A Taxonomy and Evaluation for Systems Analysis Methodologies in a Workflow Context: Structured Systems Analysis Design Method (SSADM), Unified Modelling Language (UML), Unified Process, Soft Systems Methodology (SSM) and Organisation Process Modelling (OPM)

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Abstract

Complex information systems require a methodology for their development in a structured manner. Many different methodologies exist, each sui table for a particular type of application. In this report we develop a taxonomy covering 14 different classification features for methodologies targeted at the workflow area. Features identified include concerns, method structure, data gathering means, pe ople involved, notations, decomposition, policies, reuse, adaptability, flexibility, exception handling, method output, CASE tool and quality assurance. The capabilities of a number of methodologies are expressed in tabular form relative to this taxonomy for workflow systems and to a more general taxonomy dealing with both hard- and soft-system aspects. The results show that there is no methodology that covers all of the taxonomic aspects identified. Organisational Process Modelling (OPM) and Soft Systems Methodology (SSM) are relatively strong on soft aspects and weak on hard aspects. Unified Modelling Language (UML) and Unified Process are relatively strong on hard aspects and weak on soft aspects. Structured Systems Analysis and Design Method (SSADM) is p erhaps the most comprehensive but some soft aspects are omitted. The combination of techniques such as UML and Workflow is identified as a way forward.

1. Introduction

It is generally accepted that complex information systems require a methodolgy to take their development forward from the initial requirements of users to an implemented documented functioning system, which satisfies the end -users in its functionality and interface (Beynon-Davies, 1998). Many kinds of methodologies have been proposed since the 1970s in the area of systems analysis (Hawryszkiewycz, 1998). A glossary for some of the commonly-used acronyms is given at the end of this report. The large number appears to result from different procedures in the various software development houses and the varying appropriateness of paradigms from application to application. It is probably true to say that every methodology has a target area of application. For example Structured Systems Analysis Design Method (SSADM) is suited to implementation in a transaction-oriented relational database system. Unified Modelling Language (UML) is suited to implementation in an object-oriented environment.

Initially methodologies concentrated on tangible aspects of user problems, that is concepts, which could be readily represented by program code and data structures. However, such aspects form only a part of the whole user problem. In effect any information system has two aspects namely hard system and soft system. The hard system part includes several elements such as data, events, processes and interfaces. The system also needs some resources (people, money and equipment) to achieve the required objectives that should possess certain qualities. On the other hand, the soft system part includes several elements such as the identification of the problem, the user involvement, the organisational structure, goals and policies, the employee job satisfaction, different points of view, the employee's values, and the system acceptability and usability.

2. Characteristics of Particular Approaches

2.1 OPM (1999)

The Organisation Process Modelling (OPM) method of Warboys (1999) deals with some elements of both hard and soft systems aspects. OPM covers two of the hard system elements, which are events and processes. It has a different approach to model the organisation or the system processes which is through identifying the interaction between the agents that carry out some activities (processes) to achieve their goals. We can consider the events as the necessary motivations to achieve the objectives of each agent. So the event is the agent's motive to achieve its goal. The deficiency of the OPM method is the lack of data structure, which is important in an information system analysis and design. The main purpose of this approach is to process the data. Also the design of the interfaces is not considered and there is no identification of the required resource or quality assurance.

On the other hand, OPM covers most of the soft system elements. OPM defines the scope of the problem by using the system model. However, the process objectives might be usefully analysed through the decomposition of the different goals to establish a relationship between the objectives and the processes that will satisfy them. Also, OPM promotes the involvement of users to define the problem situation and gather many important aspects about it through interviews, discussions and workshops. Moreover, the OPM modeller communicates with the users to validate the models and the final system. It is necessary to carry out a reasonable evaluation of a process to define the values of the organisation. So if the organisation is considered to be an efficient utiliser of resources then a more Taylorist emphasis may be developed by the organisation. The Taylorist approach comes from Fredrick Taylor (Taylor, 1911) who is the pioneer of mechanistic models of an organisation. He tried to apply the principles of science to the organisational process. He broke down jobs into the smallest possible parts and used time and motion studies to identify the best way to do each and how to fit them together so that the whole task could be done efficiently. So Taylorism can be seen as reducing workers to parts of a machine. Modelling, in general, helps to develop a greater understanding of the organisation and its relationships with others. There will be inevitable conflicts and hidden agendas that have to be resolved if possible. However, if conflicts can not be reconciled, the approach of the process modeller will be the way that is acceptable to the process owner. If this is not possible the modeller needs to change the process in a way that may be at variance with the will of its owner. OPM is built around the idea of dialectics to resolve the differences between the models to encourage sharing of viewpoints between the problem stakeholders. The dialectic refers to the debate necessary to resolve the differences between the views. OPM models the different point of views for the problem situation by using the rich picture technique from the Soft System Methodology (SSM). In OPM, it is advisable to use the established techniques of Soft Systems Methodology (SSM) to specify the employees' goals and views in the organisation. In addition, OPM supports the system acceptability (the system should not threaten the intended users to use it to achieve their desired work-related goals) and usability (the intended users should be able to use the system) by relating the software capabilities to the tasks that the users want to perform. This is done by matching the structure of the users' task to the structure of the software system. Among the problems identified with OPM are:

- ‘The organisational goals and employee value, located in the social context of a system, are emergent and not objective ly available. They have to be debated before they can be articulated and emerge as requirements’ (Warboys, 1999).
- ‘OPM does not attempt to deal with all aspects of the problem of developing software in an organisation but continually interfaces to those as pects just beyond its remit’ (Warboys, 1999).
- There is no facility in OPM for supporting the employee job satisfaction.

2.2 SSADM version 4 (1990)

Structured Systems Analysis and Design Method (SSADM) is a detailed method, which covers almost every eleme nt of the information system (Duncan, Rackley & Walker, 1995). It includes many techniques that deal with each aspect of the system. The logical data modelling presents the data structure of the system and the data flow modelling defines the system processes. Also, the entity -event modelling specifies the system events and dialogue design depicts the interface and dialogue of the system. Finally, the requirements catalogue holds all the requirement information about the development system including the requ ired resources which are defined in the feasibility study or the business system option steps and the quality assurance which ensures that at each step the product satisfies certain quality standards.

SSADM also deals with some of the soft system aspects. The problem to be solved is identified at the strategic planning stage that studies the organisational requirements and defines the business areas that need to be improved and specifies their priorities to the organisation. So SSADM gets the result of the strategic planing regarding the system that needs to be developed or improved. SSADM starts by studying the feasibility of the system to define its operational, economical and technical feasibility. SSADM documents these decisions in the Requirements Catalogue (RC). The analyst also identifies other problems through detailed investigation of the current system. Moreover, SSADM supports the user involvement through the use of interviews and discussions in the identification of the system requirements. The us ers review the products at each stage in the development life cycle with the analyst available to identify any defects in the requirements. There is a new trend for the user to become a full member of the project team. Also, the organisational structure, g oals and policies are investigated in the strategic planing. These are documented in the Project Initiation Document that is used as the starting point in developing the system.

