Decision enhancement and business process agility

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To Him to whom all knowledge is His knowledge,

Dad, Mum, Kezia, and Cora

Preface and Acknowledgements

The demand for Business Process Agility (BPA) in organisations today is on an increase due to their ever changing internal and external factors in the business environment. To achieve this agility, organisations should have the ability to identify changes in the environment and respond promptly to them. In this research, a Business Process Agility Decision Enhancement Studio (BPA-DES) that provides business process analysis, simulation, collaboration, and communication services, packaged as suites with guidelines, to support stakeholders during the BPA decision process, was designed, developed and evaluated. This was in response to the gap left by most BPM suites that provided technological support to the business process life cycle, but paid little attention to the decision process that takes place when improving business processes in response to the identified changes in a business environment.

The BPA-DES supports continuous business process improvement and enhances organisations' operational agility by enabling timely identification of improvement opportunities through the workflow analysis and risk assessment. It promotes flexible stakeholder participation and collaboration by providing a collaboration process to guide stakeholders in the generation and selection of Business Process Improvement Alternatives (BPIAs). Also, it facilitates information flow among stakeholders during the BPA decision process through the communication service that enables sending of emails and SMS. Therefore, the BPA-DES provides a new theoretical and practical approach for achieving BPA that directly focuses on BPA decision process and goes beyond providing technological support by also providing guidelines on how stakeholders can work in collaboration to explore business process improvement alternatives.

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Mercy Rebecca Amiyo

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1. INTRODUCTION

1.1. Business Process Management and Agility

Business organisations have business goals that govern their work (Weske, 2007). The business goals are achieved by executing a collection of logically related activities that add value to their customers or market. The activities are collectively known as a business process (Weske, 2007; Muehlen et al., 2007; Caetano et. al., 2005; Hammer and Champy, 2000). Business processes are commonly regarded as an organisation's daily operations.

Execution of such business operations or business processes may be manual or with the support of information systems (Weske, 2007; Aalst, 2004). Information systems that are used to support organisational operations fall in two or more categories; those that are configured or driven by a business process model, and those that support specific tasks e.g. word processing or accounting. The former category of information systems are considered to be process aware because an automated part-of or whole business process is embedded in them. In process aware information systems (PAIS), the enactment of the business process is controlled by a generic software system, for example a Workflow Management System (WFMS) (Weske, 2007). To achieve effectiveness and efficiency in their operations, and to maintain a competitive advantage, organisations have to have effective Business Process Management (Oosterhout et al., 2006; Hill et al., 2006; Sarkis 2001; Sharifi and Zhang, 1999).

Business Process Management (BPM) is both a methodology and a toolset for solving process problems (Christine, 2008) in that it is a process-centric management discipline that provides a structured approach of "employing methods, policies, metrics, management practices and software tools to manage and continuously optimize an organisation's activities and processes" (Hill et al., 2008; Kamoun, 2007). It thus consists of concepts, methods and techniques to support the design, enactment, management (i.e. administration and configuration) and analysis of operational business processes (Weske, 2007; Aalst, 2004), that is the business process lifecycle.

Originally, BPM focused on enabling stakeholders to design, configure, enact, and monitor and evaluate their business processes making necessary adjustments. BPM approaches included operations and maintenance, total quality management and business process re-engineering (Hill et al., 2006). However with dynamic business environments and the emergence of new competitors, organisations have to quickly and continuously evaluate and improve their business processes to meet the demand as well as to enhance their performance (Trkman, 2010). In other words, there was a need to align their business processes to optimally cope with the changes in the environment. BPM therefore cannot be viewed as a one-time project but as a continuous effort within an organization with constant improvement in business processes (Trkman, 2010). Continuous business process improvement (CBPI) by enabling rapid iteration of business processes and underlying systems is thus seen as one of the key elements of the BPM discipline (Hill et al., 2009).

1.2. Business Process Management

Business Process Lifecycle

A business process is described as *a collection of logically related activities that are performed to achieve a given business goal/outcome for a particular customer or market*, i.e. it must add value to a customer (Weske, 2007; Caetano et al., 2005; Hammer and Champy, 2000). A business process is built by linking a number of activities, from different sources in an organisation, to show the flow of data and control among them (Alonso et al., 1996). The activities are carried out in a manner that meets the terms specifying the functional responsibilities and relationships within an organisation (Caetano et al., 2005). Business processes facilitate organisations in the understanding of their operations, design, and realization of flexible information systems to support their staff in performing business processes activities (Weske, 2007). Information systems (IS) that are configured according to a business process specification (process model) are referred to as 'Process-Aware' Information Systems (PAIS) (Aalst, 2004). Examples of PAIS are Workflow Management Systems (Weske 2007; Aalst, 2004) and Enterprise Resource Planning Systems (Aalst, 2004). A business process goes through four phases in its lifecycle namely: design and analysis; configuration; enactment; and evaluation (Weske, 2007; Aalst, 2004).

(i) *Design and Analysis phase*: entails the development of a process model that describes or is a real reflection of a business process. This is done using business process modeling, validation, simulation, and verification techniques.

(ii) *Configuration phase*: Once a process model has been developed, it is tailored or customized to suit the organisational environment using technical information.

(iii) *Enactment phase*: business processes are then executed to achieve given business goals. The processes activities are initiated in a given order, following execution constraints which are specified in the business process model. The enactment of different business processes in an organisation is coordinated by a business process management system (BPMS) (Aalst et al., 2003; Aalst, 2004). A BPMS is defined by Weske (2007) as "a generic software system that is driven by an explicit representation of a business process". During this phase, information is gathered and stored in a log file; for example, a typical log file gives information about the start and end of an ordered set of activities known as entries.

(iv) *Evaluation phase:* involves the analysis of business processes with the aim of improving them. The main purpose of process/workflow analysis is to understand the performance and behaviour of a business process. Workflow or process analysis may be done following a top-down approach which focuses on process documentation or a bottom-up approach that focuses on data generated during the execution of a process (Maruster and Beest, 2009). Some of the methods and techniques that can be used to analyse a process include Process Mining (Weske, 2007; Aalst, 2005), Activity Based Costing (Greasley, 2000), Business Activity Monitoring (Weske, 2007; Aalst, 2004).

In the past, information gathered (system event logs) at the enactment phase in the life cycle of a business process was rarely used except for security and audit purposes. However, today these event logs can be used to analyse and understand the underlying business process through process mining (Aalst, 2005; Aalst, 2007b).

Efficient and effective achievement of business goals calls for coordination and functioning between human resource and other organisation resources such as the PAIS. This is achieved through Business Processes Management (Weske, 2007). Business Process Management extends the traditional Workflow Management (WFM), which focused on getting a PAIS to work i.e.

first 3 stages of the business process lifecycle (Aalst, 2004; Aalst et al., 2003), this meant that supporting the whole lifecycle of a business process (Aalst et al., 2003; Aalst, 2004).

Definition of Business Process Management: Two Viewpoints

Two main viewpoints exist of what Business Process Management (BPM) is; a technology (software tools) view and a management discipline view (Hill et al., 2006; Kol et al., 2008). Looking at the technological view, BPM consists of four major phases (Aalst, 2004; Aalst et al., 2003) which correspond to the four stages in a business process' lifecycle mentioned above (Weske, 2007). It therefore supports the development of a PAIS, diagnosis of business processes, flexibility of business processes, among other functionalities (Aalst, 2004).

As a management discipline, BPM aims at improving business process agility and operational performance (Hill et al., 2006) by providing methods, policies and management practices. The main aims of BPM can be summarized as; representation of business processes, activities and execution constraints between the process activities (Weske, 2007), and the continuous controlling, monitoring, optimizing and modification of business processes (Hill et al., 2006).

Over the years, Business Process Analysis, particularly Business Activity Monitoring (BAM) has received much attention because of its potential in improving business process agility (Aalst et al, 2003; Aalst 2004). It focuses on the evaluation phase of the business process lifecycle i.e. simulation, verification and validation of process designs/models with the aim of improving them (Weske, 2007; Aalst, 2004; Aalst et al., 2003). Under BAM, analysis is done on data logged (event logs) during the execution of business processes at the enactment phase (Weske, 2007). This analysis is aimed at diagnosing or getting insight about the behaviour of the operational process (Aalst 2004; Aalst et al., 2003). Based on the analysis results, modifications or improvements to the business process design or model are made and the whole business process lifecycle is repeated (Weske, 2007).

BPM shifted from management theories and practices such as Business Process Re-engineering (BPR) to technologies that increased agility (Neubauer and Stummer, 2007; Miers, 2006). These technologies enable continuous and direct improvement of business process (Neubauer and

Stummer, 2007; Miers, 2006; Hill et al., 2006) and have been integrated into business process management suites. This shift in BPM was deemed necessary in order to survive in an ever changing business environment and to enable effective control and continuous modification/improvement of business processes.

Continuous Business Process Improvement

In light of the above, coupled with the increasing competition in terms of cost and quality (Hill et al., 2006) facing businesses today, there is a demand for continuous business process improvement (BPI). The increased BPI demand is attributed to a number of factors for example political stability, social factors (e.g. stakeholder and staff requirements), the market, competition and customer requirements (Hill et al., 2006; Sarkis, 2001; Zhang and Sharifi, 1999). For instance, when there is political unrest, the population at large is in fear and thus most businesses either close or open for short periods of time. As a result the public receives minimal service and organisations lose on revenue. It would thus require them re-strategize and change how they are carrying out their operations to ensure low expenditure costs. More so, increase of competitors targeting the same customers in the market place puts a demand on individual organisations to seek to out-compete the competitors or develop a niche for oneself in order to maintain a competitive advantage.

Additionally, customer interests and requirements keep varying which has an impact on how an organisation operates in terms of service delivery in order to satisfy and keep the customers interested. As a result organisations are continuously seeking ways of improving their service delivery methods and consequently their business processes. Similarly, staff/stakeholder requirements are dynamic and thus an organisation needs to be able to improve its business processes to accommodate their interests to keep them motivated (Hill et al., 2006; Sarkis, 2001; Zhang and Sharifi, 1999).

These internal and external factors affect the execution of operations or business processes in an organisation (Hill et al., 2006). Therefore, in order to survive in such a dynamic environment, having responsive Business Process Management (BPM) has become a necessity to organisations. Responsive BPM requires one to first understand the organisation's business

environment by being able to recognize opportunities for change; furthermore, to understand the internal and external drivers of business process improvement (Sambamurthy et al., 2003). To gain this understanding, it becomes paramount to perform continuous analysis and evaluation of business processes and the environment (Bjorn and Ralf, 2010). Not only does responsive BPM call for an organisation to understand its environment to identify opportunities for improvement, it also necessitates the ability to respond quickly to the detected and sensed changes (Hill et al., 2006). This ability is referred to as Business Process Agility.

1.3. Business Process Agility

The increasing competition in terms of cost and quality, and the continuously changing business (e.g. competition), social (e.g. stakeholder and staff requirements) and political environments in the world today, have increased the demand for agility in organisations (Hill et al., 2006; Sarkis, 2001; Zhang and Sharifi, 1999).

Agility is defined by Sarkis (2001) as "the ability to thrive in an environment of continuous and often unanticipated change". It is achieved by identifying changes in the business environment and providing the appropriate capability in respond to them (Lin et al., 2006; Sharifi and Zhang, 1999). From the business perspective, Oosterhout et al., (2006) define Business Agility as the "ability to swiftly and easily change businesses and business processes beyond the normal level of flexibility to effectively manage unpredictable external and internal changes". Oosterhout et al., (2006) consider the normal level of flexibility as having pre-defined ways of dealing with changes that may occur during the execution of a business process.

Basing on these definitions, we define *Business Process Agility (BPA)* as the *ability to 'swiftly' and appropriately adjust a set of related activities performed to achieve a given business goal in response to identified internal and external changes that occur in a business environment, beyond the normal level of 'flexibility'*. We view identified changes as being either predicted, unpredictable, anticipated or unanticipated. Thus for organisations to remain competitive, business process agility is a must (Oosterhout et al., 2006; Hill et al., 2006; Sarkis 2001; Sharifi and Zhang, 1999).

The important aspects of business process agility that can be derived from its definition above include;

(i). **Flexibility** - the ability of easily re-configuring (Sarkis, 2001) or modifying/adjusting a business process. Flexibility beyond the normal level refers to the ability to make adjustments/modifications that are not predefined to business processes when faced with unexpected change (Oosterhout et al., 2006);

(ii). **Speed** - the ability to make adjustments/modifications to business processes in a timely manner (Oosterhout et al., 2006; Lin et al., 2006),

(iii). **Optimization** - all the changes should be done ensuring minimal wastage of resources,

(iv). **Innovation** - opportunistic improvements of business processes i.e. generation of new ideas and business strategies to facilitate continuous business process improvement considering the changes in the business environment as opportunities (Oosterhout et al., 2006; Lin et al., 2006). For example some service providing organisations in Uganda such as the National Water and Sewage cooperate (National Water and Sewage Corporation, 2008) and UMEME (Mugalu, 2012), the electricity distribution company adopted the mobile money innovation as a opportunity to improve their billing business process enable their customers' to pay their bills using this service.

Furthermore, Keen and Sol (2008), mention that agility also includes collaboration and coordination especially when it comes to making decisions. Therefore to easily automate one's business processes in an efficient and agile manner, collaboration and involvement of stakeholders in continuous business process improvement should be encouraged (BizAgi Limited, 2008).

From the definition of what BPA is and its aspects presented above and as seen in literature, (Oosterhout et al., 2006; Lin et al., 2006; Hill et al., 2006; Sarkis, 2001; Zhang and Sharifi, 1999), it can be argued that organisations can increase their competitive advantage by having the ability to;

(i). Detect and/or predict changes e.g. new customer requirements, drop in prices for a given product,

(i). Identify opportunities to improve business processes,
(ii). Flexibly modify/adjust business processes at a minimum cost,
(iii). Easily develop new products whenever there is an opportunity (innovation), and
(iv). Quickly respond to detected/sensed changes in the business environment.

This is mainly because they are able to identify change and response to it e.g. if an organisation is being able to identify its customers' needs, it is in a better position to develop products or provide services that will satisfy them (Hill et al., 2006; Sarkis, 2001; Zhang and Sharifi, 1999).

Additionally, considering that BPA involves continuous business process improvement as discussed in the previous section (section1.2), having the abilities mentioned above could lead to better operational performance since the improvements made are guided by identified changes (Hill et al., 2006; Sarkis, 2001). More so, by being able to improve one's business processes quickly in response to identified changes in the business environment (such as customers' requirements) may consequently lead to an increase in profits. Furthermore, for the business to grow and transform in step with these changes (Hill et al., 2010). BPA is therefore a necessity for organisations to achieve their business goals and improve their business processes in response to the changes in the business environment (Hill et al., 2006).

Points of Agility

In the quest to achieve agility, organisations sought key enablers in making a business process flexible and dynamic. That is, points in a business process that can easily be monitored and modified by a stakeholder or user (IBM Corporation, 2008). Such points are referred to as 'points-of-agility' (IBM Corporation, 2008). In order to affect the performance of a business process, persons that are knowledgeable about the business process manipulate a given point-of-agility without having to change the whole process (IBM Corporation, 2008). Six points of agility have been identified by IBM (IBM Corporation, 2008). These include:

(i). **Events**; in cases where the instances of a process originate from multiple sources or users, they appear to be random and non-sequenced. These are correlated into a single actionable instance pattern.

(ii). **Analytics**; this point-of-agility, deals with the analysis of information related to business processes. This information may be historical data, data from application,

generated during execution i.e. event logs, or other sources. Analysis of such data supports decision making and improvement of business processes and business performance in general.

(iii). **Rules**; business rules refer to an arrangement of procedural logic that are applied and followed when making basic decisions e.g. assignments and routing. Business rules can be changed at any time to improve the performance of the business process.

(iv). **Service Selection**; this involves selecting an appropriate service or set of services to respond to a given service request. It is a point-of-agility because a set of services is selected to respond to change that may have occurred in the business environment.

(v). **Active Content**; this point-of-agility refers to information or data that is logically filled and/or automatically changed or personalised. This is a point-of-agility because each time this information is altered there are a number of actions that are triggered in a business process.

(vi). **Policies**; these refer to a combination of business level declarations that are used to dynamically form business processes from gathered business functionalities of an organisation.

Attainment of BPA thus requires an organisation to invest in activities that enable them to identify changes in its business environment that will affect its business processes. As mentioned in the previous section, continuous business process analysis and the consideration of external factors (e.g. political and economic stability, market demands) in one's business environment, facilitate the identification of such changes which are viewed in this research as improvement opportunities. Once improvement opportunities have been identified, adjustments/modification to one's business processes in response can be explored by generating various ideas of improvement, evaluating them and selecting a suitable one (Bjorn and Ralf, 2010).

Therefore, realization of BPA is seen to be a continuous process involving the identification of improvement opportunities, exploration of business process improvement alternatives, and implementation of selected alternatives. Decision as to what should be improved, what improvements can be made, and which should be implemented to satisfy stipulated requirements

are considered and made during this process (Taylor, 2009). In this research, we refer to this process as the BPA decision process.

1.4. Approaches to Business Process Agility

To meet the increasing demand for business process agility, BPM technologies have shifted from the traditional management methods like Operations and Maintenance (O&M), Total Quality Management (TQM) and Business Process Re-engineering (BPR) (Hill et al., 2006) to business process management suite approaches that support business processes as models, which can be directly manipulated (Hill et al., 2006).

The approaches developed to achieve and improve business process agility centre on continuous process improvement (CPI). CPI focuses on continuous monitoring and improvement of a business process, leading to the enhancement of an organisation's productivity and efficiency (Hill et al., 2006; Miers, 2006). This is achieved through a process improvement lifecycle or a process revision cycle as defined by Hill et al., (2006) and shown in Fig. 1-1. Miers (2006), states that the best practice of BPM involves carrying out 'smaller iterations/cycles' at each phase of the process revision cycle. To support the continuous improvement of business processes, many BPM-enabling tools, combined into BPM suites since 2000, have been developed (Hill et al., 2006).

