Abstract: Workflow management systems (WFMSs) are finding wide applicability in small and large organizational settings. Advanced transaction models (ATMs) focus on maintaining data consistency and have provided solutions to many problems such as correctness, consistency, and reliability in transaction processing and database management environments. While such concepts have yet to be solved in the domain of workflow systems, database researchers have proposed to use, or attempted to use ATMs to model workflows. In this paper we survey the work done in the area of transactional workflow systems. We then argue that workflow requirements in large-scale enterprise-wide applications involving heterogeneous and distributed environments either differ or exceed the modeling and functionality support provided by ATMs. We propose that an ATM is unlikely to provide the primary basis for modeling of workflow applications, and subsequently workflow management. We discuss a framework for error handling and recovery in the METEOR2 WFMS that borrows from relevant work in ATMs, distributed systems, software engineering, and organizational sciences. We have also presented various connotations of transactions in real-world organizational processes today. Finally, we point out the need for looking beyond ATMs and using a multi-disciplinary approach for modeling large-scale workflow applications of the future.

1.1 INTRODUCTION

A workflow is an activity involving the coordinated execution of multiple tasks performed by different processing entities [Krishnakumar and Sheth, 1995]. A workflow process is an automated organizational process involving both human and automated tasks. Workflow management is the automated coordina-
tion, control and communication of work as is required to satisfy workflow processes [Sheth et al., 1996a]. There has been a growing acceptance of workflow technology in numerous application domains such as telecommunications, software engineering, manufacturing, production, finance and banking, health care, shipping and office automation [Smith, 1993, Joosten et al., 1994, Georgakopoulos et al., 1995, Fischer, 1995, Tang and Veijalainen, 1995, Sheth et al., 1996b, Palaniswami et al., 1996, Bonner et al., 1996, Perry et al., 1996]. Workflow Management Systems (WFMSs) are being used in inter- and intra-enterprise environments to re-engineer, streamline, automate, and track organizational processes involving humans and automated information systems.

In spite of the proliferation of commercial products for workflow management (including modeling and system supported enactment), workflow technology is relatively immature to be able to address the myriad complexities associated with real-world applications. The current state-of-the-art is dictated by the commercial market which is focused toward providing automation within the office environment with emphasis on coordinating human activities, and facilitating document routing, imaging, and reporting. However, the requirements for workflows in large-scale multi-system applications executing in heterogeneous, autonomous, distributed (HAD) environments involving multiple communication paradigms, humans and legacy application systems far exceeds the capabilities provided by products today [Sheth, 1995].

Some of the apparent weaknesses of workflow models that need to be addressed by the workflow community include the lack of a clear theoretical basis, undefined correctness criteria, limited support for synchronization of concurrent workflows, lack of interoperability, scalability and availability, and lack of support for reliability in the presence of failures and exceptions [Breitbart et al., 1993, Jin et al., 1993, Georgakopoulos et al., 1995, Mohan et al., 1995, Alonso and Schek, 1996b, Kamath and Ramamritham, 1996a, Leymann et al., 1996, Alonso et al., 1996a]. In addition, a successful workflow-enabled solution should address many of the growing user needs that have resulted from:

- emerging and maturing infrastructure technologies and standards for distributed computing such as the World Wide Web, Common Object Request Broker Architecture [OMG, 1995b], Distributed Common Object Model (DCOM), ActiveX, Lotus Notes, and Java.
- increasing need for electronic commerce using standard protocols such as Electronic Data Interchange (EDI) (e.g., ANSI X.12 and HL7),
- additional organizational requirements in terms of security and authentication,
- demands for integrated collaboration (not just coordination) support,