In addition, the users interact with the analyst to choose appropriate option s from Business System Option (BSO). BSO describes what the system should do. The analyst presents many options for the users to choose from. BSO includes some aspects about the impact of the system on customers and the need for training to increase employ ees job satisfaction, acceptability and usability of the system. Also SSADM documents the different views of the people regarding the system in the Requirements Catalogue. These views are documented as requirements for the new system. Finally, the involve ment of the user in analysis and design will increase the acceptability of the new system. This is achieved by involving the user in reviewing the products of the development cycle stages. Prototyping is used to check the system requirements. The project management determines the prototype scope. The impact of the system on the staff is studied during the selection of Technical System Options, which will increase the usability of the system for the users. The users participate in choosing the options that w ill be implemented. The prototype helps the users to accept and use the new system. Also, the involvement of the users in the dialogue design increases the system usability level. The latest version of SSADM proposes the use of SSM (Soft Systems Methodolog y) in the early phases (CCTA, 1993).

2.3 UML version 1.3 (1998)

UML (Booch, 1999) is an expressive modelling language that covers every aspects of the system development process. It is extensible to include new features that will emerge in the

development process through many mechanisms such as stereotypes, tagged values and constraints. UML can be used with any object -oriented development method. UML can be adapted with Business-Oriented Software Engineering process (BOE Process) to cover more fully the modelling of enterprises.

BOE Process and UML cover most of the hard system elements. In the object -oriented paradigm the data is encapsulated with the operations in the class, which is modelled in the class diagram. An activity diagram models the busines s process. The processes are described by 'means of activities, which can be active sequentially or in parallel and for which branching and synchronisation can be defined' (Oestereich, 1999: 61). An activity diagram has a swimlane feature, which is used to partition the activities into groups that represent business units that are responsible for these activities. However, the interface, 'a collection of operations that are used to specify a service of a class or a component' (Booch et al., 1999: 151), is m odelled in class and component diagrams. The interface is modelled either as a class with stereotype of <<interface>> in the class or component diagram or as a lollipop icon positioned to one side of the class or component. Finally, the system quality is m easured by using prototyping. During the analysis facet, there is explorative prototyping to define the application domain and the requirements of the users. During the design phase, an experimental prototyping is used to verify the proposed solutions.

UML does not have any components to model the resources but the developers can model them by using the stereotype feature. The resources can be modelled as classes with stereotype <<resource>>.

BOE Process also deals with the soft system elements. The problem is identified in response to take advantage of an opportunity or to eliminate any defects in the organisation. The strategic planning specifies the problems that need to be solved and assigns priorities to them to identify their importance to the organisa tion. The development process is used to solve the problem that has the highest priorities by gathering information about it. BOE Process also supports the user involvement during the system analysis to gather data through interviews with them and workshops. This data will be documented in some form such as use case models, CRC (Class-Responsibilities-Collaborators) cards or technical dictionaries. The users will be involved in the explorative prototypes to validate the system requirements and in the experi mental prototypes to verify the usability of the final system. This will encourage the users to accept and use the system to perform their tasks and minimise their resistance. Moreover, the new system sometimes needs to be integrated in an application area . To achieve an efficient and reasonable integration, the points of contact with the surrounding process need to be analysed. UML uses the activity diagram to integrate the new system into the organisational structure. Through the modelling of the business processes, activities can be divided into sub-activities called swimlanes (responsibility lanes) which allow assignments to be represented for an organisational structure. Modelling of organisational structures, role concepts and privileges can be handled in trivial situations. The employee job satisfaction involves two aspects.

- First is for the employee in the development team who tries to solve the problem and implement the system in the organisation. His job satisfaction will be in achieving the goal that the project manager assigned to him. The project manager assigns goals to the employees who are suitable for their skills and responsibilities and lets them choose the way to achieve these goals. If any problem occurs, the project manager will try with the employees concerned to solve it. Also the project manager is responsible for evaluating the performance of the employees so as to monitor and identify their weaknesses and motivate their performance.
- Second is the employee who will use the final developed system. His satisfaction will be increased if the system helps him to perform his task in a suitable way without forcing him to follow restricted procedures. An analyst collects information about the problem and its domain through the interview with the users of the system and domain experts. He should consider the different views. If there is any contradiction in their views, the analyst should resolve them. The project manager should support the teamwork rather than the individuals.

As a weakness BOE does not include any support for the employee's values.

2.4 Unified Process (1999)

The Unified Process method (Rational Software Corporation, 2000) covers most of the hard system elements. It supports object -oriented techniques as its models are base d on object, class and relationship concepts. In the object -oriented paradigm the data is encapsulated with the operations in the class, Such data is modelled in the class diagram with the persistent data being stored in a database. An activity diagram mod els the business process. An activity diagram has the swimlane feature, which is used to partition the activities into groups that represent the business units, which are responsible for these activities. In addition, the events are depicted by using the i nteraction diagrams that are collaboration diagrams, sequence diagrams and activity diagrams. Which diagram is used depends on the required information and detail. For example the collaboration diagram is used in the analysis since the focus is then on the requirements and responsibilities of classes or objects and the sequence diagram is used to depict the chronological sequences of interactions in the design.

The interface has two types.

- The user interface, which presents the functions or operations tha t the system offers to its customers or users. This interface is considered in the requirement capture to specify and prototype the user interfaces of the use cases of the developed system to understand the interactions between actors and the system. These interfaces are presented by using screen sketches on paper or prototype tools.
- The internal interfaces between the classes or sub -systems. This interface, 'a collection of operations that are used to specify a service of a class or a component' (Booch et al., 1999), is modelled in class and component diagrams.

These interfaces specify the operations that are provided by the design classes and sub -systems. The design class that offers an interface must also offer methods that realise the operations of the interface. A sub-system offering an interface must also contain design classes or other sub-systems that offer the interface. The resources in the Unified Process include time, cost and the people who will develop the system (worker is a Unified Process t erm for a role) and the tools that will be used to help workers perform their tasks. The Unified Process provides guidelines that help the assigned people to do their tasks and produce the required artefacts and plan for the next phases and iterations. The project manager assigns people to workers depending on their skills. He should also provide the workers with suitable training on how to use the tools. He should consider the number of iterations in each phase, how long each iteration takes and the total cost of each phase and the final system. The Unified Process checks the system quality through performing some explorative prototypes in the inception and elaboration phases and several tests in the test phase to ensure that the system accomplishes the use rs requirements such as the integration, configuration, negative and stress tests. Finally, the Unified Process deals with the business issues through developing a business model that helps to understand the functionality of the business system. Business m odelling is supported by two kinds of UML models namely use case models and object models (Rational Software Corporation , 1999). A business use case model defines the business processes of a company in terms of business use cases and business actors. A bu siness object model defines how each business use case is realised by a set of workers, work units, business rules and other regulations imposed on the business. Each realisation of a business use case is modelled in interaction diagrams and activity diagr ams.