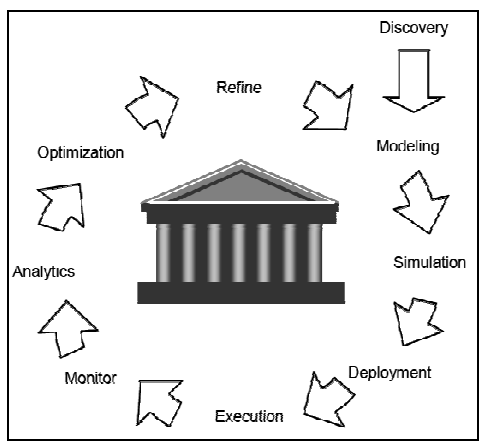

Fig. 1-1: Process Revision Cycle (Source: Gartner, February 2006)

Keen and Sol (2008) defined a suite as a set of services to support a decision making process that is, a combination of information technology tools with guidelines on how the tools can be applied. Muniafu (2007) also defined a suite as a set of integrated IT development tools, systems and analytical methods that are explicitly aimed at achieving a given goal. These suites enable stakeholders to control (monitor and modify) various aspects of business processes (Hill et al., 2006). Examples of these are the IBM Business Process Management (BPM) suite (IBM Corporation, 2008), BizAgi Business Process Management (BPM) suite (BizAgi Limited, 2008).

Business Process Management Suites

A number of BPM suites (see IBM Corporation, 2008; BizAgi Limited, 2008; Singh and Thompson, 2008) that consist of tools and/or services that support the design and analysis, configuration, enaction and evaluation steps of a business process lifecycle, have been developed (Hill et al., 2006). A BPM suite is defined by Hill et al., (2006) as "a set of integrated technologies that enable process stakeholders and users to go quickly around the process revision cycle". A BPM suite primarily consists of 5 components, namely a process modeling tool, a server-based execution engine, a browser-based workspace, BAM intelligence dashboards, and tools to support simulation and optimization capabilities (Christine, 2008). It may have additional components such as a business rules engine or decision services, a content management tool such as a database, collaboration tools, an Enterprise Service Bus (ESB), and industry-specific or application specific frameworks (Christine, 2008).

Development of these BPM suites was to enable flexibility and to support CPI thus business process agility (Christine, 2008; Miers, 2006; Hill et al., 2006). The BPM suites facilitate business process agility by providing means to easily and flexibly monitor the performance of the business process, and to modify the business process model (IBM Corporation, 2008; BizAgi Limited, 2008; Hill et al., 2006) through 'points-of-agility' (IBM Corporation, 2008).

It was observed that a number of BPM suites support BPA use business rules as their point-of-agility e.g. Corticon business rule management studio (Corticon Technologies, 2009), and the IBM BPM suite, which also makes use of the business measures (IBM Corporation, 2008). The BizAgi suite on the other hand supports the whole business process lifecycle (BizAgi Limited,

2008) through the business rules point-of-agility. To improve or to further support business process agility, BPM suites have been combined with other technologies such as Service Oriented Architecture (SOA) (Christine, 2008; Dan et al., 2008; Kamoun, 2007; Hill et al., 2006; Kuhr and Hamilton, 2008), Event Driven Architecture (EDA) (Christine, 2008; Ghilic-Micu et al., 2008).

Service Oriented Architecture BPM Suites

Suites made up of a combination of BPM and SOA technologies are said to improve business process agility by increasing flexibility (Christine, 2008; Dan et al., 2008; Kuhr and Hamilton, 2008; Kamoun, 2007). BPM technologies provide better visibility of process progress and performance (Christine, 2008; Dan et al., 2008; Kuhr and Hamilton, 2008; Kamoun, 2007) while SOA technologies provide functionalities to increase flexibility. The functionalities include; (i) enabling rapid business process improvement through assembling new business processes from existing ones, (ii) reducing costs of improvement by supporting common sharing, linking and reuse of business processes, (iii) increasing reliability and reducing risks by reusing well-tested services.

Service Oriented Architecture (SOA) is defined by Kamoun (2007) as "an architectural approach to system development that builds and delivers reusable and encapsulated business services so that different applications can share them in a loosely coupled and highly interoperable manner". With complexity of business processes and the need to access information from various sources, the alignment of IT and business process became a necessity and not a luxury (Christine, 2008; Kamoun, 2007). In addition, organisations' desire for flexibility and responsiveness to the changing environment (business agility) increased (Kamoun, 2007). Thus, there was need to find solutions that would provide them with these capabilities.

In SOA-enabled BPM suites, business processes are implemented as services and BPM tools as SOA composition applications. BPM tools output SOA metadata that can be imported by SOA composite application (Kamoun, 2007). SOA is implemented as a component in BPM suites using the Enterprise Service Bus (ESB) technology which acts as a mediator between services. The ESB is combined with a service registry and repository to manage service assets and

policies, data services middleware, and service monitoring solutions (Christine, 2008). As a result, business process services in the repository can be assembled into new business processes to meet the changes in the business environment from existing services (Dan et al., 2008, Christine, 2008). Examples of BPM Suites that have SOA include Agilepoint (Singh and Thompson, 2008), Unisys BPM suite (Unisys, 2009) among others. SOA thus compliments BPM which organises people in an agile way, by organising technology for greater agility (Hill et al., 2006).

Event Driven Architecture BPM Suites

Success of an organisation's business lies in their ability to sense-and-respond to both internal and external events as they happen (Christine, 2008). *Event Driven Architecture* (EDA) is defined by Chandy and Shulte (2007) as "a style of application architecture centered on an asynchronous 'push'-based communication model". The combination of BPM with EDA technologies (Christine, 2008) introduced the concept of events to the traditional business processes (Ghilic-Micu et al., 2008; Christine, 2008) thus providing support for sense-and-respond patterns.

The ability to sense-and-respond involves detecting patterns indicating improvement opportunities and possible threats from valuable information extracted from logged events. Upon the EDA architecture in EDA enabled BPM suites; an application detects change and issues a notification that will initiate a reaction in the receiving node as illustrated in Fig. 1-2 (Ghilic-Micu et al., 2008; Lundberg, 2007). Furthermore, in addition to the implementation of an EDA architecture, sense-and respond patterns may also be supported by running complex event processing (CEP) systems as a parallel platform to a BPM suite (Ammon et al., 2008; Lundberg, 2007). The detected patterns are reported through business activity monitoring tools to stakeholders who make appropriate decisions in response (Chandy and Shutle, 2007). Event-enabled BPM suites therefore have the ability to listen and respond to incoming events (Christine, 2008). This ability improves business process agility through detecting unexpected change (events) and responding appropriately. It also provides decision-makers with real-time, detailed visibility into their business processes, extending the limited visibility offered by the BAM dashboards (Christine, 2008).

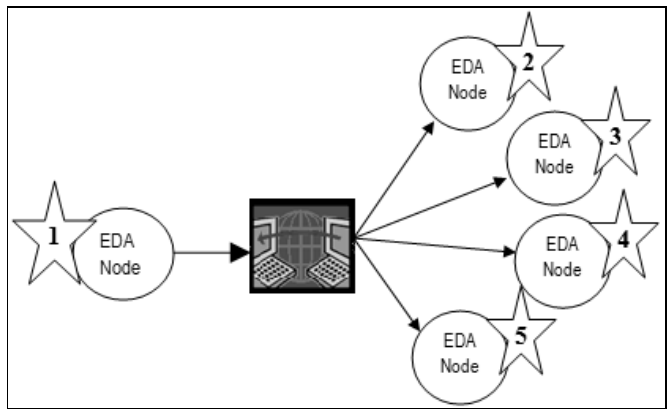

Fig. 1-2: The Publish/Subscribe Mechanism in an Event-Driven Architecture (Source: Ghilic-Micu et al., 2008)

Some researchers went a step further to combine BPM, SOA and EDA. In EDA and SOA enabled BPM suites, EDA facilitates faster communication between the different people and/or services though 'push' functions (Lundberg, 2008). EDA thus deals with the slow speed problem experienced when communication between the SOA components is made up of a combination of pull and scheduled (batch) operations (Ghilic-Micu et al., 2008; Lundberg, 2008). Therefore when used as a communication paradigm, EDA enhances SOA enabled BPM suites (Ghilic-Micu et al., 2008; Lundberg, 2007) and improves business process agility further.

Collaborative Business Process Management

In the daily execution of business processes, several people from different departments, and/or having different roles, interact and take part at different stages of a business process in order to achieve business goals (Bjorn and Ralf, 2010). Likewise in business process improvement efforts, the need for collaboration moves further beyond internal stakeholders (stakeholders who take part in business process) to include external stakeholders such as politicians, customers, and other experts for example business process analysts and software engineers (Liu et al., 2008). This is particularly necessary because multiple skills are required in the identification of improvement areas and exploration of alternative ways of improvement. More so, it is thought

that involving stakeholders and top management in the decision process involved in business process analysis and BPI alternative exploration would increase their commitment and acceptability of business process changes.

So far the approaches for achieving BPA so far mentioned in the previous sections concentrate on supporting some or all the phases of a business process life cycle; that is the design and analysis, configuration, enactment and the evaluation. However the collaboration aspect of BPA has been left out that is; the various interactions among stakeholders during the execution of business processes, is not considered. Collaborative BPM was thus developed as another approach of improving business process agility.

Collaborative BPM seeks to provide support for collaborative interactions among stakeholders that could take place before an action is taken at a given step in the business process flow, or during the execution of a business process activity (Christine, 2008). It describes coordinated initiatives that involve actors from the inside or outside of an organisation (Bjorn and Ralf, 2010) by capturing information shared during informal interactions among participants when solving exceptions into repositories. The captured information such information from emails and documents, is used for future reference. By early 2008, companies like Oracle started developing BPM solutions that provide stakeholders with the ability to create and manage ad hoc tasks or attach workspaces to individual steps in a process that is, at the point of need (Christine, 2008). According to a survey carried out by Oracle in 2008, Collaborative BPM was being used in three areas: (i) Exception Handling which involves the capturing of all information e.g. emails and documents used to resolve exceptions that occurred in the course of executing a given structured process; (ii) Case Management where instances of cases may require undefined interaction between stakeholders to arrive at an appropriate solution rather than defined case handling process; and (iii) Research Processes where different stakeholders search for and contribute information regarding business processes (Christine, 2008). In the respective areas, collaborative BPM sought to support 'offline' stakeholder interactions/consultations (i.e. those that are not part of the modeled business process and take place over emails) through the use of common workspaces. Such interactions/consultations arose whenever an undefined (or exceptional) event

occurred; in the event of an exceptional case; and during the research process, respectively (Christine, 2008).

Nevertheless, research in Collaborative BPM has since then increased on account of the high importance attached to stakeholder involvement and collaboration for the success of BPM projects (Den Hengst and De Vreede, 2004; Bjorn and Ralf, 2010) and BPA. Collaborative BPM has thus became a fast rising research area (Bjorn and Ralf, 2010) leading to the collaborative business engineering (CBE) research field. The CBE approach combines business process re-engineering (BPR) with collaboration and simulation modelling (Den Hengst and De Vreede, 2004). In other words, collaborative business engineering (CBE) furthers the supports of collaborative tasks in BPM with particular focus on stakeholder participation. According to Den Hengst and De Vreede (2004), CBE is an approach that seeks to address insufficient stakeholder involvement and poor analyses of the business processes challenges by bringing collaboration and simulation modelling support into the business process reengineering process. These are reasons that among others lead to failure in business process re-engineering projects in BPM. It presupposes that stakeholders in an organizational process have the essential information that is required for the effective completion of a redesign effort and thus should be involved in the redesign activities. The CBE approach thus adopts a procedural rationality perspective that focuses on facilitating a diagnosis and design process that will yield a satisfying and acceptable solution (Den Hengst and De Vreede, 2004).

1.5. Challenges of BPA Approaches

Notwithstanding the various approaches and BPM suites that have been developed to provide Business Process Agility (BPA) as described in the previous section, a number of issues remain matters of concern in the quest to achieving and/or improving business process agility in an organisation.

First, most of the reviewed BPM suites focus on the business rules point-of-agility (Corticon Technologies, 2009; BizAgi Limited, 2008; IBM Corporation, 2008; Singh and Thompson, 2008). However, the analytics points-of-agility has not received much attention yet analysis of business processes related information such as events logs, is vital in giving more insight to a

business process' behaviour. We argue that attaining this kind of insight would enhance BPA by providing a means to identify change in the business environment, and opportunities (internal and external drivers) to improve a business process.

Secondly, most of the BPM suites have very limited support for sense-and-respond patterns in terms of implementing EDA in BPM suites (Christine, 2008; Lundberg, 2007). Companies have implemented pull functions at the surface of their business process which achieves an event-driven behaviour. However they do not implement EDA at the core of the business process (Lundberg, 2007). In addition to this, attempts to support the sense-and-respond patterns have been done by running a parallel complex event processing (CEP) platform (Ammon et al., 2008; Lundberg, 2007) which increases the costs.

Third of all, the decision process involved in business process improvement has received little to no attention in the recent past due to limited support for collaborative BPM (Christine, 2008) thus BPM collaboration is still a key challenge in BPM research (Bjorn and Ralf, 2010).

More so, it was observed from the reviewed BPA approaches discussed in the previous section, that less attention to the guidelines that align people (stakeholders involved) with the technology when exploring BPI alternatives during the BPA decision Process. Most of the BPM suites developed focus on providing tools and/or techniques that support the business process lifecycle (analysing and designing, configuring, enacting and evaluating business processes). There is therefore a need to provide a means of fusing the three aspects; stakeholders, BPM suites within the BPA decision Process.

1.6. BPA Decision Process

The BPA decision process involves deciding as to what should be improved, what improvements can be made, and which should be implemented to satisfy stipulated requirements, and to enable risk management and identification of opportunities for improvement (Taylor, 2009). It involves continuous analysis of the business process in order to identify areas that need improvement and/or problems. Additionally, stakeholders seek to understand their business environment by identifying changes in customer requirements, political and economic status, market demands,

costs, and competition in order to identify problems and/or opportunities for them to improve their business processes so as to meet the demands and to maintain a competitive advantage. Having identified problems and/or improvement opportunities, they explore possible solutions, and the selection of a suitable solution or course of action from among them. Consequently the BPA decision Process can be broken into three distinct phases; the identification, development and selection phases (Al-Tarawneh, 2012).

Due to the dynamic nature of organisations' business environments, the BPA decision process is highly unstructured, complex and risk inherent continuous process that has impact on the future on an organisation (Al-Tarawneh, 2012). More to that, it is multifaceted and thus a highly consultative process involving various skilled and knowledgeable stakeholders/people within and outside an organisation due to the cross-cutting nature of business processes. Additionally, there are no predefined solutions or ways of improving a business process in response to identified changes in a business environment. This makes the BPA decision process uncertain and highly risky in case of selecting a wrong BPI alternative. Thus the BPA decision process can also be described as a value-dominated, uncertain and consequential process.

The BPA decision process therefore necessitates careful management to align and acquire the required knowledge/skill set and stakeholders with appropriate technology in order to gain the most needed value, and steer clear of chaos and costly consequences that would otherwise affect the operations of an organisation (Bjorn and Ralf, 2010). Also it requires that participation and coordination of multi-disciplinary stakeholders as well as collaboration among them is ensured.

Challenges of the BPA Decision Processes

Although any change to a business process would have effect on the various stakeholders, Muehlen and Ho (2006) state that lack of or poor communication between BPM stakeholders is a challenging risk that affects all the phases of a business process' lifecycle; which includes its analysis and improvement.

Furthermore, regardless of the BPA decision process being continuous and knowledge intensive requiring multiple skills and expertise thus calling for interaction amongst stakeholders (BizAgi

Limited, 2008); it is also challenged by poor stakeholder involvement (Den Hengst and De Vreede, 2004). This challenge is commonly reflected as insufficient participation of top management and/or operational users (Den Hengst and De Vreede, 2004). Yet, involving various stakeholders in the decision making process in business process management would increase their commitment and acceptability of business process improvements. Additionally, achieving BPA requires an organisation to have the ability to identify (i) changes in its business environment, and (ii) internal and external BPI drivers, in order to improve their business processes accordingly (Lin et al., 2006; Sharifi and Zhang, 1999). This ability enables organisations to identify improvement opportunities and necessitates the involvement of stakeholders especially in improving the business process (Den Hengst and De Vreede, 2004; Bjorn and Ralf, 2010).

What is more, it was observed from literature that there is no structured approach to decision making during continuous business process efforts. This is seen as a challenge because it is of importance to carefully coordinate involved stakeholders and the continuous adaptation of new conditions to avoid chaos (Bjorn and Ralf, 2010).

Therefore, there is a paramount need to support stakeholder involvement and collaboration for successful and continuous business process improvement (Den Hengst and De Vreede, 2004; Bjorn and Ralf, 2010) as any changes in the business process would have effect on the various stakeholders. More so, to support the BPA decision process in order to carefully coordinate involved stakeholders and the continuous adaptation of new conditions to avoid chaos (Bjorn and Ralf, 2010).

Bearing in mind the challenges of the BPA approaches discussed in section 1.5, particularly the fact that none of the approaches developed directly targets the BPA decision process shown by the minimal support for collaborative BPM, the challenges facing the BPA decision process may be addressed by providing an environment that will support stakeholder involvement and collaboration i.e. that facilitates collaboration, coordination, communication by providing guidelines for successful and continuous business process improvement. In addition, the environment should enable business process analysis, and BPI alternative exploration

capabilities. These capabilities may be provided as decision enhancement services. A decision enhancement service is a combination of a suite(s) and guidelines on how to leverage the suite(s) to make decisions. More to that, decision enhancement services seek to align technology, people and process (Keen and Sol, 2008) something that is seen to be lacking in the existing BPA approaches.

