Paul Goodwin and Robert Fildes, and the four anonymous reviewers for their valuable comments and references on earlier versions of the paper.

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