The Unified Process method also deals with the soft system elements. The problem is defined as a response to taking advantage of an opportunity to eliminate any defects in the organisation. The strategic planning specifies the problems that need to be solved and assigns priorities to them to identify their importance to the organisation. The development process is used to solve the problem that has the highest priorities by gathering information about it. In addition the Unified Process encourages user involvement during the requirements capture by gathering data or requirements through interviews with them and participation in workshops. These requirements will be documented in use cases, business or domain models and supplementary requirements. The us ers will be involved in checking the artefacts of the iteration

and phases. This will encourage the users to accept and use the system to perform their tasks and minimise their resistance. Moreover, the organisational structure, goals and policies are dealt with in requirement capture.

The Unified Process is a generic process that needs to be specialised depending on many factors such as organisational, domain, life cycle and technical. The organisational goals and policies are documented in the business m odel and supplementary requirements. The business model is 'a technique for understanding the business processes of an organisation' (Jacobson & et al., 1999). Business modelling is supported by two kinds of UML models: use case models and object models. The business use case model, which is depicted as use case diagrams, defines the business processes as business use cases and customers as business actors. A business object model specifies how each business use case is realised by a set of workers who use a set of business entities (orders or invoices) and work units. The business rules and other regulations imposed on the business are associated with these different objects. The supplementary requirements include non-functional needs such as interface and physical requirements and design and implementation constraints. The implementation constraints control the coding or construction of a system. Such constraints include, for example, required standards, policies for database integrity, resource limits and operation environments. There are many factors contributing to the employee's satisfaction, for example, project feasibility, risk management, team structure, project schedule, project understandability and sense of accomplishment. Project feasibility and free risk project help employees to enjoy their works. Satisfaction is achieved through the iterative approach that allows the feasibility of a project to be assessed early and the mitigation of critical risks. The Unified Process approach recommends build ing a developing team in a small group to work effectively. The process structure (assessing a risk, developing a sub-system, performing an iteration) and the system architecture (including sub -systems and components and their interfaces) permit this and l et the employees understand and obtain an overview of the system. The effective scheduling of a project assists in increasing the employees' satisfaction because they are involved with the end result of their work. In addition, the iterative approach helps the employees to get frequent feedback about their work and provides closure. Such factors increase the employees' sense of accomplishment.

At the beginning of the life cycle, there is a little information about the required system. So an initial team ma y include the project manager, the architect, a developer experienced in analysis, a test engineer and representatives of the users. Such a team is constructed to develop detailed information about the system. The different views of the team members are in tegrated to give the best answers for help in developing the system. In the transition phase, the Unified Process ensures the acceptance of the system by performing the acceptance test. The acceptance test is done by releasing a beta version to the users f or them to verify and report any problems, defects or observations to the developers for correction. The acceptance test concludes when the system meets the users requirements. The developers provide the users with documentation to use the system and to help them with any issues regarding the new system. This will help the users to accept and use the system in performing their tasks.

A weakness is that the Unified Process does not include any support for the employee's values.

2.5 SSM (1990)

Soft Systems M ethodology (SSM) deals with some elements of hard systems aspects. SSM (Checkland & Scholes, 1990) supports the activities and processes through using a conceptual model to represent the activities of the root definition. The resources can also be presented in the root definition and the activities modelled can be related to them in the conceptual models. SSM validates the quality through defining measures for activities in a conceptual model of the proposed system. Activities monitor these measures and tak e control action to improve matters in the proposed system. In addition the business issues are considered as a combination of the different perceptions in the conceptual models that help to identify business system options and define acceptance criteria f or the delivered system.

As a weakness SSM does not support the other elements of the hard approach such as data, events and designing interfaces.

On the positive side, SSM deals with all the elements of the soft approach. SSM may therefore be used to improve our understanding of ill-structured problems. The rich picture model is used to represent the complexity of the human affairs and the problem situation. This helps to discuss the problem situation with the people involved so as to get a clearer pictur e of it. The users are also involved in gathering information about the problem situation through interviews and discussions in the workshops. SSM provides the means for the analyst to discuss the situation in the users' own terms using the root definition s and conceptual models. The users will be involved in choosing the activities to construct a consensus for the primary task model required in defining information for a system that accommodates the different users' viewpoints. The technique also encourage s debate to define the required changes to improve the situation. Moreover SSM uses the rich picture technique to model the organisational structure, goals and policies in the problem situation. The primary task model is used to depict the main role of the organisation. The job satisfaction of the employees is achieved through their involvement in the debate to compare the conceptual models and the real world and specify the differences and changes necessary to match the scenarios more closely. In addition, SSM deals with different perceptions of the problem by selecting the most relevant set of the perceptions. Conceptual models of system activities are then developed to depict these perceptions. These models are combined in ways that accommodate the differ ent perceptions and may extend to reconcile conflicting concerns or needs. SSM documents the employee's value in what is termed *Analysis Two,* which defines the roles, norms, and values. A role is a 'social position recognised as significant by people in th e problem situation' (Checkland, 1990). A role is characterised by the expected behaviours of objects, sometimes termed norms. Actual performance in a role will be judged according to local standards or values. So after each interview, discussion or examin ation of a document, an exchange of experiences needs to be made and the roles, norms and values inferred. Finally, the acceptance of the method depends on the result of a project. If the project achieves the users' requirements that will encourage the use rs to use the system. The users' involvement throughout the project encourages them to accept the system and to use it.

3 *The Workflow Approach (1996)*

The workflow management technology (Jablonski & Bussler, 1996) introduces new qualities into the task o f combining the people, organisation and processes to form a *value chain.* Such a chain is a management terminology for a string of companies working together to satisfy market demands. The value chain typically consists of one or a few primary value (produ ct or service) suppliers and many other suppliers that add on to the value that is ultimately presented to the buying public. *W*orkflow management is intended to improve the quality of the service or product.

Workflow systems are used to 'document and contr ol the transitions between tasks in a process and bring together the resources (human and information) needed to complete each task' (Stark and Lachal, 1995). They bind and integrate the critical factors of the enterprise such as people, organisation and processes. Workflow management has taken functionality out of the application programs. It provides a systematic approach to turn islands of automation into an effective and efficient force with valuable commercial impact (Jablonski and Bussler, 1996).

The advantages of workflow systems are saving labour and paper, reducing 'dead time' in processes and improving their quality. Workflow systems should provide process management facilities that allow changing processes either to make the best use of available resources or to respond to changing needs (Stark and Lachal, 1995).

Jablonski and Bussler (1996) cite three definitions of workflow management systems. The first definition is from the consulting area. and Lavery (1991) defines the workflow management as:

'a proactive computer system which manages the flow of work among participants, according to a defined procedure consisting of a number of tasks. It co -ordinates user and system participants, together with the appropriate data resources, which may be accessible directly by the system or off -line, to achieve defined objectives by set deadlines. The co -ordination involves

passing tasks from participant to participant in correct sequence, ensuring that all fulfil their required contribution, taking default actions when necessary'.

This definition includes some of the workflow management elements such as tasks, participants, data resources and task procedures that control the performing of the tasks by the participants.

The second definition is from the research domain. Reinwald (1994) defines the workflow management system as 'an active system that manages the flow of business processes performed by multiple persons. It gets the right data to the right people with the right tools at the right time'. This definition adds other workflow management elements such as tools and the optimal execution time.