1.7. Decision Enhancement Services

Decision Enhancement (DE) is "a management lens or way to look out at the dynamic and volatile domains of complex private and public sector decision-making and, increasingly, their interdependencies and necessary collaborations" (Keen and Sol, 2008). DE aims at enhancing decision making processes through professional practices that fuse human skills and technology (see Fig. 1-3); bringing together the best of executive judgment and experience with the best computer modelling, information management and analytic methods while facilitating scenario-building and evaluation, collaboration and simulation to rehearse the future as illustrated in Fig. 1-4 (Keen and Sol, 2008).

This is done by providing services that target all levels of decision making in an organisation; enhance the link between people and technology mainly by enabling visual thinking through multimedia; and through the combination of process enhancements, facilitation and appropriate analytical methods and computer tools or suites (Keen and Sol, 2008).

The combination of a suite(s) and a method on leveraging the suite forms a decision enhancement service. A decision enhancement service is geared to facilitating effective deployment of technology for achieving decision process agility; that is a decision process that is characterized by speed, flexibility, coordination, collaboration and innovation (Keen and Sol, 2008). Decision enhancement services may be delivered through studios to enable various knowledgeable stakeholders to evaluate different what-if scenarios of possible solutions to a given problem.

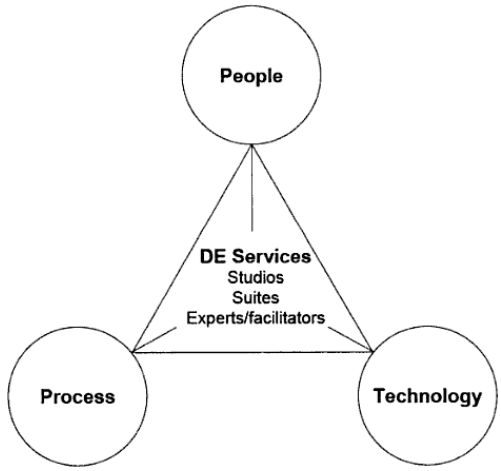

Fig. 1-3: Decision Enhancement: The fusion of people, process and technology through studios (Source: Keen and Sol, 2008)

A studio is an environment or shared space or forum designed around a process or processes, that contain a set of integrated tools/technologies that enable stakeholders (people) to interactively collaborate to generate and analyse possible solutions to a given problem (Keen and Sol, 2008; Muniafu, 2007).

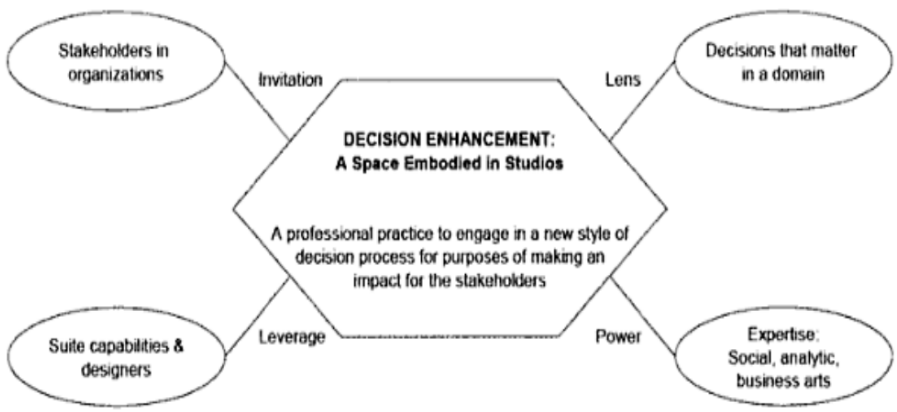

Fig. 1-4: Decision Enhancement - A Field of Practice (Source: Keen and Sol, 2008)

Such a set of integrated tools/technologies is referred to as a suite (Keen and Sol, 2008; Muniafu, 2007, Hill et al., 2006; Kol et al., 2008). These suites are deployed in a studio using process methods and recipes on how the stakeholders/users can interactively use the deployed suites (Keen and Sol, 2008; Muniafu, 2007). Studios are therefore useful in solving problems and have been used in several domains. For example, they have been applied in the education field to teach programming course units (Hundhausen, 2002; Bequette and Ogunnaike, 2001; Bequetter et al., 1999), to plan airports (Keen and Sol, 2008), and in BPM to develop business rules (Corticon Technologies, 2009).

In DE, studios provide environments consisting of services that enable identified stakeholders (Fig. 1-4 illustrates the various categories of stakeholders/expertise) to explore different solution scenarios and basing on the results, decisions are made.

1.8. Research Questions and Objective

Research Questions

Considering the increased demand for BPA and notwithstanding the BPM suites that have been developed to provide BPA, little to no attention has been paid to the decision process involved in coming up with alternative solutions on how to improve business processes in response to identified changes and BPI drivers in organisations. Therefore the major question that this research aimed at answering was:

"How can the decision process involved in Business Process Agility be enhanced?"

To effectively answer this research question, we divided this question into the following sub-questions;

i) *What is the decision process followed in exploring different modifications/adjustments of a business process?*

ii) *What challenges are faced by stakeholders involved in the decision process followed in exploring different business process improvement alternatives?*

iii) *How can these challenges be addressed to enhance the BPA decision process?*

Research Objective

In answering these research questions, we worked towards building an artefact that would address the challenges identified as to be facing the stakeholders involved in the BPA decision process in order to enhance the process of exploring Business Process Improvement (BPI) alternatives in response to identified changes or improvement opportunities in a business environment.

1.9. Research Approach

A research approach defines how a researcher conducted his/her research highlighting the philosophy, strategy, research methods and instruments or techniques that were used (Galliers, 1992).

Research Philosophy

A research philosophy is the way of thinking adopted by a researcher to guide his/her inquiry (Orlikowsk and Baroudi, 1991). More to that, it entails the perspectives followed by researchers during the development of knowledge (Trochim, et al., 2007). A research philosophy is the way of thinking adopted by a researcher to guide his/her inquiry (Orlikowsk and Baroudi, 1991). More to that, it entails the perspectives followed by researchers during the development of knowledge (Trochim, et al., 2007). According to Flowers (2009), the perceptions, beliefs, assumptions, the nature of reality and the knowledge of that reality, adopted by a researcher will influence how he/she conducts the research from the initiation to the conclusion.

The commonly presented philosophies that are used in information systems research are positivism, interpretivism and critical research also known as realism (Leitch et al., 2009; Cassel and Johnson, 2006; Orlikowsk and Baroudi, 1991). In addition to these philosophies is the design science paradigm which has its roots in engineering and natural sciences (Hevner et al., 2004).

Positivism

The positivist research perspective has its roots in logical positivism and natural science and focuses on the belief that there exist pre-fixed relationships within phenomena which can only be

studied/examined using structured instrumentation; methodological procedures derived from those in natural science (Cassel and Johnson, 2006). We can therefore say that positivism is based on realism and stresses rationality, universality, objectivity, and value-free knowledge as is the case in natural sciences (Leitch et al., 2009) as illustrated by the assumptions presented by Orlikowsk and Baroudi (1991) . These assumptions include;

(i) The phenomenon of interest is single, tangible and can be fragmented, and there is a unique, best description of any chosen aspect of the phenomenon.
(ii) The researcher and the object of inquiry are independent, and there is a sharp demarcation between observation reports and theory statements.
(iii) Nomothetic statements, i.e., law-like generalizations independent of time or context, are possible, implying that scientific concepts are precise, having fixed and invariant meanings.
(iv) There exist real, uni-directional cause-effect relationships that are capable of being identified and tested via hypothetic-deductive logic and analysis.
(v) Inquiry is value-free.

Considering the above, positivist researchers assume that observation is theory neutral (Leitch et al., 2009; Cassel and Johnson, 2006) in that, the theory is true only if it is repeatedly falsified by empirical events (Orlikowsk and Baroudi, 1991). Positivist research therefore seeks to increase the understandability of theories by identifying law-like generalizations that explain what has been observed (Leitch et al., 2009). However, when researching on social phenomena, it is difficult and problematic to make generalizations because the ideals are typically compromised in the requirements (Orlikowsk and Baroudi, 1991).

Interpretivism

In contrast to positivism, interpretivism is a research philosophy in which the line of thought is that people attach meaning to phenomena in their social world which in turn results in a particular social action. As a result, the world is not considered to be made up of unchanging objects but as a social process made up of human subjective and inter-subjective experiences. In light of this, interpretivism asserts that reality cannot be understood independent of the social actors (including the researchers) that construct and make sense of that reality (Orlikoswsk and

Baroudi, 1991) or in pursuit of objective truth (Leitch et al., 2009). This implies that all observation is theory and value-loaded (Leitch et al., 2009).

Research following this line of thought therefore aims at understanding human behaviour (Leitch et al., 2009) as a means to finding a shared understanding or a relativistic view of issues or events concerning the phenomena under study. In other words, understanding how different people in a social process attach meaning to objects, and how the embedded meanings affect their courses of action, in order to interpretively explain why the people act the way they do (Orlikoswsk and Baroudi, 1991).

Critical Philosophy

On the other hand, compared to the positivist and interpretive research philosophies, critical philosophy has an evaluation arm. In this arm, a critical researcher seeks to critically evaluate and transform the social reality being studied. This school of thought aims at identifying and exposing contradictions and conflicts that might be inherent in social systems structures through their critical analysis or assessment (Orlikowsk and Baroudi, 1991).

Design Science

Design science is fundamentally a problem-solving paradigm seeking to "create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, and use of information systems can be effectively and efficiently accomplished" (Hevner, 2007). It aims at stressing the development of artefacts that contribute to the body of knowledge and are relevant to the community, in other words, the 'utility of artefacts' (Winter, 2008; Carlsson, 2006; Hevner et al., 2004). Artefacts may be methods and instances of systems for a given set of user requirements presented as models (Hevner et al., 2004). Design Science research involves three cycles namely, the relevance cycle, the design cycle and the rigor cycle as shown in Fig. 1-5 (Hevner, 2007; Hevner et al., 2004).

The 'Relevance Cycle' aims at the identification of a problem or an opportunity in a given application domain. The business environment is explored to determine the business needs, an input to the design cycle, as well as to define an acceptance criteria for testing produced artefacts

(Hevner, 2007; Hevner et al., 2004). The 'Rigor Cycle', involves thorough review of past knowledge in terms of foundations and methodologies to identify applicable knowledge; knowledge that can be applied in solving a given problem. It also ensures that the artefacts produced by the research are innovative and add to the existing knowledge base. The rigor cycle also provides input to the design cycle in terms of appropriate theories and methods for construction and evaluation of artefacts (Hevner, 2007; Hevner et al., 2004). The 'Design Cycle' is the core of design science. It involves the building and evaluating of artefacts following a set of guidelines defined in Hevner et al. (2004). Artefacts can be in form of instantiations, models, methods or constructs (Winter, 2008; Carlsson, 2006; Hevner et al., 2004).

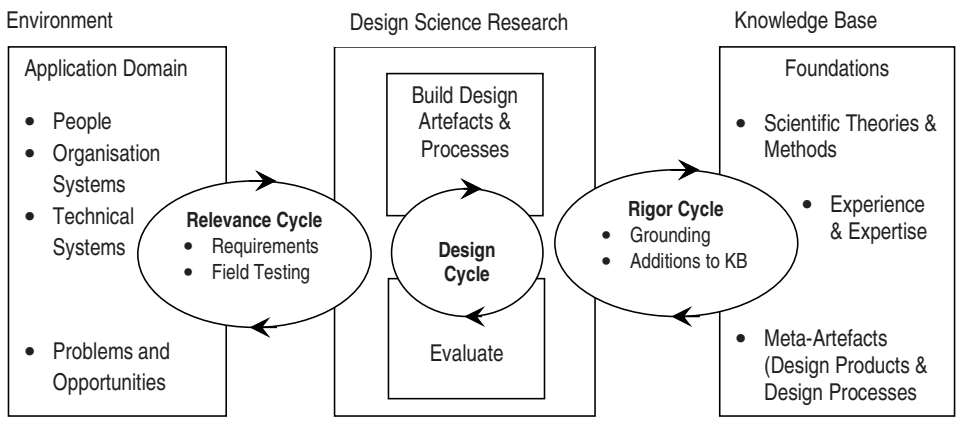

Fig. 1-5: Design Science Research Cycles (adopted from Hevner, 2007)

In this research, the design science research paradigm was followed in answering the research questions so as to achieve the research objective. Taking into consideration that business processes involve different stakeholders in an organisation, it is important to consider and understand the meanings attached to the different aspects of the business process that lead to subsequent actions. We chose to use the design science research paradigm or philosophy because it enables the understanding of organisational issues associated with decision making in business process management. The understanding is achieved by including the stakeholders in the research process in order to build an artefact that will enhance their exploration of Business Process Improvement (BPI) alternatives (BPA decision process). Instances of the designed environment at different case studies were used to evaluate and refine the design further. The

two design science perspectives of a 'design' i.e. design as a product and design as a process were followed in this research.

- *Design Product*: The research aimed at coming up with a design of an environment that would support the decision process involved in exploring business process improvement alternatives in response to identified changes in a business environment, to improve business process agility.
- *Design Process*: The research sought to provide ways of performing a set of activities to explore business process improvement alternatives.

Following the relevance cycle, a case organisation's business environment was explored to gain an in-depth understanding of the BPA decision process and the challenges therein. The relevant information was gathered using interviews. The gathered information was analysed and functional requirements for the decision enhancement services. In the rigor cycle, existing literature was reviewed in order to affirm our research inquiry and identify tools and techniques that were used to provide the decision enhancement services that satisfy the functional requirements. The functional requirements from the relevance cycle and the tools and techniques identified in the rigor cycle were used as inputs into the design cycle. In the design cycle, the BPA-DES was designed to provide support the stakeholders in the BPA decision process by providing decision enhancement services. Additionally, the Collaboration Engineering (CE) approach was followed in designing the BPIAE collaboration process. The designed BPA-DES was evaluated following the four Action Research (AR) steps described in Zuber-Skerritt (1991) namely, planning, acting, observing, and reflection. In the planning step, appointments were made and rapport established at the different case organisation. In addition to reported success in other research studies such as (Nabukenya et al., 2008; Kamal et al., 2007; Koneri et al., 2005), AR was chosen for two other reasons. First because it enabled us to answer the 'how can' (how can the challenges faced by the stakeholders be addressed to enhance the BPA decision process). Secondly, it allowed for the researcher to evaluate the BPA-DES in a real life setting.

In the act stage, walk-through sessions were conducted at the two case studies. Observation guides, interview guides, simulations and questionnaires were conducted and administered to gather participants' opinions about the usefulness and usability of the BPA-DES suites as discussed in chapter 5. The gathered information was analyzed and reflected upon to identify

refinement aspects subsequent testing sessions and to finally come up with conclusions about the usefulness and usability of the BPA-DES.

Research Strategy

A research strategy has been described by Nabukenya (2009) as an ordered set of steps followed when inquiring into a phenomenon being investigated. There are two main types of research strategies; the inductive and deductive strategies (Trochim, 2006; Neuman, 2003). These strategies underline five inquiry systems; Leibnizian, Lockean, Kantian, Hegelian and Singerian inquiry systems (Lester, 2005, Mitroff, 1973). Trochim (2006) describes a deductive research strategy as one that seeks for proof of established theories in given situations. The emphasis in deductive research is the purely formal, mathematical, the logical, and the rational aspects of human thought (Mitroff, 1973). This research strategy is therefore regarded as a 'top-down' approach to conducting research (Trochim, 2006).

On the other hand, Trochim (2006) describes an inductive research strategy as one that seeks to define a theory based on observations from given situations. Inductive research is regarded as a 'bottom-up' approach to conducting research in which open-ended exploration is done (Trochim, 2006). The choice of a research strategy greatly depends on the nature of the research problem (Nabukenya, 2009). The former is favourable when dealing with well-structured problems while the latter is favourable when dealing with ill-structured problems or when seeking to define problems (Trochim, 2006). An ill-structured problem is one that is not routine, that is, one whose precise nature is not clear, inputs are rapidly changing, and has no clear best solution (Mintzberg et al., 1976; Simon and Newel, 1958).

In this research, the decision process involved in exploring alternative ways to improve business processes in response to identified changes, and internal and external drivers for improvement, is not clearly defined. The research was thus conducted following an inductive-hypothetical research strategy. The inductive-hypothetical research strategy is based on the Singerian (Churchmanian) inquiry system. The Singerian inquiry system is an "archetype of synthetic interdisciplinary systems" which argues that the system of science is non-separable; logic cannot be attained independent of psychology and sociology (Mitroff, 1973). In other words, the ethical

values and practical consequences are viewed as the sources of evidence; the consequences of research claims and arguments are ethically and practically defensible (Lester, 2005). The inductive-hypothetical research strategy (Sol, 1982) is characterized by (i) emphasis of problem conceptualization through the specification and testing of premises in an inductive manner; (ii) opening up of possibility for interdisciplinary problem solving (iii) enablement of generation of multiple solution alternatives to the problem under investigation in the existing situation, (iv) independence of the analysis and synthesis phases of solution finding by permitting feedback and learning. It is also suitable for solving problems from organisational practice. These characteristics made it suitable for tackling the objective of this research.

In pursuing the inductive-hypothetical research strategy, five steps are followed (see Fig. 1-6); initiation, abstraction, theory formulation, implementation, and evaluation.

Initiation Stage: In this stage, theories surrounding business process agility were studied from literature to gain an in-depth understanding of the approaches and challenges that exist in achieving BPA. Furthermore, case studies were carried out on organisational business processes in order to gain a deeper understanding of the business needs pertaining decision making and BPA.

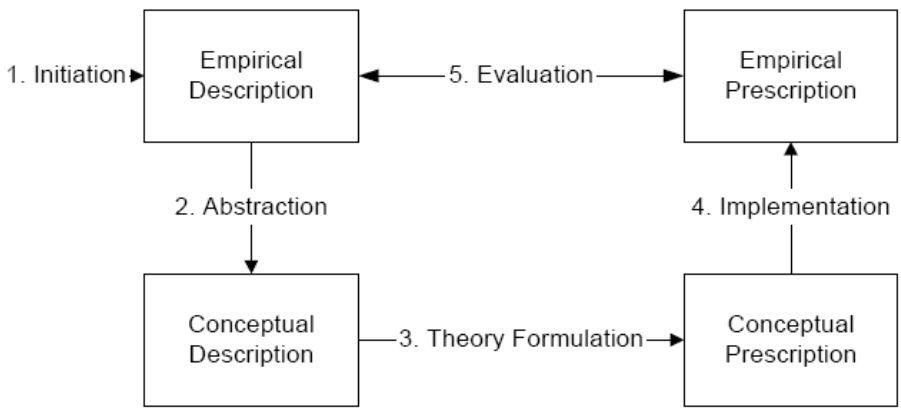

Fig. 1-6: Inductive Hypothetical Research Strategy

Abstraction Stage: The gathered information from the initiation stage was analysed to identify internal and external drivers for business process improvement, and derive functional requirements for the required environment. The requirements provided the conceptual description of what the designed artefact should provide.

Theory Formulation Stage: Basing on the derived requirements, Sol's descriptive framework for design approaches (Seligmann et al., 1989) was followed to design the environment to support the BPA decision process. The environment designed provided the conceptual prescription of what should constitute the required environment.

Implementation stage: Dry runs with volunteers taking roles of stakeholders of a given business process were conducted and the results used to improve the environment design. The volunteers included six staff members from the ICT and Business department of the Faculty of Economics and Business, University of Groningen (RUG), six staff members from the Faculty of Computing and Informatics Technology (FCIT), Makerere University and six PHD students from FCIT, Makerere University. In business process considered was the student registration process followed by the FCIT. The staff members and students from Makerere represented the possible internal stakeholders and the staff from RUG represented possible external stakeholders e.g. two were business process experts, of the environment.

Evaluation Stage: In this stage, the developed instance of the environment was subjected to testing at different case study organisations using walk-through sessions with business process stakeholders. The aim of the testing was to evaluate the environment's usability and usefulness in supporting the BPA decision process. Feedback from the stakeholders was gathered using questionnaires, and interview and observation guides.

Research Instruments

At the different phases of the research a number of research instruments were used. Table 1-1 shows a summary of the research instruments used at a given phase of research.

Table 1-1: Summary of research tools applied at different research stages

Research Strategy Phase	Research Instrument used
Initiation	In-depth Literature Review
Abstraction	Case study Interviews In-depth Literature Review
Theory Formulation	In-depth Literature Review
Implementation	In-depth Literature Review
Evaluation	Case Study Interviews Questionnaires In-depth Literature Review Walkthrough Sessions

Case study

A case study is defined by Yin (2003) as "an empirical inquiry that investigates a contemporary phenomenon with its real-life context especially when the boundaries between phenomenon and context are not clearly evident". It involves the examination of a phenomenon in a natural setting using different data collection methods to collect information (Benbasat et al., 1987; Darke et al., 1998). It was selected because of its suitability for understanding the BPA decision process and the associated challenges in organisational contexts. More so, because of its appropriateness in answering descriptive (*what*) i.e. research questions (i) and (ii), as well as explanatory (*how or why*) questions i.e. research question (iii).

Case studies were used at the initiation stage characterized by an exploratory study, and during the evaluation phase that involved testing and evaluating the BPA decision enhancement studio.

Interviews

An interview is a data collection method where a researcher asks a respondent a set of questions and records his/her answers (Neuman, 2003).

Interviews were used in data collection at the initiation stage during the exploratory study to understand the business environment and to identify the business needs (Interview guide 1 in Appendix A). They were also used during the theory formation phase to get people's opinions about the appropriateness of the specified suites with respect to the activities that need to be performed when carrying out business process improvement (Interview guide 2 in Appendix A).

In-depth literature review

This is the analysing of existing documentation on a given subject/topic (Neuman, 2003). It was used to identify different constructs, frameworks, methods, instruments, theories and techniques that are applicable for the development of suites and recipes. Literature was reviewed throughout the research phases in order to ground observations as well as identify appropriate knowledge concepts that can be applied in carrying out risk assessment, workflow analysis, BPI exploration, and information dissemination activities.

Questionnaires

This is a set of open- and/or closed- ended questions administered to a number of respondents to gather information on a research phenomenon (Neuman, 2003). Johnson and Turner (2003) categorize questionnaires into 3 categories; Qualitative, Quantitative and Mixed Questionnaires.

In qualitative questionnaires the type of questions are unstructured, exploratory, and in-depth open-ended, while those in qualitative questionnaires are closed ended. Respondents answer the qualitative questionnaires in their own words but select from a set of possible responses in quantitative questionnaires. Mixed questionnaires on the other hand are a self-report instrument filled out by respondents and contain a mixture of completely open- and closed-ended questions (Johnson and Turner, 2003).

Mixed questionnaires were selected because of suitability in measuring attitudes of participants as well as gathering extra information that could have been possibly missed in a closed ended question. They were used to evaluate the designed environment. The sample questionnaire is in Appendix B.

1.10. Research Contribution

The research provides an understanding to the BPA decision process highlighting the challenges there of. In doing so, it was observed that the existing BPA approaches provide minimal support for the BPA decision process. Therefore in following the described research approach in section 1.9, the research sought to design an environment to enhance the BPA decision process.

In light of this, the BPA Decision Enhancement Studio (BPA-DES) design described in chapter 3 contributes a new theoretical and useful approach for achieving BPA that directly focuses on BPA decision process. The BPA-DES provides a combination of workflow analysis, simulation, risk assessment, communication and collaboration decision enhancement services, packaged as suites with guidelines deployed in a studio environment.

The BPA-DES improves organisations' business process agility by providing decision enhancement services which support timely identification of improvement opportunities i.e. workflow analysis and risk assessment suites and guidelines for analysing the behaviour and performance of business processes and the inherent risks respectively. Additionally, the BPA-DES provides a collaboration process that provides a structured approach for identifying problems and/or improvement opportunities in a business process, generation of improvement alternatives and selecting a suitable business process improvement alternative during the BPA decision process. This provides a flexible decision making approach for exploring business improvement alternatives in response to the identified improvement opportunities. Also, the BPA-DES facilitates stakeholders' involvement and participation which addresses the challenge faced currently in the BPA decision process particularly through its collaboration services as well as through its communication services that promotes information flow.

The BPA-DES is also relevant to organisations because it enables stakeholders to collaborate in quickly coming up with new ways of improving a business process in a flexible manner. The guidelines provided in the BPA-DES facilitate coordinated interactions among stakeholders and between stakeholders and the technology provided in the suites. More to that, the BPA-DES enhances communication among stakeholders in the BPA decision process through the communication services, that enable them to disseminate information through email and SMS

notifications. The simulation services further enhance the evaluation of business process improvement alternatives by providing stakeholders with a glimpse into the performance of the proposed improvement solutions. This facilitates effective decision making in business process improvement efforts i.e. selection of a suitable improvement solution. Therefore the BPA-DES enhances the BPA decision process by enabling stakeholders to make efficient and effective decisions on how to improve a business process.

1.11. Outline of Thesis

The thesis is organized into six chapters as shown in the Fig. 1-7. Following the research strategy, brief descriptions of the thesis chapters are presented in this section.

The initiation stage entailed the review of literature to gain understanding of issues surrounding decision making in business process agility. Findings from literature are presented in chapter 1.

In the abstraction stage, an exploratory study was conducted and requirements were derived from the observations made. These are presented in chapter 2. The requirements were used in the theory formation stage to develop a BPA decision enhancement studio design which is presented in chapter 3.

Chapter 4 gives account of the activities that took place during the implementation stage. It describes how the designed BPA decision enhancement studio was realized in form of a prototype. A studio prototype of the BPA decision enhancement studio was developed in the implementation stage.

The studio's usability and usefulness were then evaluated using different case studies. Observations made during the evaluation stage are presented in chapter 5 of this thesis. The refined and verified studio design is considered the theory and thus contribution of this research.

In conclusion, chapter 6, that is the epilogue, gives an overview of the answers to the research questions, reflections on the research, and recommendations for future research.

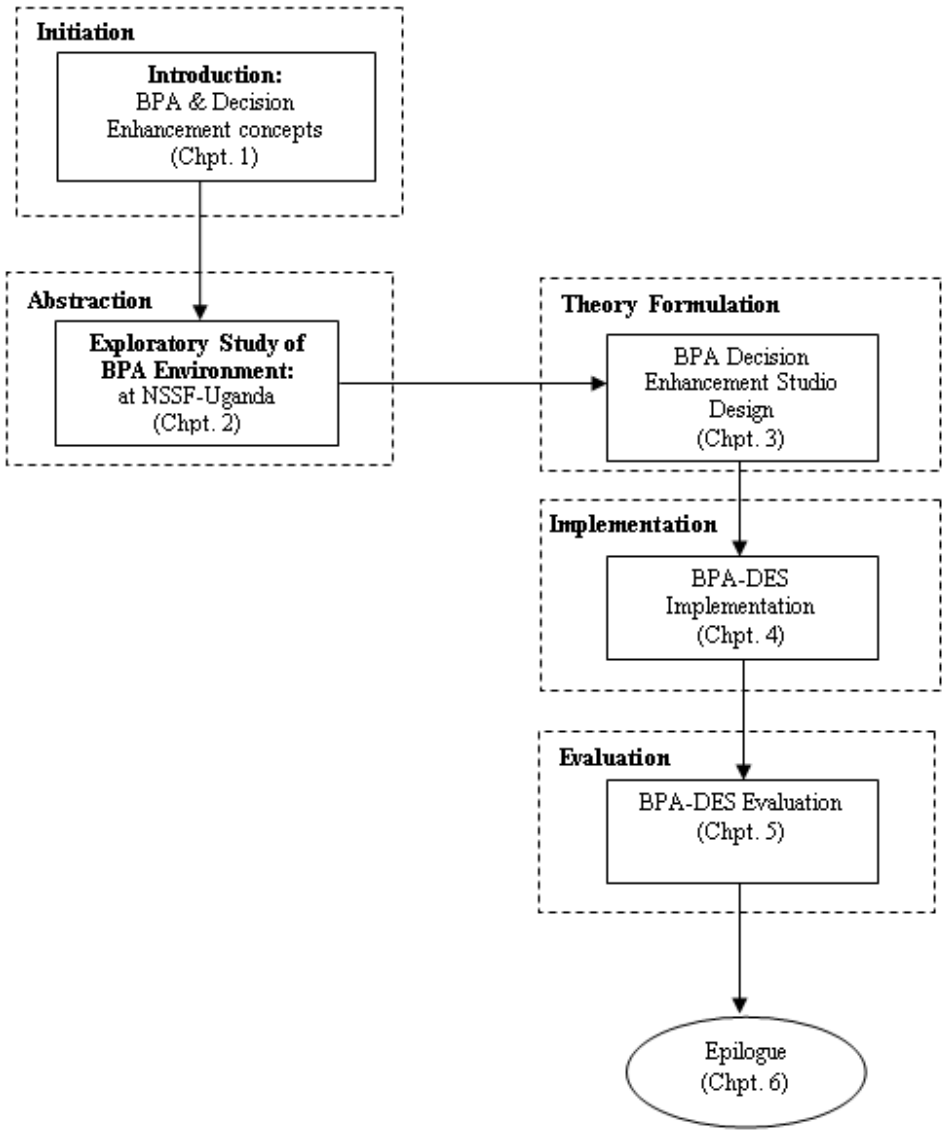

Fig. 1-7: Research Outline

2. EXPLORATORY STUDY OF A BPA ENVIRONMENT

2.1. Case Study: National Social Security Fund-Uganda

The National Social Security Fund (NSSF) is a national saving scheme authorized by the government of Uganda to provide social security services to employees in Uganda in accordance to the National Social Security Fund Act, Cap 222 in the Laws of Uganda (National Social Security Fund, 2011). The scheme was established by an Act of Parliament in 1985 as a means of protecting employees against the uncertainties in the social and economic life. It avails services to all employees in the private sector including Non-Governmental organisations that are not covered by the Government's pension scheme, through its twenty four (24) branches spread throughout the country. The core functions covered are; collection of contributions for its members into the fund and the payment of benefits to them from the fund (National Social Security Fund, 2011). All the organisation's operations are performed within the boundaries of the NSSF Act, and directives from the Bank of Uganda (BOU) and the Ministry of Finance.

Over the years, NSSF has had the monopoly of providing these services in Uganda. However the vision by Government to liberalize the pension sector in Uganda would bring about more competition into their business environment. By the time of the case study in August 2009, it was still a vision but in April 2011 the government began making steps towards its realization through a bill tabled before the Parliament of Uganda. The bill seeks to empower employees with the freedom to select any licensed retirement benefits scheme that suits their needs (The Parliament of the Republic of Uganda, 2011).

In light of the above and in preparation to remain competitive in the free market there was an increased demand for business process agility in the organisation. Secondly, with the increase in the number of employees contributing to the fund, the need to improve service delivery especially in processing benefits amplified. Due to these pressures, the organisation sought to improve its business processes to meet the demands which made it an appropriate case study.

2.2. Phases of the Exploratory Study

The exploratory study was carried out in 3 phases; preparation, data collection and data analysis.

Preparation stage; interview guides were prepared; permission to carry out research at NSSF-Uganda headquarters was sought. The target people were identified and appointments were made with the people. The interview guide used during this study is presented in Appendix A.
The target groups identified were the heads of four departments; namely the performance intelligence unit (PIU), the information systems department (ISD), the risk department and the operations department were interviewed. The target respondents in these departments were the head(s) of the respective departments. This target group was chosen because they are the main decision makers in the organisation.

The operations department was selected because it is the core department mandated to spear head and carry out the organisation's business processes. These business processes include contributions, benefits and investment. The operations department interfaces with the employees and employers to facilitate delivery of the organisation's services to them. The other departments support the operations department by;

(i). Providing technical support and implementation of necessary changes with respect to the workflow management system. This is the responsibility of the ISD.

(ii). Monitoring and assessing the performance of the business processes. The results of these activities are presented in the form of reports. This is the responsibility of the PIU.

(iii). Assessing the risk involved at each step in a business process and providing recommendations on how to mitigate the identified risks. This is the responsibility of the risk department.

The heads from these departments were also interviewed because they are primarily involved in the analysis of the organisation's business processes to monitor its performance and to seek opportunities of improving it. In addition to these, they also take part in the decision making process of determining how the business process should be improved.

Data Collection phase; Interviews were carried out at the headquarters of the National Social Security Fund (NSSF) during the month of August in 2009. In addition to this, annual reports and other documentation from the organisation were reviewed to further understand the organisation's business processes. Information about how business process agility (BPA) is achieved, and the decision process involved in pursuing BPA was sought. In addition, factors or challenges facing BPI at the organisation was also sought after. These results are presented in the following sections.

Data Analysis phase; in this phase, data gathered in the data collection phase was judged against literature so as to come up with BPA decision enhancement requirements as presented in section 2.4.

2.3. BPA Decision Process at NSSF

Business Process Agility at National Social Security Fund

At the time of the study, BPA was a newly adapted concept at NSSF. As a way to incorporate it into the organisation, additional new departments were created to spear-head its achievement. These were the performance intelligence unit (PIU) and the risk departments. The PIU department was tasked with the responsibility of monitoring and evaluating the performance of the organisation's business processes. The risk department was charged with the task of identifying risk indicators for each process, the risk level and recommend ways to mitigate them.

Business Process Performance Evaluation

In evaluating business process performance, the PIU carried out regular checks (fortnightly) to assess the performance of the business processes with the aim of identifying areas that needed to be improved in order to improve service delivery. At the time of the case study more attention was given to the benefits business process as compared to the other business processes i.e. the contributions, and investments processes because of its criticality.

The regular checks were performed in a step-wise manner, to mainly identify how much time each benefit claim took at a given process activity. This involved gathering information from people by word-of-mouth, complaints logged in by staff members and contributing members, and from process execution log data recorded by their workflow management system.

The gathered data was cleaned (that is to make the data complete) by the PIU staff members using their experience, and analysed using Microsoft applications such as Excel. The results were used to generate business process analysis reports. Furthermore, follow-ups with staff members involved in the benefits process were also carried out to find out reason(s) for delays in identified cases.

Risk Management

At the time of the study, the researcher observed that the risk department was carrying out an exercise to evaluate each business process to identify the predictable and anticipated risk indicators and the level of risk.

Identification of risk indicators was carried out by the risk department staff members in coordination with the responsible departments. At the time, focus was on the benefits and contribution business processes. The risk assessment involved the operations, audit, finance departments that execute the benefits and contribution business process and the PIU. Staff members in the risk department analysed and calculated the risk levels of the identified risks. Thereafter, control measures and a set of recommendations to address and mitigate the risks were developed by the risk department members and used to monitor risk levels in the organisation.

The findings, recommendations and action points would then be communicated to contact persons in the responsible departments for implementation.

Business Process Agility Decision Process

In light of its dynamic business environment for example, changes like liberalization, increase in unemployment due to early retirement, economic instabilities, NSSF just like any other

organisation sought to improve its business processes to become the Social Security Provider of choice for many in their target market.

During the study, it was observed that opportunities to improve the organisation's operations were sourced from*: business process performance evaluation reports* generated by the PIU, and *risk assessment reports* consisting of identified risks and their corresponding recommendations generated by the risk department. Thereafter, alternative courses of action were discussed in interdepartmental meetings and other relevant decision making committees. The categories of people involved in the decision making process included; board members, heads of department, area managers, and top managers. However the composition of stakeholders in a given decision making session depended on the kind of decision to be made. It was also observed that all changes agreed upon were carried out within the defined restrictions in the NSSF Act of 1985 and directives from governing bodies.