The third definition is from the industrial area. The Workflow Management Coalition (1993) defines the workflow management system as 'one which provides procedural automation of a business process by management of the sequence of work activities and the invocation of the appropriate human and/or IT resources associated with the various activity steps'. This definition places emphasis on the work and the agents that will perform it.

3.1 Workflow Management Origins

Some software technologies have affected the development of the workflow management such as office automation, database management, e-mail and other technologies. Office automation is considered the main origin of the workflow management approach. There are some office information system requirements that can be applied in the workflow management systems such as scheduling activities, function integration, personnel assistance and task management. In the early days of the workflow management, some systems were tailored for use in office environment. In database management, some research has been done to deal with the transactions in the workflow management systems.

- First, it is necessary to deal with Event-Condition-Action (ECA) in active databases to handle tasks in workflow management systems.
- Second, there is the extended transaction model to handle the failure and execution atomicity of the work tasks.

Workflow management systems share some characteristics with e-mail such as actively using routing information. Document management affects workflow management systems through managing the work documents. There is little effect of software process management on the workflow management system. In addition, the business process modelling includes several aspects such as economy, technology and computer-orientation. The scope of workflow management systems is also so wide that they can be considered as an enactment infrastructure for business process modelling. Finally, enterprise modelling and architecture requires a global and process-centric view so workflow management systems should consider including all aspects of application system rather than partial aspects (Jablonski and Bussler, 1996).

3.2 Workflow Management Technology Generation

The workflow management technology has several phases.

i. The beginning phase is where experiences with academic and commercial prototypes have to be gained.
ii. The conceptual phase is where conceptual work is done. Conceptual models and architecture are developed. Design methodologies are first established in this phase.
iii. The proliferation phase is where the workflow management tools are widely spread.
iv. The standardisation phase is where norms and standards are developed.

Also, there are three stages of the development of the workflow management approach in a particular business:

i. The home-grown stage is where there is a lack of workflow model

ii. The rudimentary stage is where there is an autonomous workflow engine, which executes the workflow models, but which is defined independently from the application programs. Changes are restricted depending on the workflow model and the execution engine.
iii. The dynamic stage is where the workflow model can be adjusted to new application requirements. Also the workflow management system architecture can be adapted to new hard-and-software infrastructures (Jablonski and Bussler, 1996).

Most of the workflow tools use one of the following two architectures.

1) Electronic forms provide the interface for tasks. These forms are transported through task stages using messages. This type of product supports the building of applications, which are used to get the work done.
2) External task applications provide the interfaces for tasks. The process environment is controlled by a workflow engine, which keeps track of the progress of each instance of the process. This type of product provides sophisticated process management.

Workflow systems are used well when the five conditions below hold.

1) Processes have explicit component tasks.
2) Rules determine the logic of transitions between tasks.
3) Tasks use digital information resources.
4) Tasks need to be communicated to workers.
5) There is a need for process control (Stark and Lachal, 1995).

Jablonski and Bussler (1996) also introduced a comprehensive workflow model, which is called Mobile Workflow Model. It is a comprehensive model, which is considered as a reference model for the classification and assessment of other workflow models and architecture. It has five essential perspectives and six additional perspectives for other purposes.

1) Functional perspective.
   From this angle we define what has to be done. This consists of either elementary or composite workflows.
2) Operational perspective.
   From this angle we define the workflow operations which are implemented by application programs.
3) Behavioural perspective (control flow).
   From this angle we define the execution order of workflows. It is optimal to specify only those execution order dependencies, which are fundamental, even if only a partial ordering results. An execution order specifies the control flow dependencies between the sub-workflows of a workflow independent from data flow dependencies. At run time both control flow and data flow have to be considered when execution order of sub-workflows is determined.
4) Informational perspective.
   From this angle we define the data requirements in the workflow management system. There are two types of data. First is control data, which is used by the workflow management system to control the execution of the different workflows. Second is production data, which is external data that can be used by workflow management system.
5) Organisational perspective.
   From this angle we specify who is responsible for performing the different tasks.
6) Causality perspective.
   From this angle we describe the rationales for the specification of a workflow and for the execution of a workflow instance. This area includes business policies, enterprise strategies and legal business rules, which regulate the definition of the workflow types.
7) Integrity and failure recovery perspective.
   From this angle we define two types of failures in workflow management systems: semantic and system:

i. Semantic Failures
   They are application area dependent.
ii. System Failures

They are technical problems. They affect the execution of the workflow instances, which could not proceed without running a recovery mechanism. They are caused by erroneous program code, a power failure, a hardware failure, a base service software failure or a network failure. The workflow management system cannot model the system failures.

8) Quality perspective.

The quality perspective includes several aspects. The cost and time will be restricted in the quality perspective. A high quality workflow instance execution will not consume excessive time and system resources. Data is needed to assess the quality of a workflow type specification. One method is to compile workflow instance executions as may be found in a log file. This data is analysed to find execution bottleneck, resource intensive workflow steps and long-running workflows.

9) History perspective.

From this angle we build an audit trail for each workflow instance. The audit trail has information about what happened while a workflow was performed

10) Security perspective.

Security is concerned with the responsibility to access an object. There are many issues that determine the access right for the user such as his responsibility from the organisation perspective, the security reasons and organisational policies. This does not cause any problem as long as they agree on who is allowed to perform the workflow operation.

11) Autonomy perspective.

This perspective is global. It has three aspects such as mobility, distribution and execution threads.

Jablonski and Bussler (1996) also presented the run time infrastructure, which consists of implementation model, implementation architecture and implementation. The implementation model includes the functional components, which form the conceptual basis for the run time part of a workflow management system. It describes the workflow components and the protocols between them. The implementation architecture, which is used to enact the functional components, has three aspects such as the functional components, databases and communication mechanisms. The implementation infrastructure is then implemented using the available techniques and tools.

4 Taxonomy for Workflow Systems

Table 1 identifies the workflow features that form the basis of our taxonomy. The notes following the table provide further details of each feature.

Features \ Approach	WORKFLOW
1) Concerns	Workflow management systems aim to improve the efficiency and the effectiveness of a company through the improvement of its business process.
2) Method structure	An approach has two parts: A) Business-oriented part. i. Enterprise planning. ii. Business area analysis. iii. Reconstruction. B) System-oriented part. i. System specification. ii. Module programming and testing. iii. System integration and testing.
3) Data gathering means	A) Interviews and discussions with the domain experts. B) Interviews and discussions with the users. C) Examining the organisation documents.
4) People involved	A) Organisation management. B) Domain experts. C) Users. D) Developers.
5) Notations	There are no specific notations for descr ibing the workflow management system.
6) Decomposition	A workflow management system supports a business process that can be decomposed into tasks.
7) Policies	They are stored in the organisation perspective in the comprehensive workflow model.
8) Reuse	It is nec essary to support reusability in the workflow management systems through the reuse of the existing information and artefacts in the enterprise to describe the workflow specifications. Also, workflow management system can reuse scripts, definition and sub -workflows that can be used in different workflows.
9) Adaptability	It is achieved through the use of dynamic modelling which specifies a process during the runtime.
10) Flexibility	Flexibility occurs on using control flow rather than concrete flow and using a dynamic model rather than a static one.
11) Exception handling	It is done by using event -handler capabilities or the human intervention.
12) Method output	The output is a workflow management system for a specific deployment area or a comprehensive workflow managem ent system that covers the entire enterprise.
13) CASE tool	There are two kinds of tools that are used with workflow management system namely, build time tools and run time tools.
14) Quality assurance	Workflow management systems support the quality of a process through identifying the process rules and the weakest parts in it. Also, workflow systems reduce redundant data entry and time consuming in data retrieval.

Table 1: Features of the Workflow Approach that form the Basis of our Taxonomy:

4.1 Notes on Taxonomy

1) Concerns

Workflow systems aim to improve the efficiency of a company through lower costs, a higher capacity for workload, a greater effectiveness through standardisation of procedures and the optimisation of performance in aspects such as process cont rol and process management Workflow systems provide computer support for process logic.

2) Method structure

Jablonski and Bussler (1996) introduce an approach for workflow management systems. It consists of two realms. The first one is the business-oriented realm, which domain experts deal with and the other is the system-oriented realm which information technology experts deal with.

The business-oriented part constitutes enterprise planning, business area analyses and reconstruction phases. The enterprise-planning phase identifies goals, objectives, business strategies and business areas. The business area analyses investigate the considered business process by using a descriptive model. The reconstruction phase aims to detail and complete the descriptive model to smooth the transition to the system-oriented part. It needs support from both domain experts and information technology experts. The result of this phase is a constructive model, which describes both domain-oriented and system-oriented information using an implementation-independent language. The entities of the constructive model are defined and their relationships are outlined.

The system-oriented part consists of three phases: 1) system specification, 2) module programming and testing and 3) system integration and testing. In the system specification phase, the details about the selected implementation method are specified. The result of this phase is an implementation model, which describes how the application system will be implemented. In the module programming and testing, the modules are coded by using a specific computer language and each module is tested. The final phase is the system integration and testing where the different system modules are integrated and the final system is tested against its requirements.

3) Data gathering means

There are many ways to collect data for the workflow management system such as interviews and discussions with the domain experts, interviews and discussions with the users and examining the organisation documents.

4) People involved

There can be many people involved in developing a workflow management system such as organisation management, domain experts, users and system developers.

5) Notations

There is no specific notation for describing the workflow management system.

6) Decomposition

Workflow systems aim to support and improve the business process, which contains several aspects such as its logic, its need to handle human and information resources and to perform its tasks and to manage processes in an overall mann er. The process is decomposed to tasks. A task is 'just a step or a stage in a process' (Ovum, 1995). Most workflow systems have an implicit view of a task, which has three elements: the use of application resource, a single person's effort and one time interval.

7) Policies

Policies are stored in the organisation perspective in the comprehensive workflow model.

8) Reuse

It is necessary to support reuse in workflow systems through reusing the existing information and artefacts in the enterprise to specify the workflow specifications and the reuse of scripts and definitions of other workflows. Some workflow systems identify the repeated activities to form sub-workflows that can be used in different main workflows.

9) Adaptability

The use of dynamic modelling, which specifies the tasks of a process during the run time, help to design an adaptable system that can react to events that occur when the process has started.

10) Flexibility

One feature of the flexibility in workflow systems is the different flows between task s in a process. There are two kinds of flow namely concrete flow and control flow. The concrete flows are used to transmit forms, data or documents between tasks. In this type of flow, the tasks of the workflow use the content resources with different stat es that change through the progress of the tasks defined within the process. So it is inflexible to design workflows in which different tasks use different content resources. It is difficult to deal with parallelism that requires a split and join of the content resources associated with the process. However, in the control flows the tasks can use different content resources. So the control flows are more flexible than the concrete flows.

There is flexibility in defining a process by using a dynamic model instead of a static one. In the static model, the tasks in a process, the resources they use and the rules that control the transition between each task must be defined at design time. In the dynamic model, the definition of a process and its tasks is done during the run time.

11) Exception handling

Some workflow systems use event-handling capabilities to deal with error and exception situations. Otherwise the human user has to intervene during the execution of the workflow instance and correct the failure.

12) Method output

The output is a working workflow management system that can be used in a specific deployment area or a comprehensive workflow management system that can be used by the enterprise to cover several deployment areas such as accounting, human reso urces and other applications.

13) CASE tool

A workflow management system has two stages: build time and run time. The build time part allows a modeller to specify all aspects of the workflows. Then the workflows are executed by the run time part of the system.

Build Time:

The conceptual part of the build time is the workflow model, which contains all information to describe a workflow. The tools that support the build time are as follow:

i. A workflow editor is used to define the workflow.
ii. A workflow language compiler is used to compile the language to check the integrity of the specified model.
iii. Simulator and animator tools are used to validate the specified workflows.
iv. Administration tools are used to manage the workflows and store their information in a database, library or repository.

Run Time:

The main purpose of the run time is the execution of workflows. There are some tools that support run time as follow:

i. Monitor tools are used to observe and control progress of workflow execution.
ii. Analysis tools are used to assess the effectiveness and efficiency of workflow execution.
iii. Administration and configuration tools are used to manage the execution infrastructure.
iv. The worklist manager offers worklists, which are the user interfaces to the workflow management system.

14) Quality Assurance

Workflow systems support the quality of a process through identifying the rules that are enforced during the performing of a process. The process management of the workflow systems supports the process improvement by helping the manage rs to identify its weak aspects. Workflow systems help to reduce redundant data entry and time consumed in data retrieval.

5 Comparison of Workflow Approach with Others

Workflow systems support most of the hard system approach elements. They support data through the use of the database. There are two architectures to design the workflow systems. The first architecture is a form-based architecture where the form is the essential part of the workflow system. The form is moved from one user to another to per form the required tasks of the process. The data of the form fields are connected to a database that stores and displays the data. The second sort is an engine-based architecture where the workflow engine controls and manages the process and its tasks. All data of the workflow management system are stored in a database. Such data are passed by using parameters or variables (Stark and Lachal, 1995). Workflow systems also support events. There are two types of events: internal and external. These events trigg er the initiation or execution of the process instance to handle them. Some workflow systems that support the dynamic model have an event -handler, which deals with specifying the next task in the process path.

The process is the core of the workflow syste m. The essential objective of the workflow systems is to support the process and optimise its performance. In the form-based architecture the logic of the process is attached with the form which is transmitted between users. The logic of the process and it s tasks are written in a script language. On the other hand, the engine -based architecture stores process definitions and the states of process instances in a database. In workflow systems, there are different types of interfaces that help to communicate with their parts variables (Stark and Lachal, 1995). The Workflow System Coalition identifies five types of interfaces as follow:

i. Process definition tools interface.
ii. Workflow client application interface.
iii. Invoked application interface.
iv. Workflow interoperability interface.
v. Administration and monitoring tools interface (Jablonski and Bussler, 1996).