Notwithstanding the efforts in place to achieve BPA, it was noted that there was no apparent BPA decision process defined for business process improvement in response to identified changes. Nevertheless from the interview responses, activities observed to make up the decision process included;

(i). *Identification of an area that requires change in a given department*: During this activity, departments identified area(s) of concern to be improved. In addition, they collected relevant information from literature and from users' experiences to generate possible solutions. The gathered information was used to prepare PowerPoint and paper presentations on the issue/problem with possible solutions. Decisions on the prioritization of identified issues with their most suitable corresponding solutions were first made at the departmental level prior to tabling them before an interdepartmental committee that held meetings fortnightly (every two weeks). The interdepartmental committee was adopted since the operations in the different departments were cross cutting and therefore interaction, coordination, and cooperation amongst the stakeholders was needed.

(ii). Review of issues and alternative solutions: In this activity, representatives from the different departments presented their identified area(s) for improvement and

corresponding proposed solutions to the interdepartmental committee and other decision making committees deemed necessary. The alternative solutions were then reviewed by a review sub-committee formed for this purpose.

The review committee evaluated the proposed solutions by using Microsoft Excel mainly to analyse operation data, summarized and presented their findings to the interdepartmental committee.

(iii). *Decision Making*: Basing on the presentations, the interdepartmental committee selected the alternative solution(s) deemed most suitable for improving the business process during this activity. The chosen solution would be presented to the executive committee comprising of the heads of department. Any decision that could not be handled by them (top management) would be forwarded to the board of directors.

(iv). *Adoption Definition*: For selected and approved solutions steps on how to carry out the modifications and adjustments on the business process were specified and agreed upon in an adoption definition activity.

(v). *Sensitization:* Before rolling out selected solutions in the organisation, staff members were sensitized on the changes to be implemented.

(vi). *Rolling out of the solution*: At this stage, the selected solutions and changes were implementation in the business process.

Business Process Agility Decision Process Challenges

Furthermore, from the interviews carried out at NSSF-Uganda headquarters internal and external challenges of the BPA decision process were identified.

Internal Challenges

The internal challenges affecting the BPA decision process mentioned by the interviewees at NSSF- Uganda headquarters included;

i). *Limited stakeholder participation*: The limited participation was attributed to a number of factors such as lack of or limited clarity and understanding of an improvement opportunity, and failure to clearly envision the benefits associated with a given proposed improvement alternative. These minimized a stakeholder's willingness to

participate (e.g. share information and knowledge) in the decision process. In other words, failure to clearly visualize the need for change or to understand how one would benefit from a given BPI alternative caused stakeholders to participate less in the decision process and thus inhibited BPA.

ii). *Poor information flow*: This was manifested as poor dissemination or the failure to pass down BPI decisions and/or relevant BPI implementation information to concerned users or other stakeholders. This hindered or slowed down the implementation of improvements to their business processes.

iii). *Restriction of membership in the decision-making process*: In some departments, decisions as to what improvement to make to a business process were limited to a small section of the departmental staff. For example heads of departments and/or a selected number of other departmental staff. This was seen to cause a gap between management and junior employees which could later impede implementation of improvements to a business process.

iv). *Bureaucracy*: The strict decision making organisational structures that existed tended to slow down or even inhibit responsiveness to changes in the business environment that required improvement or adjustments to be made to the business processes. This lack of flexibility in the decision making process reduced the agility of the organisation.

v). *Lack of enough and/or current information*: Periodic data was used to analyse the performance of the organisation's business process. Data logged by the workflow management system over a given period of time would be collected and filtered by a member of staff to generate reports. These reports would be used to analyse the performance of the business process. This meant that decisions would be made based on static and not real time information.

vi). *The need to cut costs*: this affected the BPA decision process since the stakeholders resorted to Microsoft applications such as excels for data analysis. As a result complex analytics performed by specialized software could not be performed. This made the data analysis and later report writing activities within the BPA decision process e.g. in risk assessment and business process analysis, tedious and labour intensive.

External Challenges

The interviewees at NSSF- Uganda headquarters pointed out the following external challenges to be affecting the BPA decision process.

i). *Fluctuating stock prices*: The organization (NSSF-Uganda) sets its annual interest rate for employees' savings at the beginning of the financial year, basing on the anticipated revenue from its investments such as stock shares, and cannot change it until the next financial year. However, stock prices keep changing and thus the organisation's returns on investment (ROI) in stock shares are also unpredictable. Therefore, any drop in the stocks prices would mean that the organisation's investments in stock shares would not bring in the anticipated revenue from the sale of the stocks. Consequently, low ROI would ideally require the organization to lower its interest rate on the employee's savings in response to the identified change in the business environment, which according to policy cannot be done.

ii). *Economic stability (e.g. inflation)*: Interest rates embedded within business process rules of activities that deal with crediting beneficiaries' accounts are set based on the economic status at the beginning of the financial year. The stability of the economy therefore has an impact on the interest rates in that, changes in the economic status e.g. inflation rate. However, the economic status frequently changes and is unpredictable. This could mean revising the interest rates defined by the organisation frequently in response to the economic status; however such changes would adversely affect the stability of the organization.

iii). *Political influence*: NSSF's operations are governed by the Ministry of Finance, thus changes in its operations have to be approved by the Minister.

iv). *NSSF Act and directives from Bank of Uganda and the Ministry of Finance*: These affect the BPA decision process since all the decisions have to be made in alignment to directives from these organs as well as the NSSF Act. For example, changing interest rates within a financial year is not permitted therefore proposed changes as a result of changes in the economic status and stock prices as mentioned above, can only be implemented at the start of a financial year.

2.4. Discussion of Findings

In line with a number of business processes, organizational, and business agility researchers (Jafarnejad and Shahaie, 2008; Raschke and David, 2005; Sharifi and Zhang, 2001), the exploratory study findings presented above affirm that agility drivers are related to socio-economical, financial and political changes in addition to cost and efficiency. *Agility Drivers* are defined as the changes and pressures from an organisation's internal and external business environment that necessitate it to seek new ways of managing their operations (business processes) in order to maintain competitive advantage (Raschke and David, 2005; Sharifi and Zhang, 2001). It is therefore important to have foresight of possible threats, disruptions and opportunities from the business environment and insight of the organisation's capabilities and resources in order to respond effectively to unpredictable events (Raschke and David, 2005, El-Ghareeb, n.d.). These are seen as avenues for identifying the areas of a business process that need to be improved i.e. improvement opportunities, which provide the starting point for business process improvement efforts. In other words, these are inputs into the BPA decision process.

The findings also show that multiple stakeholders are involved in the BPA decision process and that it is a cross-departmental process, in that members from different departments are involved in exploring improvement alternatives for a given business process. This is in line with observations made in literature (Den Hengst and De Vreede, 2004; Bjorn and Ralf, 2010). In addition the findings show that BPA decision process entails continuous business process analysis, risk assessment, generation and selection of alternative solutions, and involves a lot of sharing of information. Therefore, we can say that collaboration, rigorous workflow analysis and risk assessment, in addition to effective information flow and communication among stakeholders are paramount for the success of the BPA decision process and business process improvement projects in general.

Internal and external factors

Raschke and David (2005) define external factors as those changes and pressures (challenges) arising from the outside of an organisation that affect the BPA decision process and are beyond the control of an organisation. While internal challenges are defined as those changes and

pressures (challenges) that originate from within the organisation and can be controlled by an organisation (Raschke and David, 2005). In line with Raschke and David (2005), the heads-of-department that were interviewed stated that NSSF Uganda has control of only internal challenges affecting the BPA decision process but no control over the external challenges or factors. Nonetheless they mentioned that both need to consider both categories since they affect the BPA decision process (Raschke and David, 2005).

Consequently the external factors can be viewed as a boundary for the kind of improvements that can be made to an organisation's business process, e.g. at NSSF-Uganda, changes made to their business processes have to be within the permissible limits stipulated in the directives from Bank of Uganda and the Ministry of Finance. It is therefore important to keenly monitor external factors in order to respond appropriately (El-Ghareeb, n.d.). For example NSSF-Uganda independently monitors the country's economic stability and fluctuating stock prices to gather information that can be used as a basis for improving the organisation's business processes. Furthermore, where need arises, the management of NSSF-Uganda makes recommendations of changes that can be made to the NSSF Act and other policies provided by the governing bodies.

Business Process Analysis: Workflow Analysis and Risk Assessment

In the evaluation phase of business process lifecycle, the performance of the business process is analysed in order to make improvements (Weske, 2007; Aalst, 2005). When carried out continuously an organisation's agility is boosted (Raschke and David, 2005) since workflow/business process analysis provides insight into a business process' performance and behaviour (Aalst, 2005; Aalst, 2007b) and may reveal possible threats, disruptions and improvement opportunities (Raschke and David, 2005).
The growing amount of event logs generated from information systems supporting business processes provides a valuable source of information from workflow or business process analysis (Aalst, 2005; Aalst, 2007b).

In addition to workflow analysis, from the results we observed that risk management adds value to business process management and is important for effective business process management and

improvement. Marrying these two fields is in line with other researches by Sienou et al. (2008), Muehlen and Ho, (2006), and Muehlen and Rosemann (2005).

Risk management has been widely studied in the project management research field (Jafaari, 2001). Jaafari (2001) defines risk as the "exposure to loss/gain, or the probability of the occurrence of loss/gain multiplied by its respective magnitude". On the other hand, risk management involves the identification, analysis and control of risks affecting different aspects in an organisation (Muehlen & Ho, 2006; Muehlen & Rosemann, 2005). Its purpose is to reduce or eliminate the possibility of a risk occurring, simultaneously offering an opportunity to improve performance (Muehlen & Ho, 2006).

With advancements in the business process management field, risk management has also become an important factor (Sienou et al. 2008; Muehlen & Ho, 2006; Muehlen & Rosemann, 2005). Marrying of these two fields is mainly due to the robustness risk management provides in decision making which in turn enhances business process agility (Sienou et al. 2008). Risk management is therefore considered an important aspect for business process improvement as identified risks give insight to stakeholders involved in the exploration of alternatives on how to improve their business processes (Sienou et al. 2008). This kind of relationship between risk and process management is referred to as risk-oriented process management (Sienou et al. 2008), (Muehlen & Rosemann, 2005). Risks are commonly looked at as a negative thing; however they can be viewed as potential problems that may have positive or negative effects on an organisation's operations and performance (Sienou et al. 2008; Muehlen & Ho, 2006; Muehlen & Rosemann, 2005). This means that identification of risks gives stakeholders an opportunity to avoid unwanted consequences, manage the occurrence of unwanted events or to get ways of mitigating them. In addition, it provides them with an opportunity to improve their business processes by re-designing or making adjustments to them in order to reduce or even eliminate the occurrence of a given risk (Muehlen & Ho, 2006).

Risk management just like business process management necessitates interaction between different stakeholders at different levels of an organisation (Christine, 2008; Muehlen & Ho, 2006). However, among other risks within the business process management life cycle, Muehlen

and Ho (2006) identify the lack of/poor communication between BPM stakeholders and participants. This risk or problem affects all the phases in the lifecycle.

At NSSF-Uganda, it was observed that two kinds of analyses were done on the business processes namely, performance analysis and risk assessment. The PIU analysed the event logs using the functionalities provided by Microsoft Excel; however, the analysis process was found to be tedious making it difficult to perform analysis on a real time basis. The risk department, on the other hand reviewed the processes to identify potential risks related to each task/activity and made recommendations of what should be done to mitigate the risks as well as setting tolerance levels for each. The results of the risk assessment were used to give insight to stakeholders involved in the BPA decision process on how to improve their business processes (Sienou et al. 2008). Additionally, as a way of identifying improvement opportunities for their business processes, respective departments in the organisation (NSSF-Uganda) were tasked with the responsibility to review their operations to identify the areas for improvement in order to improve the organisation's business processes. For example the customer care unit under the operations department, would collect feedback from customers which was used as an information source for identifying improvement areas/opportunities.

Collaboration in a BPA Decision Process

It was observed from literature (Bjorn and Ralf, 2010; Hill et al., 2006; Sarkis, 2001; Zhang and Sharifi, 1999) that business process agility involves continuous analysis and improvement of business processes, which are activities that are knowledge intensive and call for multiple skills and expertise (Bjorn and Ralf, 2010; BizAgi Limited, 2008). When coupled with the cross-cutting nature of business processes (Den Hengst and De Vreede, 2004), involving of business process stakeholders in the BPA decision process is paramount. This is mainly because involving stakeholders and top management in business process analysis and BPI alternative exploration decision processes would increase their commitment and acceptability of business process changes. Also because careless management and coordination of continuous business process improvement when adapting to new conditions needs may lead to chaos (Den Hengst and De Vreede, 2004).

Observations from the exploratory case study at NSSF-Uganda, such as the regular involvement of departmental staff members in the search for improvement areas; regular performance checks carried out by the PIU and risk department; and the bi-weekly meetings held by the interdepartmental committee at NSSF-Uganda, affirmed that BPA is a continuous process. Therefore it calls for participation of, interaction between, coordination of, and collaboration among various stakeholders at different levels of the BPA decision process. Conversely, the BPA decision process was challenged by poor information flow between the decision makers involved in exploring how to improve their business processes and the implementers.

Furthermore, in situations where there was actual communication or interaction between decision makers, the information would hardly reach the people responsible for implementing the approved business process improvement. This may be attributed to the rigidity and bureaucracy characterizing their decision process.

The above observations were in line with observations made by earlier researchers (Christine, 2008; Muehlen and Ho, 2006). Therefore BPM collaboration has remained a key challenge in BPM research and is commonly manifested as poor stakeholder involvement or insufficient participation of top management (Muehlen and Ho, 2006; Den Hengst and De Vreede, 2004) due to limited support for this decision process. Thus far, there is a need to support collaboration among and participation of stakeholders in the decision process of exploring BPI alternatives in response to the identified changes in a business environment or identified improvement opportunities and consequently improving business process agility. More so, there is need for a flexible way of making decisions in order to increase responsiveness to changes in a business environment. Furthermore, to bridge the gap between management and junior employees which may otherwise reduce the agility of an organisation, and impede implementation of improvements to a business process as was seen at NSSF-Uganda.

2.5. Requirements for Decision Enhancement Services

In light of the above discussion, this research focused on the internal challenges because they can be controlled by an organisation. The external factors were considered as additional information providing the boundaries or restrictions within which changes are to be made. From the internal

challenges and other findings of the exploratory study in addition to observations from literature, requirements for BPA decision process enhancement were identified and categorized as collaboration requirements, business process analysis requirements and communication requirements.

a) Collaboration requirements

From literature it was seen that the BPA decision process calls for the interaction among various stakeholders. However, stakeholder participation was still seen as a challenge just as it is showed by the exploratory study findings. Therefore there is a need to encourage stakeholder participation. This can be done by providing a way of enhancing stakeholders' ability to identify and understand improvement opportunities and the benefits associated with a given proposed improvement alternative. Therefore the collaboration requirements include:

(i). Enabling multiple stakeholder participation in the generation and exploration of improvement alternatives, risk assessment and decision making by providing an environment in which concerned stakeholders can work jointly.

(ii). Facilitation of flexible decision making by involving a wide range of stakeholders from top management to junior employees in order to increase responsiveness to changes in a business environment, and to bridge the gap between management and junior employees.

(iii). Promotion and enhancement of stakeholder's willingness, commitment and motivation to take part in the BPA decision making process; that is in exploring and selecting business process improvement alternatives.

(iv). Enabling stakeholders to share information and knowledge during the BPA decision process.

(v). Provision of a way to use the knowledge, skills and time resources available for the BPA decision process that is, in generating and selecting BPI alternatives.

b) Business process analysis requirements

In the exploratory study, just like in the reviewed literature, business process analysis has been seen to be paramount. However, there is minimal support for the analytics point of agility as reflected in literature and also shown as a challenge in exploratory study where tools used to not support complex analysis of business processes. Therefore with respect to business process analysis, there is need to support complex business process analysis as well as to provide (i) a way of gathering enough and/or current information for business process analysis in order to make decisions based on real time information; and (ii) a cheap and effective way of carrying out complex data analysis within risk assessment and business process analysis activities. The requirements derived thus include:

(i) Enablement of in-depth workflow analysis to;

   a. Give insight into the performance and behaviour of a business process so as to identify the opportunities for improvement by providing a set of tools/techniques that can be used to analyse different aspects of a business process in a timely manner.

   b. Allow for manipulation through interaction with the business process model.

   c. Enable the simulation of the different possible modifications/improvement to a business process using simulation tools that can mimic the behaviour of a business process and log events during its execution.

   d. Facilitate analysis of the simulation logs to gain understanding of the proposed business process improvement alternatives.

(ii) Facilitation of risk assessment of the existing business process in order to identify the opportunities for improvement, as well as the proposed business process improvement alternatives by providing a set of tools that support the risk assessment activities.

c) Communication requirements

Poor communication among BPM stakeholder was seen as a challenge both from previous researches as discussed in chapter 1 and also from the exploratory results. This is seen to affect BPA. Therefore there is there is a need to improve and monitor the flow of information between concerned users or stakeholders in order to enhance the implementation of business process

improvements. Therefore the communication requirement is to provide a means of disseminating or sharing of information about decisions made through the short messaging system and/or email systems to improve the flow of information among concerned stakeholders.

In light of this, the BPA decision process can be supported and enhanced by designing a decision enhancement environment that provides in-depth workflow analysis and business process risk assessment services. In addition, collaboration and communication services to improve commitment and information flow among the stakeholders. Furthermore the environment should provide simulation services that will promote understanding of the benefits and downsides of different BPI alternatives and encourage stakeholder participation.