These interfaces can be used with the engine -based architecture. On the other hand, the user interface in the form -based architecture is the form. Some workflow s ystems provide Application Programming Interface (API) function libraries that are used to develop a new interface for the workflow system to fit into the common interface that is used in the organisation variables (Stark and Lachal, 1995).

In addition, w orkflow systems have two types of resources: human and information. Workflow systems support the quality of a process through identifying the rules that the workflow systems are forced to follow in performing the process. Also the process management of the workflow systems supports the process improvement by helping the managers to identify the weak aspects in it. Workflow systems help to reduce redundant data entry and the time consumed in handling the data (Stark and Lachal, 1995). Workflow systems support the business issues through the support of the processes of the organisation. The organisation business depends on its processes that should be carried out in optimal way to achieve the objectives of the organisation. In the form-based architecture, the process logic

is attached with the form. While in the engine-based architecture the process logic is found in the workflow engine.

Workflow management systems support all soft system aspects. The organisation problem is identified in the enterprise planning and business area analysis. It is necessary to identify if the problem needs a workflow system approach to solve it or not. Workflow systems are suitable for processes that have the following characteristics:

i. Processes have explicit component tasks.
ii. Rules determine the logic of transitions between tasks.
iii. Tasks use digital information resources.
iv. Tasks need to be communicated to workers.
v. There is a need for process control (Stark and Lachal, 1995).

The management of workflow systems should support user involvement in developing the systems because workflow systems have a profound effect on the users. The users should be consulted to implement the workflow systems and develop a pilot system to discover the impact of the system on them. Workflow systems also define the organisation through an organisational structure and an organisational population. An organisation structure defines all elements of the organisation. On the other hand, an organisation population specifies the actual entities that hold the different positions in the organisation. The enterprise planning and business area analysis phases identify the area where the workflow management system can be implemented to achieve the organisation goals and objectives. The organisation policy can be specified for each workflow operation to define the eligible agent and the rules to perform it. All these data are stored in a database to be used by workflow management system (Jablonski and Bussler, 1996).

A workflow system uses one of two models to assign work to the employees:

- First is the system-offer model in which the system offers tasks to employees who are then free to accept them or not.
- The other is the system-deliver model in which the system assigns the tasks to users directly.

The system-deliver model may provide ways in which users reject, evade, delegate or otherwise transfer responsibilities of which they are notified. The system-offer model is used to balance the workload between users. Workflow systems may impact on the employees because one of the objectives of implementing workflow systems is to reduce the staff and control the way that the employees perform their work. But this does not occur every time that a workflow system is introduced. More staff may be required to deal with customer activities such as sales and customer services and the improved operation may encourage the organisation to take on an increased workload.

Furthermore, Workflow systems could support different point of views through defining different paths to perform a process. Employee's value can be stored in the organisation population when specifying the actual entities for each role in the organisation. Workflow Systems' acceptability and usability will increase if the workflow systems solve workers' problems and the business problems such as work backlogs, lost information and the difficulty of getting the right information (Stark and Lachal, 1995). The services, which relate to user requests, must be efficient to satisfy their users. So it is recommended to do a pilot design and try it to see its effect on the users' environment (Jablonski and Bussler, 1996).

6 Comparison of Different Methodologies using the Workflow Taxonomy

Table 2 compares the different methodologies in terms of the taxonomy determined earlier for workflows.

Approach / Features	Organisational Process Modelling (OPM)	Structured Systems Analysis and Design Method (SSADM)	Unified Modelling Language (UML)	Unified Process	Soft Systems Methodology (SSM)	WORKFLOW
1) Concerns	A) The organisational context. B) Software support.	Analysis and design of commercial data processing and information system.	A) Providing the users with modelling language to develop and exchange meaningful models. B) Supporting specifications that are independent of particular programming languages and development process. C) Encouraging the growth of object tools market. D) Supporting higher-level development concepts such as component, collaboration, frameworks and patterns and integrating the best practices in the industry including a variety of views for domains,	The Unified Process' concern is to help developers to implement and deploy the software system that achieved the users' requirements.	SSM deals with ill-structured real world problem situations and attempts to improve our understanding.	Workflow management systems aim to improve the efficiency and the effectiveness of a company.

			architecture and life cycle stages.			
2) Method steps	OPM consists of four steps A) Model the system (interact agents) by Conceptual Models (CMs) B) Model the goals of the interacting agents by CMs. C) Model the method (the way that agents achieve their goals) by Role Activity Diagrams (RADs). D) Design the active (executable) model.	SSADM has 5 modules with seven stages including A) Feasibility study. B) Requirements analysis (Business system options and Investigate current system). C) Requirements specifications. D) Logical system specification (Technical system options and logical design). E) Physical system design.	The Business-Oriented Software Engineering process associated with UML is: A) Use case driven, B) Architecture and component-centred, C) Iterative (analysis, design and implementation), and D) Incremental.	The method is: A) Use case driven, B) Architecture and component-centred, C) iterative (analysis, design and implementation), and D) Incremental. ▪ It has four phases: inception, elaboration, construction and transition.	There are two modes for using SSM. Mode 1 is the use as a seven-stage methodology. Mode 2 is the use of SSM as thinking structure.	An approach has two parts: A) Business-oriented part. i. Enterprise planning. ii. Business area analysis. iii. Reconstruction. B) System-oriented part. i. System specification. ii. Module programming and testing. iii. System integration and testing.
3) People involved	A) The developer of the system. B) The owner of the process. C) The manger. A) The operational users.	A) The management. B) The developer of the system. C) The users.	A) The management. B) The developer of the system. C) The users. D) The domain experts.	A) The management. B) The developers of the system called ‘Workers’. C) The users.	A) Clients. B) Problem solver. C) Problem owner.	A) Organisation management. B) Domain experts. C) Users. D) Developers.

4) Data gathering means	A) User interviews. B) Workshops.	A) User interviews. B) Workshop discussions.	A) Interviews and workshops with the users and domain experts. B) Review the working materials of the application domain. C) Use cases. D) Prototypes.	A) A feature list. B) The system context through the domain or the business models. C) Use cases. D) A list of supplementary requirements. E) Interviews and workshops with the users. F) Review the working materials of the application domain. G) Prototypes.	A) User interview. B) Discussion in workshops. C) Examining the documents of the current processing system.	A) Interviews and discussions with the domain experts. B) Interviews and discussions with the users. C) Examining the organisation documents.
5) Notations	A) Conceptual models (CMs). B) Role Activity Diagram (RAD) is used to represent coordinative behaviour (divided into modules (roles)).	A) Data Flow Diagrams (DFDs). B) Entity Relationship Diagrams (ERDs). C) Entity Life History (ELH).	It has different diagrams to model the software system. A) Use case diagram B) Class diagram C) Behaviour diagrams: ▪ Sequence diagram ▪ Collaboration diagram ▪ State chart diagram ▪ Activity diagram D) Implementation diagrams: ▪ Component diagram ▪ Deployment diagram	The Unified Process uses the Unified Modelling Language (UML) as a modelling language. It has six models A) Use-case model B) Analysis model C) Design model D) Deployment model E) Implementation model F) Test model	SSM has several models: A) Rich Picture. B) Conceptual models.	There are no specific notations for describing the workflow management system.

6) Decomposition	The problem domain is divided into modules (roles)	The processes of the system are decomposed by using the DFD technique.	The system is subdivided into subsystems and components.	The system is subdivided into subsystems.	Some activities in the conceptual model can be considered as systems. So a root definition and a conceptual model are developed for it.	A workflow management system supports a business process that can be decomposed into tasks.
7) Policies	They can be stated through the business rules.	They are stated in the system database.	They are stated in the use case description and modelled by the activity diagram.	They are stated in the use case description and modelled by the activity diagram.	They can be documented in Analysis Two that defines the roles and its norms and values. Also, policies are represented in the rich picture.	They are stored in the organisation perspective in the comprehensive workflow model.
8) Reuse	Reuse is supported through the sub-role mechanism.	The system should be analysed and designed to be reusable through the components.	A) Direct reuse by using inheritance and delegation. B) Project reuse by using design patterns, business objects and components.	Reuse is supported by specifying a good architecture and explicit interfaces for the sub-systems and components.	There is scope for reuse of the ideas and experiences gained in the previous situations and their conceptual models.	It is necessary to support reusability in the workflow management systems through the reuse of the existing information and artefacts in the enterprise to describe the workflow specifications. Also, workflow management system can reuse scripts, definitions and sub - workflows that can be used in different workflows.

9) Adaptability	Process for process evolution (P2E), meta process is used to maintain the changing environment of the system.	The system is designed by using data structures that are flexible to adapt to any change.	A system developed by using the object-oriented paradigm easily adapts to change because of the use of the class concept through the system development process.	A system developed by using the object-oriented paradigm easily adapts to change because of the use of the class concept through the system development process.	SSM is a generic methodology that can be adapted to suit different problem situations.	Adaptability is achieved through the use of dynamic modelling which specifies a process during the runtime.
10) Flexibility	OPM allows building several method diagrams (RADs) to represent one model of goals.	SSADM places emphasis upon data, which is more stable than processes, thus enabling more subsequent flexibility.	The construction of the system by using components makes it flexible.	The Unified Process is a component-based process so the construction of the system by using components makes it flexible.	SSM is a flexible approach that may be changed while the analysis progresses. It is important to define the particular version of the methodology that will be used.	Flexibility occurs by using control flow rather than concrete flow and using a dynamic model rather than a static one.
11) Exception handling	OPM does not support exceptions.	SSADM handles exceptions in A) The entity life cycle through the 'quit and resume' term. B) Level 2 in the Data Flow Diagram (DFD). C) Requirements Catalogue (RC).	Exceptions are stated in the variations section of the use case description.	Exceptions are stated in the use cases in the design and implemented in the implementation of the system.	It is not applicable in SSM.	Exception handling is done by using event - handler capabilities or human intervention.

12) The method output	A) Modularization of the problem domain. B) The description of the organisational behaviour.	SSADM's output is the physical design of the required system, which is used to implement the system.	A) The component diagram shows the relationship between the system components. B) The deployment diagram shows which components and objects run on which node (processes or computers).	The output is the complete software system that includes all of its engineering and management artefacts.	The output is a purposeful action to improve the problem situation.	The outpu t is a workflow management system for a specific deployment area or a comprehensive workflow management system that covers the entire enterprise.
13) CASE tool	Web process	SSADM is supported by LSDM and many CASE tools from different vendors.	A) National Rose's CASE tool. B) Select CASE tool. C) Together CASE tool.	The Unified Process is supported by rational tools such as Rational Suite™ and Rational ClearCase.	There is no CASE tool to support SSM.	There are two kinds of tools that are used with a workflow management system: build time tools and run time tools.
14) Quality Assurance	OPM does not identify any quality evaluation	Review is done with the users of the products of each stage.	In analysis, the explorative prototyping. In design, the experimental prototypes.	The Unified Process checks the system quality through performing a number of tests to ensure that the system meets the users requirements such as the integration test, Configuration tests, Negative tests and Stress tests.	Quality is validated through defining some activities in a conceptual model that specify criteria that measure and monitor the other activities in the proposed system.	Workflow management systems support the quality of a process through identifying the process rules and the weakest parts in it . Also, workflow systems reduce redundant data entry and the time consumed in data retrieval.

Table 2: Comparison of Methodologies in Terms of a Taxonomy for Workflows.

Table 3 compares the different methodologies in terms of aspects of both the soft an d hard system approaches:

This table includes hard system aspects such as data, events, processes, interfaces, resource and quality (Longworth, 1992a; Longworth, 1992b) and soft system elements such as problem identification, user involvement, organisation al structure, goals and policies, employee job satisfaction, different views, employee's values, and system acceptability and usability (Checkland & Scholes, 1990). Also, there are many problems that the hard approaches could not deal with such as quality and productivity. The quality problems are incorrect problem handled, neglect of wider organisation, incorrect analysis and wrong reasons. The productivity problems are users changing their requirements, the impact of external events to change requirements , unfeasible implementation plans and poor project control. The soft system approach tries to solve some of these problems by placing emphasis on investigating the problem situation using a variety of techniques to determine the organisational policies and goals. In addition the soft approach focuses on wider issues in the social context which may influence the nature of the problem solution such as the organisational structure, employee job satisfaction, employee's values and the system usability and acceptability including user involvement (Flynn, 1998).

Method / System elements	OPM	SSADM	UML	The Unified Process	SSM	WFMS
1) Data	Not supported	Logical Data Model (LDM)	The class diagram	A) The class diagram B) Databases	Not supported	A) In form-based workflow systems, the data is represented in a form in which its fields are connected to a database. B) In engine-based workflow systems, the data is stored in the database, which is passed using parameters and variables.
2) Events	Goal model (Conceptual Model CM)	Entity Life History (ELH)	The Behaviour (Interaction) diagrams	The Behaviour (Interaction) diagrams	Not supported	There are two types of events: internal and external. They trigger the starting and execution of process instances.

3) Processes	Method model (Role Activity Diagram)	Data Flow Diagram (DFD)	The activity diagram	The activity diagram	Conceptual models	A) In form-based workflow systems, the logic of the process is attached with the form. B) In engine-based workflow systems, all process information is stored in a database.
4) Interfaces	Not supported	Dialogue Design	Modelled in class and component diagrams.	A) The user interfaces are represented by screen sketches or prototype tools. B) The internal interfaces are presented in the class and component diagrams and realised by design classes.	Not supported	There are several types of interfaces in workflow systems. The workflow System Coalition identifies five types of interfaces that can be used with engine-base workflow systems. In form-based workflow systems, the form is the user interface.
5) Resource	Not supported	Requirements Catalogue (RC).	Modelled by using the stereotype feature.	The project manager is responsible for planning and scheduling the process resources.	The resources can be presented in a root definition and the activities that are modelled related to them in the conceptual models.	There are two types of resources in workflow systems: information and human.