3. BPA DECISION ENHANCEMENT STUDIO DESIGN

3.1. Design Approach

The observations obtained from the exploratory study findings and derived requirements presented in chapter 2, formed the basis for designing an environment to support the BPA decision process. The environment design is first discussed in terms of its way of thinking, controlling, modelling and working following Sol's analytical framework presented by Seligmann et al. (1989) and shown in Fig. 3-1, for understanding information systems development. This framework was selected based on the experience of several researchers in information systems (Stojanovic et al., 2004; De Vreede and Briggs, 2005; van Slooten and Yap, 1999) who were able to successfully follow the framework in the design, development as well as implementation of information systems, approaches, methods, frameworks and solutions to problems in various domains.

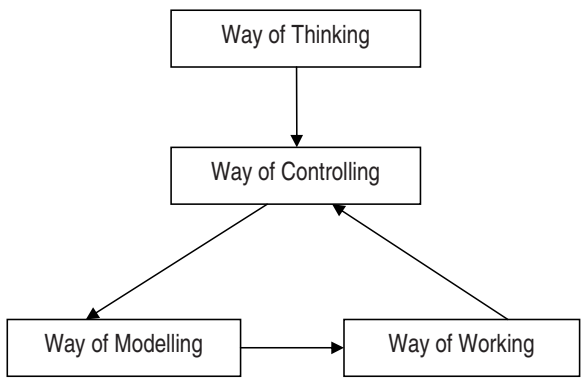

Fig. 3-1. Descriptive Framework for Design Approaches (Adopted from Seligmann et al., 1989)

Following the framework, the concepts and approach adopted in designing an environment to support and enhance the BPA decision process is described in the *way of thinking*. In other words, the way of thinking describes the approach and underlying theories used in designing decision enhancement services to support the BPA decisions process.

In the *way of modelling*, the description of the notations and modelling concepts used to represent different aspects of the decision enhancement services provided in the environment. The *way of working* defines how the decision enhancement services are used in the exploration of BPI alternatives during the BPA decision within the designed environment. The *way of controlling* describes the aspects used to manage the process of designing the decision enhancement service and the environment to support the BPA decision process.

3.2. Way of Thinking

It is clear from the discussions in the previous chapters, that the BPA decision process is a dynamic and continuous process that involves decisions that are;

- ***Complex****:* requires continuous analysis of information from various sources (such as laws, business policies and environmental factors such as political stability, and the business process behaviour e.g. bottlenecks, throughput time) to identify opportunities for improvement. More to that, the process of re-designing the business processes are complex activities (Trkman, 2010; Hill et al., 2009);

- ***Value-dominated****:* improvements (adjustments or changes) made to a business process must bring about some value addition to the organisation. This could be in terms of increased profits, efficiency, performance and reduced risks;

- ***Uncertain***: an organisation's business environment is characterized by various changes that dictate changes to a business process in response (Taylor, 2009; Hill et al., 2009; Al-Tarawneh, 2012);

- ***Consequential***: Changes in one part of a business process may affect other parts of the business process and organisation at large (Bjorn and Ralf, 2010);

- ***Involve multiple stakeholders***: the cross cutting nature of business processes necessitates involvement of process stakeholders (business domain experts). Additionally, technical personnel, organizational management personnel, business process analysts should be a part of the BPA decision process (as a minimum set of stakeholders) (Al-Tarawneh, 2012; Bjorn and Ralf, 2010; Den Hengst and De Vreede, 2004).

These characteristics of the BPA decision process show that it is a process that deals with decisions that matter (Keen and Sol, 2008). These decisions involve answering the questions, "*what aspect of a business process should be improved?*", and "*how to improve the identified aspect?*" In light of the above, the line of thought in this research is that the provision of decision enhancement services would enhance the BPA decision process.

As discussed in the previous chapters, BPA is attained through continuous business process improvement which requires continuous business process analysis (Bjorn and Ralf, 2010) in order to identify improvement opportunities. Such opportunities can be identified through risk assessment and workflow analysis. Identified risks pose an opportunity to improve one's business process through the mitigation or avoidance of such risks. Similarly workflow analysis gives insight into the performance of the business process revealing the bottlenecks which also give an organisation indication of areas of the business process that may need to be improved (Aalst, 2005; Aalst, 2007b; Raschke and David, 2005). More so, as part of workflow analysis, running simulations of proposed Business Process Improvement Alternatives (BPIAs) would increase stakeholders' understanding of the consequential benefits of the improvements. Therefore enhancing the BPA decision process would necessitate risk assessment and workflow analysis services.

The literature reviewed in chapter 1 and the exploratory study findings presented in chapter 2 indicate that there is a great need to support collaboration among stakeholders in the BPA decision process. This is anchored on the fact that execution of business processes link people from different sections or departments in an organisation. More to that, how an organisation conducts its business operations affects its target customers thus external stakeholders need to be involved in the BPA decision process. Consequently, the BPA decision process involves multiple number of stakeholders with different expertise depending on the business process under review (Al-Tarawneh, 2012; Bjorn and Ralf, 2010; Den Hengst and De Vreede, 2004). Therefore to explore Business Process Improvement Alternatives (BPIAs) for a given business process, it is paramount to provide collaboration services to enable the stakeholders involved in the BPA decision process to jointly work together in order to select an agreeable BPIA (Al-Tarawneh, 2012; Bjorn and Ralf, 2010; Den Hengst and De Vreede, 2004). More to that, the exploratory

study findings in chapter 2 show that it is also important to have a good flow of information among stakeholders to promote commitment to BPI and to ensure the implementation of selected BPIAs. Thus, provision of communication services would enhance the BPA decision process.

It is thus argued that a combination of careful analysis of a business process, collaboration and good communication or information dissemination among the stakeholders, offers a promising approach towards advancing support of and improvement of the decision process. The research thus sought to design decision enhancement services to facilitate, business process analysis, collaboration and communication during BPI exploration in response to identified changes. In other words, decision services to enable stakeholders to work together to identification aspects of a business process that need to be improved; generate business process improvement alternatives; and select a suitable business process improvement alternative. In so doing the BPA decision enhancement services should support the derived collaboration, business process analysis and communication requirements highlighted in section 2.5.

As discussed in section 1.7, we package the services in form of suites (set of technologies) and guidelines (recipes) deployed in a participative studio. This studio style was selected because the BPA decision process involves participation of different stakeholders working together to explore BPIAs. Such a decision enhancement studio would provide a good interactive environment to promote good communication among stakeholders (Keen and Sol, 2008).

3.3. Way of Modelling

To effect the BPA decision enhancement services particularly the collaboration and business process analysis services described in way of thinking (section 3.2), different types of models were used. These are; simulation models, business process models, and facilitation process models (in collaboration engineering). Furthermore, activity flow diagrams were used to describe the way of working of the BPA-DES as discussed in section 3.4.

Business Process Models

Business process models give a graphical representation of business processes (Aalst et al., 2003) i.e. they show the activities performed to achieve a given business goal and their relationships (represented as business rules). Business process models are the backbone of a WFMS or PAIS i.e. business processes are used to configure and drive the information system (see section 1.2).

Analysis of business process models enables stakeholders to investigate ways of improving business processes e.g. improving performance by reducing delays or waiting times, reducing costs. The business process modelling language e.g. Petri Nets, used to build these models have analysis techniques that can be used for investigating specifications of business process properties to provide insight into the behaviour and characteristics of a business process model (Aalst et al., 2003). Simulation models particularly enable the evaluation of business process models before they are used to configure a PAIS thus reducing the risk of costly corrections.

In light of the above, business processes in this research were modelled using Petri Nets (e.g. Fig. 3-2). Petri Nets as a modelling language was selected due to the variety of analysis techniques available to enable business process analysis. Additionally, the increasing number of process mining algorithms provides a rich selection of ways of extracting insights into the behaviour and performance of a business process (Aalst, 2011; Aalst, 2008; Aalst 2004). Petri Nets can be defined as "a graphical and mathematical modelling tool" (Murata, 1989) that can be used to visualize systems and communicate information about systems. They can also be defined as a directed bi-partite graph with 2 types of nodes; places and transitions (Aalst, 2004). The *transitions* represent the tasks or activities that occur in the business process while the *places* represent the various states in which a case can be in during the execution of a process.

Petri Nets provide simple notation that enables the graphical representation of processes (i.e. states and events/transitions that cause state changes) including concurrent, asynchronous, distributed, parallel, nondeterministic, and/or stochastic characteristics (Jensen et al., 2007;

Murata, 1989). The use of tokens in the process models or the nets facilitates the simulation of dynamic behaviour (Murata, 1989).

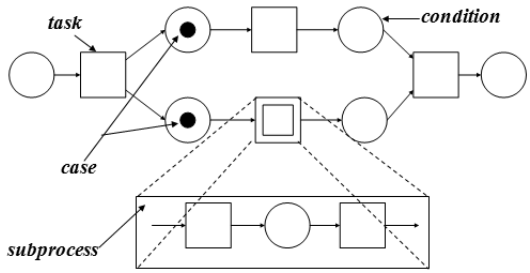

Fig. 3-2: Mapping a Process Definition onto a Petri Net

Simulation Models

A simulation model is a graphical representation of a business process that mimics the behaviour of a real business process (Aguila-Saven, 2004) i.e. to visualize business process execution during the business process design phase through simulations. Simulations that enable stakeholders to understand the behaviour of proposed BPIAs so as to evaluate and make a decision on how to improve the business process under study.

In this research the Coloured Petri Nets (CP-nets) business process modelling language was used to come up with simulation models. It was selected because they extend Petri Nets by introducing the concept of colour (Aguila-Saven, 2004) which enables differentiating of resources in a business process. Furthermore it allows for hierarchical decomposition (Aguila-Saven, 2004; Murata, 1989). Its formal mathematical representation, and well-defined syntax and semantics facilitate business process model analysis. It also allows for the inclusion of data aspects in the business process model (Aguila-Saven, 2004).

Characteristics of the simulation models

The simulation models were built using CPN Tools, an environment that is used to design, verify and simulate business process models. In CP-nets places and transitions are presented using the notation presented in Fig. 3-2. More to that, places have three kinds of inscriptions (see Fig. 3-3) namely; a mandatory color set and optional initial marking and name inscriptions.

Transitions on the other hand have four optional inscriptions (see Fig. 3-4) namely; name, guard, time and code segment (Westergaard, and Verbeek, 2012; Jensen et al., 2007).

a) *Place Inscriptions*: The *name* inscription of a place refers to the label used to identify it while the *color set* inscription specifies to the type of tokens that can be held or stored in a given place. The *initial marking* is a multiset (e.g. 1`++true to mean 1 true token in the case of a place holding Boolean color set tokens) expression specifying the initial number of tokens at a given place before running or executing the simulation model.

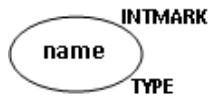

Fig. 3-3: Place Inscriptions in CP-nets

b) *Transition Inscriptions*: The *name* inscription is a label to identify an event/ task/transition while the g*uard* is a CPN Machine Language (ML) Boolean expression or list of expression that are used to implement restrictions by testing the input arc inscriptions using one or more mathematical and/or logical operators. The *time* inscription is used to specify the time delay or the time taken to perform a given transition. The *code segment* inscription is a set of ML code segments that are executed when the parent transition occurs. The input and out code segments are optional while the action segment is mandatory when defining a code segment inscription.

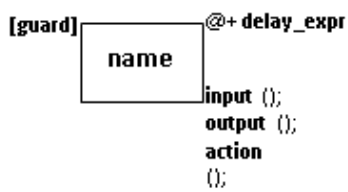

Fig. 3-4: Transition Inscriptions in a CP-net

The developed simulation models were;

a) *Stochastic*: the input data was generated randomised. The input was generated by modelling an environment process that generated tokens at a given rate.

b) *Timed*: in cases where time was of great importance, delays were implemented in the simulation models.

c) *Discrete*: events that occurred separated points of time (Aguila-Saven, 2004).

They also contained logging functions to enable the capturing of events during simulation runs. For each transition representing an activity in the business process, an action function was written to capture event information such as;

a) *Task_name;* this is the name of the process activity (transition in the simulation model).

b) Time; this refers to the time when the process activity took place. In some cases where the task took a period of time, the start and complete times are also captured.

c) ProcessInstanceId; this enables the identification of a given process instance or occurrence e.g. it could be an insurance claim or a given student.

d) Resource; this value refers to the individual of role that performed the particular business process activity during the execution of a given process instance.

Collaboration Engineering

The modelling principles in Collaboration Engineering (CE) were adopted to model the collaboration services. Collaboration Engineering is defined as "an approach to the design of re-useable collaboration processes and technologies meant to engender predictable and success among practitioners of recurring mission-critical collaborative tasks" (De Vreede and Briggs, 2005). It provides several collaboration patterns among which the major ones include; Diverge, Converge, Organize, Elaborate, Abstract, Evaluate and Build Consensus (Briggs and Vreede, 2009; Briggs et al., 2001; Briggs et al., 2003). Each collaboration pattern is modeled using thinkLets. A thinkLet is defined as the "smallest unit of intellectual capital required to create one repeatable, predictable pattern of thinking among people working toward a goal" (Briggs and Vreede, 2009; Briggs et al., 2001).

ThinkLets are composed of three components namely; tool, configuration and script (Briggs and Vreede, 2009; Briggs et al., 2003; Briggs et al., 2001). The tool specifies the particular version of hardware and software technology used to create the desired pattern of collaboration. The configuration component specifies how the tool was configured to create a pattern of interaction while the script presents a sequence of events and instructions to guide a group in attaining the required pattern of collaboration.

ThinkLets were thus used to design a collaboration process to aid facilitators in coordinating and managing a group stakeholders taking part in the BPA decision process session to explore BPIAs in the shortest time possible and at an affordable cost (Briggs and De Vreede, 2009; De Vreede and Briggs, 2005).

The collaboration process is documented using Facilitation Process Models (FPMs). FPMs focus on the logical process flow of collaboration tasks i.e. task-to-task and present this as diagrammatically representation of a sequence of thinkLets (Kolfschoten and De Vreede, 2006; De Vreede and Briggs, 2005). In this modelling convention each process step is represented as an activity (round-ended rectangle) described by an activity or step name, a collaboration think pattern and the thinkLet name. Additionally a process step may include the duration of the time planned for executing the step. It is also important to have the instantiating variable or parameter such as a guiding question or assignment. Decision points in a collaboration process are represented by a circle while a decision outcome or flow of direction by a directed arrow as shown in Fig. 3-5.

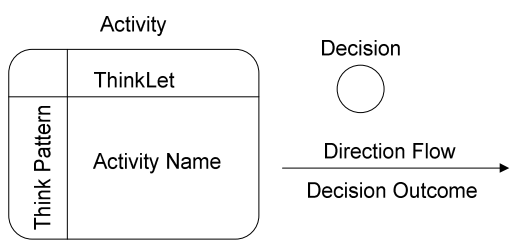

Fig. 3-5: ThinkLet Notation

Activity Diagrams

In designing the BPA-DES, description of the series of activities involved in BPA decision process was deemed important so as to provide the necessary support to the stakeholders in order to promote collaboration and communication among them, and ease in business process analysis. Unified Modelling Language (UML), a general-purpose visual modelling language that is used to specify, visualize, construct and document artefacts (Rumbaugh et al., 2005), provided a means of capturing and representing the BPA decision process activities. Activity flow diagrams were used to represent the actions, activities and control flows in the BPA decision process see (e.g. Fig. 3-7, Fig. 3-8, Fig. 3-10, Fig. 3-11, Fig. 3-12, Fig. 3-19)

3.4. Way of Working

Following the way of thinking described in section 3.2 and considering the derived requirements presented in chapter 2, four (4) suites were identified to provide the required decision enhancement studio services for continuous business process improvement and BPA (see Fig. 3-6).

To support business process analysis the *Risk Assessment* (RA) and Workflow *Analysis* (WFA) suites were identified to support evaluation of risks within business processes, and the business process' performance, respectively. The *BPI alternative Exploration, Communication and the RA* suites support the collaboration and communication requirements within the BPA decision process. Additionally, a set of guidelines on how stakeholders should conduct the BPA decision process were developed. In other words, guidelines to support and facilitate stakeholder collaboration in analysing business process to identify improvement opportunities and exploring BPI alternatives. The guidelines specify the activities to perform during the BPA decision process.

As shown in Fig. 3-7, the first step in the process of exploring BPI alternatives is the analysis of the as-is or current business process. The aim of these analyses is to identify opportunities for improvement that is, aspects that can be improved. Using the RA suite stakeholders work jointly together to identify, assess and control risks involved in their business processes. Risk

Assessment is considered an important aspect for business process improvement as identified risks give insight to stakeholders involved in the exploration of alternatives on how to improve their business processes (Sienou et al., 2008). This is due to robustness with regard to decisions that risk management provides that in turn enhances business process agility (Sienou et al., 2008).

Identification of a risk gives stakeholders an opportunity to avoid unwanted consequences, manage the occurrence of an unwanted occurrence or to get ways of mitigating them. Identification of risks thus gives them with an opportunity to respond by improving their business process i.e. re-designing or making adjustments to a business process reduces or even eliminates the occurrence of a given risk (Muehlen and Ho, 2006).

More so, stakeholders use the WFA suite to analyse the as-is or current business process to understand its behaviour (i.e. the ordering of activities e.g. concurrent and sequential ordering of activities) and performance (e.g. bottlenecks, throughput time). The bottom-up approach of process analysis using process mining (Maruster and Beest, 2009) was considered in this research. This approach has been chosen because it provides insight to the performance and behaviour of an actual process i.e. what is actually happening rather than what is expected to happen. It focuses at identifying performance issues and potential improvement opportunities (Maruster and Beest, 2009). This information is extracted from data recorded by an information system during process execution through process mining (Weske, 2007; Aalst, 2005). This data is known as event logs; an event log is a set of process instances where a process instance is a sequence of activities known as traces and information related to the tasks performed such as the time an activity was performed and by whom it was performed (Aalst, 2007a; Aalst, 2007b; Maruster and Beest, 2009).