6) Quality	Not supported	Requirements Catalogue (RC).	A) In analysis, the explorative prototypes. B) In design, the experimental prototypes	A) In inception and elaboration phases the explorative prototypes. B) In test, there are several tests such as integration, configuration, negative and stress tests.	There are measures for activities in the conceptual models. Also some activities monitor these measures and take control action to improve matters in the proposed system.	Workflow systems support quality through identifying the rules that should be followed to perform a specific process. Workflow systems improve the supported process by identifying its weaknesses and reducing the time to perform tasks.
7) Business issues	Method model (Role Activity Diagram)	A) Data Flow Diagrams (DFD). B) Entity Life History (ELH).	Activity diagrams are used to describe and model the business process.	The Unified Process support business issues by developing the business model that defines the business processes.	Business issues are handled as combination of the different perceptions in the conceptual models that help to specify business system options.	Workflow systems support the business issue of the organisation through the support for business processes.
8) Identify the problem or problem objectives	The system model is used to define the problem scope.	The strategic planning defines the problem that needs to be solved.	The strategic planning defines the problem that needs to be solved.	The strategic planning defines the problem that needs to be solved.	Rich picture is used to present the problem situation, which includes different people perceptions.	The organisation problem is identified in enterprise planning and business area analysis. Then it is necessary to identify if workflow systems will solve or improve the situation.

9) User involvement	Users are involved in A) Gathering information about the system. B) Validating the models and the final system.	Users are involved in A) Gathering information about the system. B) Reviewing the products of each stage.	Users are involved in A) Gathering information about the system, which is documented in the use case models, CRC and technical dictionary. B) Reviewing and checking prototypes.	Users are involved in A) Gathering information about the system, which is documented in the use cases, business or domain models and supplementary requirements. B) Checking and validating the artefacts of iteration and Phases.	Users are involved in A) Gathering information about the problem situation. B) Choosing activities to construct a consensus primary task model. C) Debating to define the required changes.	Workflow systems encourage the involvement of the users in implementing a workflow system.
10) Organisational structure, goals and policies	OPM analyses the process to define organisation values.	The strategic planning investigates the organisational structure and documents the result in the Project Initial Document.	The activity diagram is used to model the organisational structure and the integration of the new system.	Documented in the business model and supplementary requirements.	Presented in A) Rich picture model. B) Primary task model.	Workflow systems present the organisation in an organisational structure and an organisational population. The organisation goals can be specified in the enterprise planning and business area analysis. An organisation policy is identified for each workflow operation.

11) Employee job satisfaction	Not supported	SSADM deals with the employee's satisfaction through the user involvement to choose the Business System Option (BSO) that defines its impact on the users and their need for training.	The employee job satisfaction is achieved through allowing the employee to choose a suitable way to perform his assigned job.	There are many ways for increasing the employee's satisfaction such as project feasibility, risk management, team structure, project schedule, project understandability and sense of accomplishment	The employee's job satisfaction is achieved through the user involvement through the stages of SSM.	There are two ways to assign tasks to employees. First is the system-offer model in which the system offers tasks to employees who are free to accept them or not. The other is the system-deliver model, which may provide ways for users to reject or delegate responsibilities.
12) Different point of views	OPM has different techniques to deal with different views: A) Consideration is given to the process owner's view or the analyst will change the process. B) The use of the dialectic concept C) Rich picture is used to represent the different views.	The different views of the system are documented in the Requirements Catalogue.	The analyst should consider the different views of the system and resolve any contradictions.	The different views of the interested people in the system are integrated to reach the best answer.	The different views are identified and the relevant views are modelled in conceptual models. Then these models are combined in ways to accommodate the different views and may extended to reconcile the conflicts.	Some workflow systems can define several process paths to support different views of a process.
13) Employee's values	OPM recommends the use of SSM to define the employee's goals and views	Not Supported.	Not Supported.	Not supported	The employee's values are documented in Analysis Two that specifies the roles, norms and values.	Such values can be stored in organisational population.

14) System acceptability and usability	OPM attempts to match the users' task and the structure of the software system.	SSAMD increases the system acceptability and usability through A) The users involvement in developing the system. B) The use of the prototype. C) The study of the system impact on the staff.	The involvement of the users in the experimental prototypes to verify the usability of the system will encourage the users to accept and use the final system.	A) Involving the user in developing the system. B) Performing an acceptance test for the developed system. C) Providing the users with documentation and help line.	The acceptance of the method depends on the result of the project. So the achievement of the user's requirements and their involvement in the project promotes the acceptance and usability of the delivered system.	The acceptance of workflow systems will increase if they solve workers' problems and the business problems. Also, the services that relate to user requests must be efficient to satisfy their users.

Table 3: Comparison of Methodologies in Terms of both Soft and Hard System Aspects.

7 Conclusions

The different methodologies that are used for developing an information system deal with the hard and soft systems aspects as follows.

The Organisational Process Modelling (OPM) is a simple method, which handles principally the interactions between agents as they achieve their goals for modelling the organisational process. It deals with some aspects of the hard system approach and most of the soft system issues. For the latter it uses some of the Soft Systems Methodology (SSM) techniques to deal with the problem. The most telling criticism of this method is its lack of facilities for representing data structures.

Structured Systems Analysis and Design Method (SSADM) is a detailed method which covers almost every element of the information system. It deals with every aspect of the hard system issues but only some of the soft system issues. So, there is a trend in the latest version of the SSADM to use SSM in the early phases.

Unified Modelling Language (UML) is an expressive modelling language that covers all aspects of the system development process. UML can be used with any object-oriented development method. First, it was used with Business-Oriented Software Engineering Process (BEO Process). Then, it was used in the Unified Process. Both of the methods cover most of the hard system aspects and some of the soft systems aspects. Neither BEO Process nor the Unified Process supports the employee's values.

Finally, Soft Systems Methodology (SSM) deals with some elements of hard system aspects and all of the soft system aspects. SSM does not support hard system aspects such as data structures, events and the design of interfaces.

It can be concluded that there is no methodology that covers all these aspects. So it is advisable or recommended to combine some of these methods. SSM is used to deal with soft system issues and the other methods such as SSADM and UML are used to cover the hard system issues. SSM is used as a front-end method to develop an information system or a workflow system.

Workflow systems are used to document and control the organisation's processes through combining the human and information resources of the organisation. So the development of a workflow system needs a method to deal with both the human (soft) and information (hard) issues. The combination of techniques such as UML and Workflow is the subject of a future report.

Glossary of Modelling Terminology

BOE: Process: Business-Oriented Software Engineering Process in object-oriented paradigm
BSO: Business System Option in SSADM
CM: Conceptual model in OPM
CRC cards: Class-Responsibilities-Collaborators cards in object-oriented paradigm
DFD: Data Flow Diagram in SSADM
ELH: Entity Life History in SSADM
ERD: Entity Relationship Diagram in SSADM
LSDM: SSADM CASE tool
OPM: Organisational Process Modelling
P2E: Process for Process Evolution in OPM
RAD: Role Activity Diagram in OPM
RC: Requirements Catalogue in SSADM
SSADM: Structured Systems Analysis and Design Method
UML: Unified Modelling Language

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