Process mining as a technique for business process evaluation can be used in various dimensions. These include; process discovery, conformance checking and extension. Process discovery focus on deriving information about the original process from event logs. This may be in form of process models, organisational networks, and social networks. Conformance checking on the other hand focuses on comparing reality (model mined from event logs) with a pre-defined

process model to see whether reality conforms to expectation. Extension assumes an event log and a pre-defined process model and aims at improving the pre-defined model with new aspects or perspectives based on the event log (Aalst, 2007a; Weske, 2007).

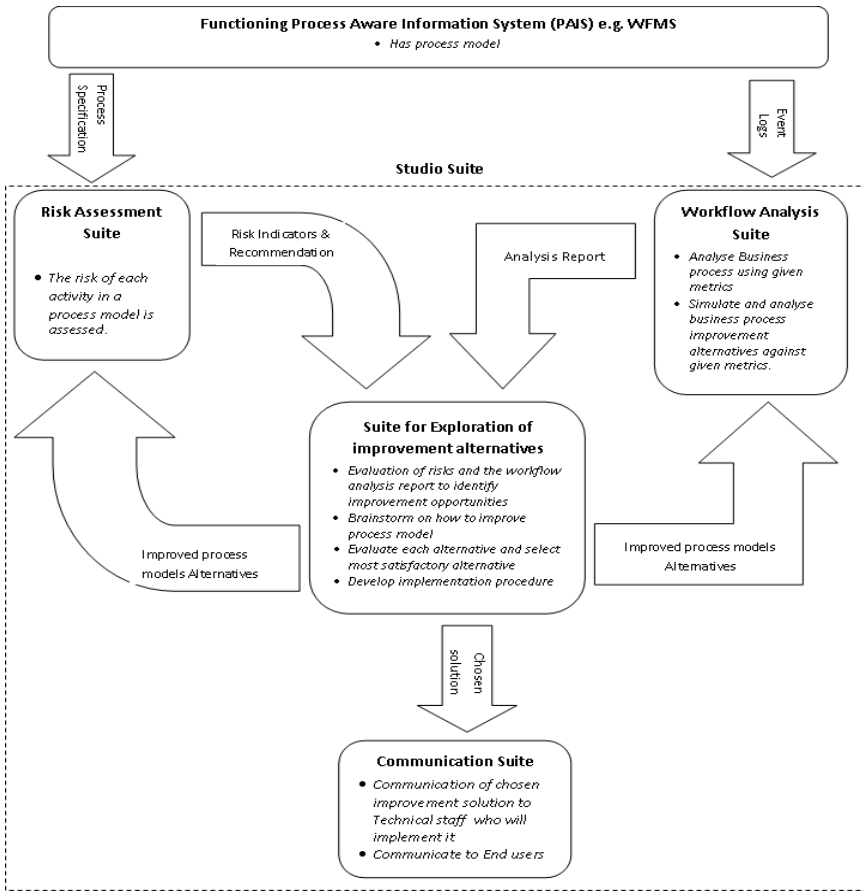

Fig. 3-6: Global BPA Decision Enhancement Studio Design

The WFA suite enables workflow analysis through process mining and simulation. Simulation is used as a means to analyse the proposed business process improvement alternatives. Basing on the improvements suggested by stakeholders, simulation models are developed and analysed.

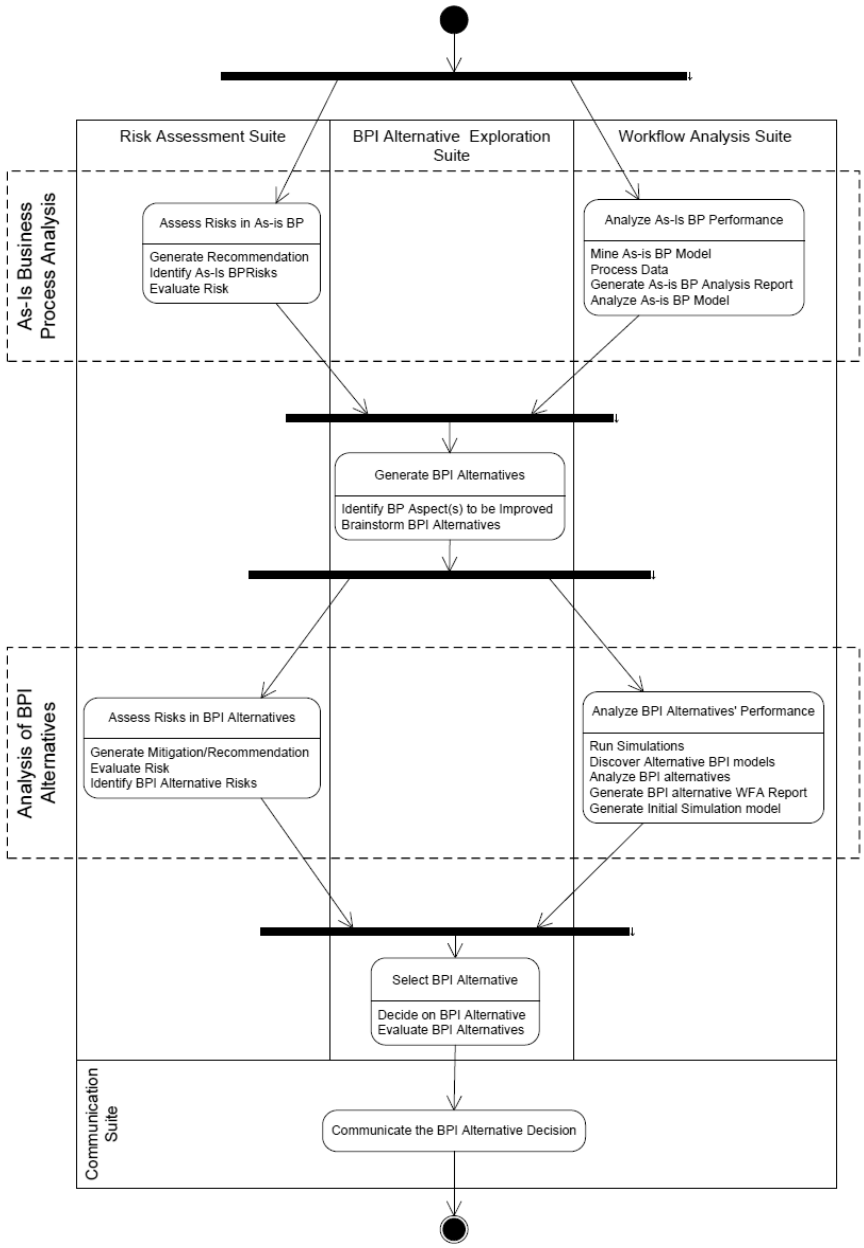

Fig. 3-7: Activity diagram showing the flow of activities in the BPA-DES

Using the generated RA and WFA reports, BPI alternatives for the identified aspects are explored using the BPI alternative exploration suite. This suite enables stakeholders to jointly generate and select a BPI alternative in collaboration. The communication suite facilitates information dissemination to ensure that the concerned parties in an organisation(s) receive information on the decisions made.

3.5. Way of Controlling

To control the BPA decision process, a set of guidelines on how the BPA decision process should be conducted were developed. Additionally, guidelines to support stakeholders facilitate stakeholder collaboration in analysing business process to identify improvement opportunities and exploring improvement alternatives. The guidelines specify the activities to perform when analysing a business process, exploring and deciding on business process improvement alternatives, and disseminating information. Additionally, guidelines also specify how to carry out each activity.

To ensure that the BPA decision process is being supported and thus enhanced, the usability of the designed decision enhancement studio and in particular the services was evaluated. In assessing its usability, the metrics used were *time* taken to carry out individual tasks and the whole process, and the *number* of different aspects in the BPA decision process such as clarifications sought during the execution of tasks and the process at large. Furthermore, the usefulness of the services in enabling BPA was also evaluated.

3.6. Risk Assessment Suite

The input into the risk assessment (RA) activity is a process specification and additional information gathered from different stakeholders who interact with the business process and will entail the activities shown in Fig. 3-8.

Considering that risk management necessitates interaction, participation and collaboration among stakeholders at different levels of an organisation, the risk management collaboration process designed by Briggs, Grinsven and De Vreede (De Vreede and Briggs, 2005; Grinsven and De

Vreede, 2002) was adopted to facilitate and support collaboration during the risk identification, assessment and mitigation sub-services (see Fig. 3-8).

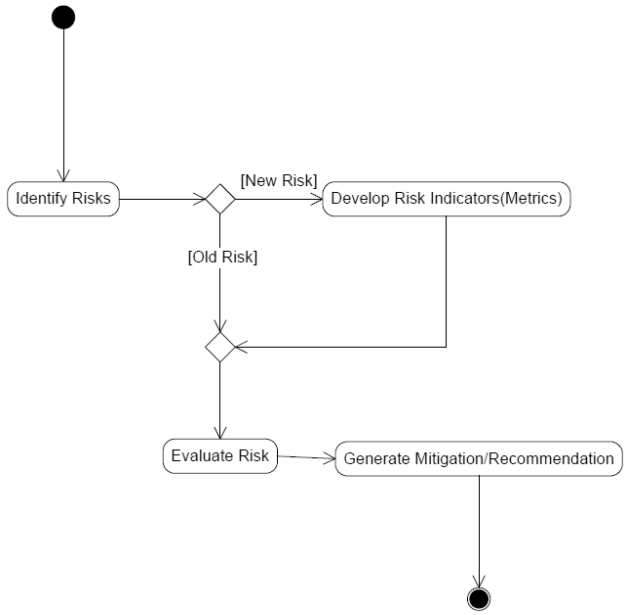

Fig. 3-8: Activity Flow Diagram showing the services in the RA Service

The *risk identification* service enables stakeholders to collaboratively analyse the business process and additional information gathered from different stakeholders who interact with the business process, to identify risks under different themes following the risk identification sub-process of the risk management collaboration process. The identified risks are arranged in terms of importance into a prioritized list. The generated prioritized list of risks is reviewed to check whether it is complete or not. The steps in the risk identification module are repeated till a complete list of risks is achieved.

Once risks have been identified, stakeholders collaboratively *develop metrics* for corresponding risks to act as risk indicators for newly identified risks. Risk indicators are used as a basis for analysing business process risks. This is done following the left most branch of the risk assessment sub-process of the risk management collaboration process in Fig. 3-9.

The *risk analysis* service enables stakeholders to identify and evaluate business process risks. The *generate mitigation/recommendations* sub-service enables stakeholders to collaboratively discuss the identified risk levels with the aim of generating mitigation or control measures following the risk mitigation sub-process of the risk management collaboration process in Fig. 3-9.

Risk Assessment Guidelines

To enable stakeholders to identify and analyse risks as well as to come up with ways of controlling or mitigating them, a number of steps are provided as a guide on how to do these activities.

Risk Identification: This activity involves the collection, comprehension and analysis of data related to the business processes with the aim of finding risks. To achieve this, the steps below were used to guide stakeholders in the risk identification.

1. ***Study the business process and identify inherent risks***: In this step, stakeholders brainstorm on what impediments or risks affect the effective execution of the business process.
2. ***Refine the list of identified business process risks to define key risks***: Stakeholders discuss the list of risks generated in step 1 with an aim of reducing the size of the list to remain with the key risks.
3. ***Categorize the risks into relevant impact areas***: In this activity, stakeholders identify the relationships between the risks in the refined list (output of step 2). Related risks are grouped under one category.
4. ***Evaluate each category to check the correct categorization of each risk***: Each category of risks is reviewed to check and ensure that each risk has been placed in the right category.

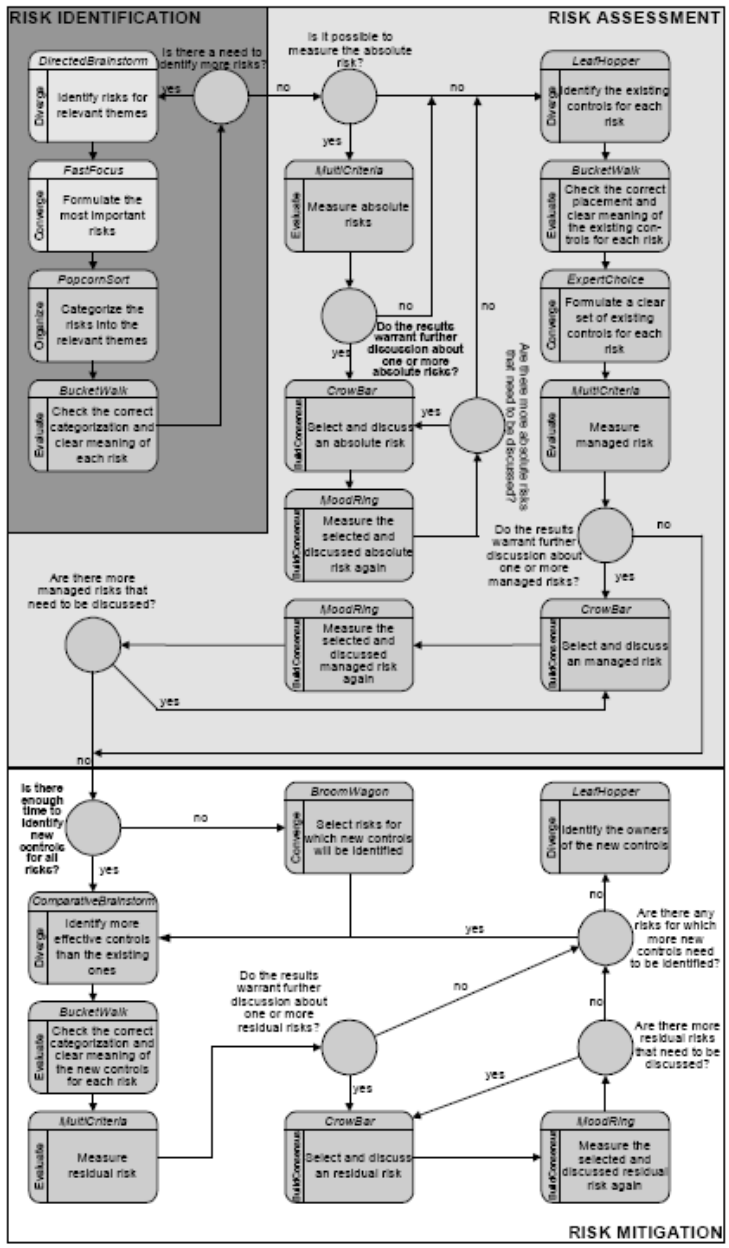

Fig. 3-9: Repeatable Collaborative Risk Management Process (Source: Adopted from Grinsven and De Vreede, 2002).

Risk Analysis: This activity involves measuring the absolute and managed business process risks using existing controls. It is carried out by doing the following steps.

1. ***Measure absolute business process risks***: **F**or the fixed risks that can be measured**,** each participating stakeholder assesses their criticality, otherwise, go to step 4. Considering the results, if one or more risks are not clear or need clarifications to be made, go to step 2 otherwise go to task four.
2. ***Select and discuss an absolute business process risk***: Discuss and make clarifications on the fixed risks that may not be clear to the stakeholders to ensure shared understanding.
3. ***Measure the selected and discussed business process risk***: Each participating stakeholder assesses their criticality for the fixed risks that were not clear or needed clarifications to be made. Basing on the results, repeat step 2 if one or more risks are not clear or need clarifications to be made, otherwise go to task four.
4. ***Identify the existing controls for each of the business process risks***: For each of the absolute business process risks, identify the corresponding control measures from the existing ones.
5. ***Check the correct placement and clear meaning of the existing controls for each of the business process risks***: For each category of risks, check the existing controls to ensure that there are no unclear, overlapping or redundant controls. Rephrase unclear ones, combine and refine overlapping ones, and remove redundant ones to remain with key ones.
6. ***Formulate a clear set of existing controls for each of the business process risks:*** In this step, identify related and/or unclear control measures for each business process risk and formulate clear controls.
7. ***Measure the managed business process risks:*** Evaluate the managed risk for the business process to identify the most critical or crucial to its effective running thus requiring immediate attention
8. ***Select and discuss the managed business process risks:*** Arrange the managed business process risks according to the level of consensus among stakeholders. Discuss the evaluation results to gain shared understanding of why one would rate the risk high or low.

9. ***Measure the selected and discussed managed business process risk again***: With a shared understanding of the managed risks, evaluate their criticality in the business process at hand.

Generate Recommendations: This activity involves the identifying of new control measures that can be used to mitigate business process risks particularly residual risks. Steps taken are;

1. ***Select the business process risks for which new controls will be identified*:** Considering the list of business process risks, sift them to select those for which new controls need to be identified.

2. ***Identify more effective controls than the existing ones for each business process risk*:** For each of the selected business process risk, collaboratively stakeholders suggest best control measures.

3. ***Check the correct categorization and clear meaning of the new controls for each business process risk*:** Suggested control measures under each selected business process risk are evaluated to ensure that they have been placed correctly.

4. ***Measure business process residual risks*:** In this step, stakeholders use the newly identified control measures to evaluate the level of respective business process residual risks.

5. ***Select and discuss the business process residual risks to assess stakeholder consensus*:** The aim of this step is to evaluate stakeholder consensus with regard to the relevance of the newly identified control measures. The business process residual risk evaluation results from step four (iv), are used to arrange the business process risks according to the level of consensus i.e. according to differences in ratings from high to lowest. Discuss the evaluation results to gain shared understanding of the different ratings as well as the relevance of the new control measures.

6. ***Measure the selected and discussed business process residual risks*:** Using the newly identified control measures, each business process risk is discussed as stakeholders evaluate them.

A prioritized list of residual business process risks is then generated basing on the participants' ratings.

7. ***Identify the owners of the new business process risk controls*:** For each residual business process risk in the prioritized list stakeholders select a person or role to be responsible for new control measures.

3.7. Workflow Analysis Suite

The aim of the workflow analysis (WFA) suite is to enable stakeholders to gain an understanding of the existing business process's performance and behaviour as well as that of the proposed BPI alternatives. The WFA suite provides the business process or workflow analysis service and simulation service. The analysis service supports process mining as the technique to analyse the business processes while the simulation sub-service supports the development of simulation models and simulation of the BPI alternatives.

The first step in workflow analysis is to understand the performance and behaviour of the existing or current or as-is business process. This involves the activities described below and shown in the activity flow diagram in Fig. 3-10.

(i). ***Process Data***: Different workflow management systems and information systems log their data using different formats which may vary from the prescribed Mining eXtensible Mark-up Language (MXML) data format used in process mining. Therefore in this step all other data formats of event logs such as CSV files, excel files, are converted into MXML. The generated MXML event logs are used as the starting point or input to the process mining (business process analysis) process.

(ii). ***Discover as-is process model***: This involves mining the as-is process model from the log file generated by an organisation's workflow management system during process execution.

(iii). ***Analyse the as-is process model***: The performance and behaviour of the mined as-is process model is analysed to identify the bottlenecks, process flow time, resource utilization, and how it conforms to given standards and/or expectations.

(iv). ***Generate Analysis Report***: This step involves generating or compiling an analysis report that contains information on the performance indicators that have been analysed and their corresponding result.

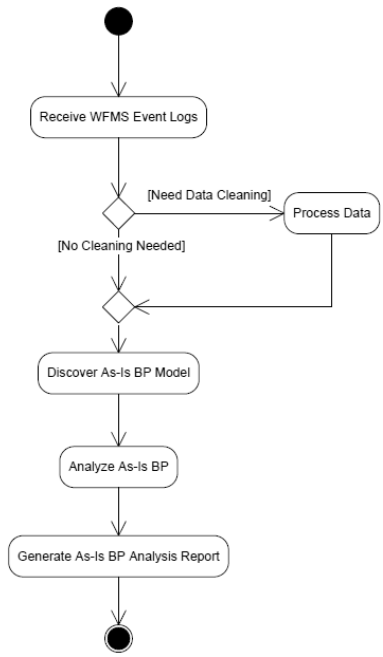

Fig. 3-10: Activity Diagram for Analysing the As-Is Business Process

In the case of evaluating BPI alternatives, the following five (5) steps are followed as shown in Fig. 3-11.

(i). ***Generate improved business process models***: This step involves the modelling of improved business process alternatives i.e. adjusting/modifying the existing (as-is) business process model to reflect the improvements suggested by stakeholders. These models will be achieved by incorporating suggested changes/improvements on a mined simulation model.

This will involve the following steps;

- ***Discover simulation models:*** An initial simulation model i.e. Coloured Petri Net (CPN) model is discovered from the event logs gathered from an organisation's workflow management system. This will be discovered following Rozinat et al. (Rozinat et al., 2009) method and technique.
- ***Modify and verify simulation models:*** This CPN simulation model is then modified to reflect the proposed improvement alternatives (To-Be process models). The simulation models will be verified to ensure that there are no errors in them. The measures that will be used to verify the models will be 'soundness', whether it is 'live' and presence of 'deadlocks'.

(i). ***Simulation Experiments***: The generated CPN simulation models are then executed to simulate the working of the business process. Event logs are logged during the execution of each improved business process alternative (simulation experiments).

(ii). ***Discover improved business process model alternatives***: This involves mining the different improved business process model alternatives for the event logs generated by their respective simulation experiments.

(iii). ***Analyse improved business process alternatives***: The different to-be or improved process models are mined from the corresponding log file generated by executing the respective simulation models. The performance and behaviour of the different mined to-be or improved process models are analysed to identify the bottlenecks, process flow time, resource utilization and performance, and how it conforms to given standards and/or expectations.

(iv). ***Generate Analysis Report***: This step involves generating or compiling an analysis report that contains information on the performance indicators that have been analysed and their corresponding result for all the alternatives. This report is used by the stakeholders to make a decision on which BPI alternative to implement.

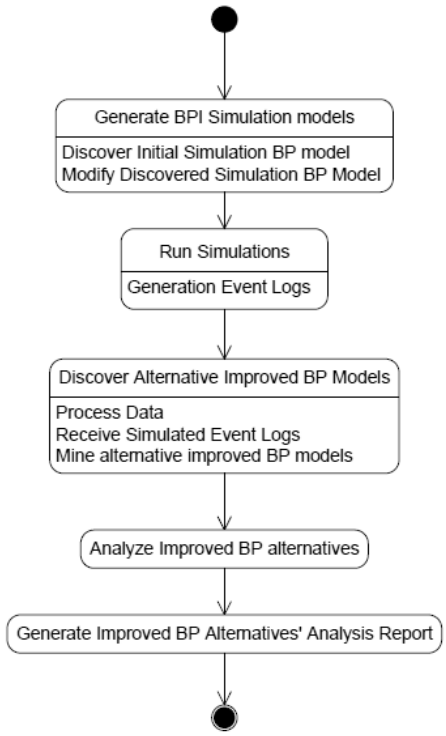

Fig. 3-11: Activity Flow Diagram for the Workflow Analysis Process

3.8. BPI Alternative Exploration Suite

The BPI alternative exploration (BPIAE) suite provides services that support stakeholders in the generation and evaluation of BPI alternatives and the selection of a satisfactory alternative. The BPIAE suite makes use of the output generated by the RA and WFA suites. The input information includes RA recommendations, WFA reports, simulation reports and additional relevant data about a business process. BPIAE involves the steps shown in Fig. 3-12. These activities are done in a collaborative manner i.e. stakeholders will jointly work together to explore BPI alternatives.

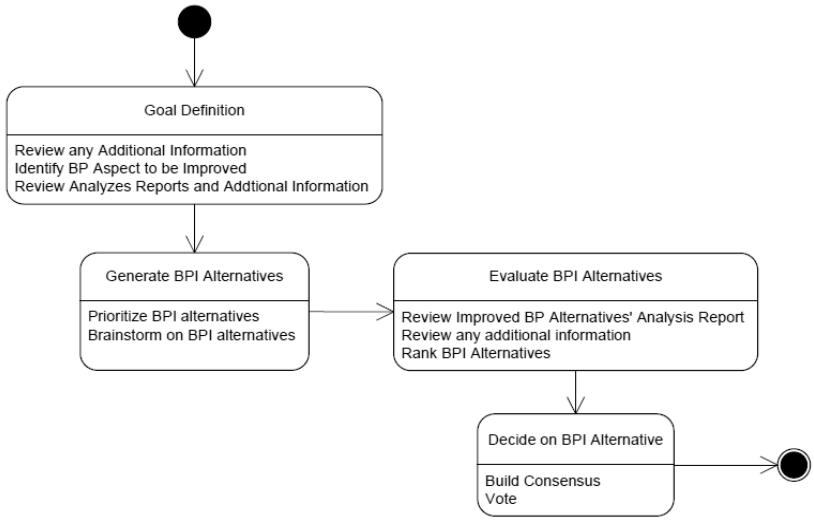

Fig. 3-12: Activity Flow Diagram for the BPI Alternative Exploration Process

This exploration process begins with the Goal definition task. This task involves the identification aspects of a business process that need to be improved. The next task in the process is the Generation of business process improvement alternatives. Once the aspect(s) of a process to be improved have been identified, the question to be answered is "How can we improve the identified aspect of the given process?" This question may be answered by having stakeholders working collaboratively to achieve the defined goal i.e. to exploring possible alternatives of improving the business process model.

The generated BPI alternatives are then submitted for analysis; simulation and workflow analysis, and risk assessment. The risk assessment, simulation, and WFA of the suggested BPI alternatives are carried out in parallel. Upon receiving the RA and WFA reports of the proposed BPI alternatives, a group of stakeholders jointly select the most suitable alternative to be implemented in the decision making task. The selected alternative will then be communicated to the individuals responsible for implementing the change to the business process.

BPIAE Collaboration Process Design

Considering that BPI alternative exploration is a repetitive (recurring) and knowledge intensive activity or process requiring input from stakeholders with varied multiple skills and experience, there was need to design a collaboration process to facilitate and support collaboration during BPI alternative exploration. In light of this, we made use of thinkLets. The collaboration process was designed following the steps defined and described by Kolfschoten et al. (2006). These steps include, (a) Goals, deliverable and objectives definition, (b) Task Decomposition, (c) ThinkLet Choice, (d) Facilitation Process Modelling (FPM), (e) Agenda Building (addressed in detail in chapter 4), and (f) Design validation (addressed in detail in chapter 5).

In the first step, we first defined the global goal and deliverables of the collaboration session. In the task decomposition step, the goal (task) was then broken down into activities that should be performed in order to achieve the goal and deliverables in a task decomposition step. For each identified activities, think patterns and thinkLets were chosen basing on the provided guidelines. Specific assignments, expected deliverables, think patterns, thinkLets were identified for each activity and used to come up with FPMs.

Step 1: Definition of Global Goal and Deliverables

Basing on the findings from the exploratory study with respect to the activities involved in the BPA decision process (as discussed in chapter 2), the global goal of the BPI exploration collaboration process was defined as *"to explore and agree upon a Business Process Improvement (BPI) alternative in response to identified change"*. Furthermore, the global deliverables were identified and these included;

(i). *List of Aspect(s) of business process that need improvement*. Documents showing the current risks involved and the current performance of the as-is or existing business process should be reviewed to define the goal of the session that is, the aspect(s) of the business process that can be improved/adjusted.

(ii). *List of BPI alternatives.* Stakeholders being able to adequately contribute ideas on how to improve the specified aspect(s) should come up with a prioritized list of business process improvement (BPI) alternatives.

(iii). *An evaluation of various BPI alternatives*. Basing on a list of mitigation or control measure recommendations, and performance results for each BPI alternative, an assessment of the alternatives should be carried out.

(iv). *An agreed upon prioritized BPI alternative*. With respect to the evaluations in (iii), a BPI alternative should be selected for implementation.

Step 2: Task Decomposition

In relation to the identified global deliverables a sequence of collaboration tasks on how to explore BPI alternatives were identified from the exploratory study findings presented in chapter 3, and from reviewed literature on business process improvement in the task decomposition stage. The tasks include;

(i). *Review workflow and risk assessment reports of the as-is business process and additional relevant literature and previous improvement documentation to assess the existing business process*

(ii). *Generate suggestions of the aspects that need to be improved in a given business process*

(iii). *Filter suggested business process aspects for improvement to only keep the most important ones.*

(iv). *Evaluate the refined list of areas that are to be improved according to the associated risks and performance of the business process (criticality)*

(v). *Formulate ideas on how the business process may be improved*

(vi). *Filter to remain with the most feasible alternative solutions from the generated pool of improvement ideas*

(vii). *Evaluate the list of most feasible business process improvement alternatives*

(viii). *Submit proposed alternative solutions for simulation, workflow analysis and risk assessment of the BPI alternatives.*

(ix). *Review workflow analysis and risk assessments reports of the BPI alternatives*

(x). *Evaluate the BPI alternatives according to risk and performance*

(xi). *Build consensus and agree on which BPI alternative best improves the identified aspect of the business process.*

Step 3: ThinkLet Choice

For each of the tasks, think patterns and thinkLets were identified for each of the identified activities in the thinkLet choice stage. The tasks were grouped in relation to the appropriate think patterns.

Diverge think pattern	:	Task (ii) and (v)
Converge think pattern	:	Task (iii) and (vi)
Evaluate think pattern	:	Task (iv), (vii), (x)
Build consensus think pattern	:	Task (xi)
Other think pattern	:	Task (i), (viii), and (ix)

After identifying the think patterns, thinkLets were chosen for the tasks to enable the achievement of the task goals. The reviewing reports and documentations in tasks (i), (viii), and (ix), stakeholders do not follow any particular think pattern and thus no thinkLet was selected.

To generate suggestions of aspects in a given business process that need to be improved, and BPI alternatives on how a given business process aspect may be improved (i.e. to achieve tasks two (ii) and five (v)), the DirectedBrainstorming thinkLet was chosen. It was chosen because it provides stakeholders with an equal opportunity to contribute ideas on what needs to be improved and how it should be improved respectively. In DirectedBrainstorming, the facilitator provides prompts that steer the group of stakeholders to coming up with a wide and assorted set of creative ideas. To cater for scenarios where stakeholders prefer to address more than one business process improvement area/aspect, the leafhopper thinkLet was selected to guide stakeholders in generating BPI alternatives because it enables stakeholders to brainstorm on the different areas simultaneously.

After generating business process aspects to be improved and BPI alternatives for identified aspects in a brainstorming activity, the FastFocus thinkLet was chosen to facilitate stakeholders to gain a common meaning by discussing the contributions and seeking clarifications. In so

doing, stakeholders are enabled to quickly extract and formulate a refined list of key business process aspects or areas that need improvement (task (iii)), and key BPI alternatives (task (vi)).

In scenarios where stakeholders prefer to address more than one business process area/aspect, the BucketWalk thinkLet was chosen followed by the BucketSummary thinkLet. The BucketWalk thinkLet was selected to enable stakeholders to review the BPI alternatives suggested for each business process area/aspect to make sure that all items are appropriately placed and understood. Using the BucketSummary thinkLet, the stakeholders are able to remove redundancy and ambiguous contributions from broad generated items to formulate key BPI alternatives.

The refined lists of business process aspects/areas that need to be improved and BPI alternatives are further discussed to gain more understanding in order to prioritize them. This prioritization is supported through the StrawPoll thinkLet which aids stakeholders in evaluating the identified business process areas/aspects and BPI alternatives with regard to the business processes' performance and risks associated to it (tasks (iv), (vii) and (x) respectively). The StrawPoll thinkLet was also preferred to other evaluation thinkLets because it helps a facilitator to gauge the level of consensus among the stakeholders and highlights points of agreement and conflict, enabling further discussion if needed.

In cases where consensus is paramount as is the case in deciding on which BPI alternative should be selected for example in task eleven (xi), the CrowBar thinkLet was selected. The CrowBar was selected because it provokes and enables;

a. a focused discussion about the issues where the group of stakeholders has a low consensus,
b. the sharing of unshared information,
c. bringing to surface assumptions to examine, and
d. the identification of the main issue causing low consensus.

Step 4: Facilitation Process Modelling (FPM)

Using the thinkLet notation described in Fig. 3-5, the collaboration tasks of the BPIAE process were modelled. The initial BPIAE collaboration process is shown in Fig. 3-13.

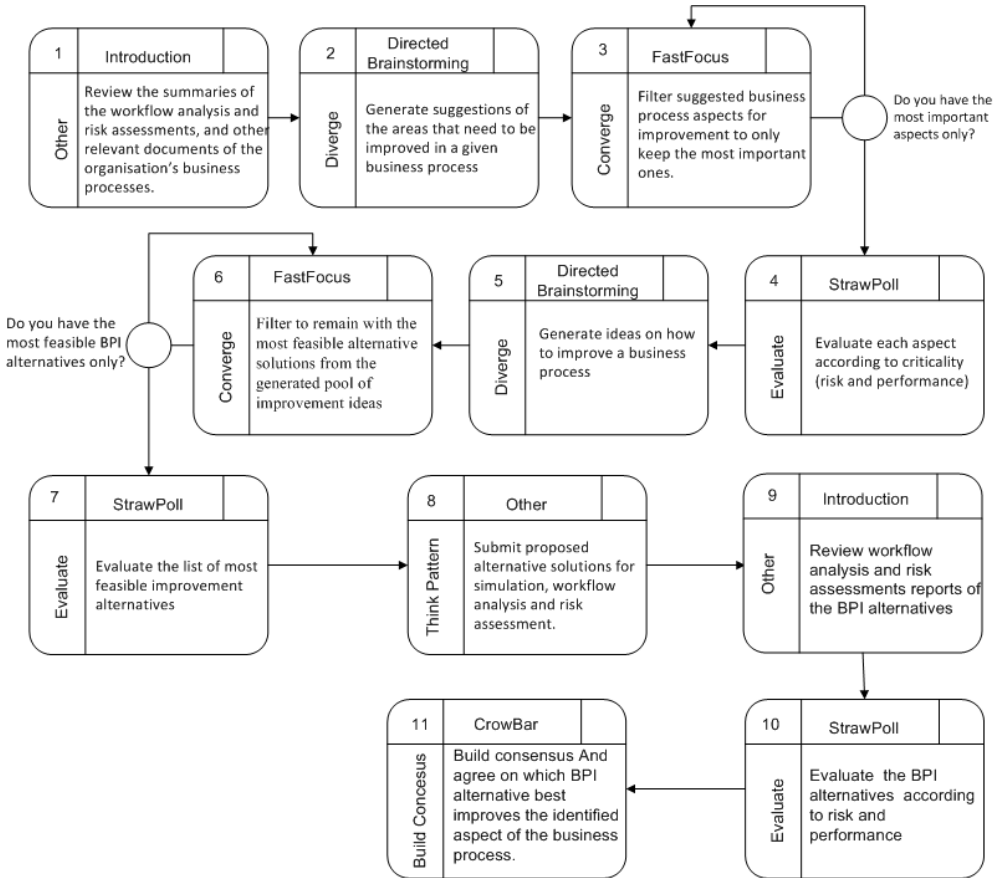

Fig. 3-13: Initial BPIAE Collaboration Process

The tasks defined in the initial BPIAE collaboration process (see Fig. 3-13) were categorized into two sub-processes each providing specific BPI exploration services namely; BPI alternative generation service and BPI alternative selection service.

Sub-process One: BPIA Generation (BPIA-G) Service

The aim of this sub-process of the BPIAE collaboration process is to support stakeholders in the generation of ideas based on process analysis, risk assessment reports of the current process

aware information system and any other relevant information from the business environment e.g. customer complaints, emerging technologies such as mobile money.

The BPIA-G service seeks to enable achievement of the first two global deliverables that is; generating a list of business process aspect(s) or area(s) to be improved and a list of corresponding BPI alternatives. It comprises of a GSS and the BPIA-G collaboration sub-process. The FPM representing the BPIA-G sub-process which involves eight (8) tasks as shown in Fig. 3-14.

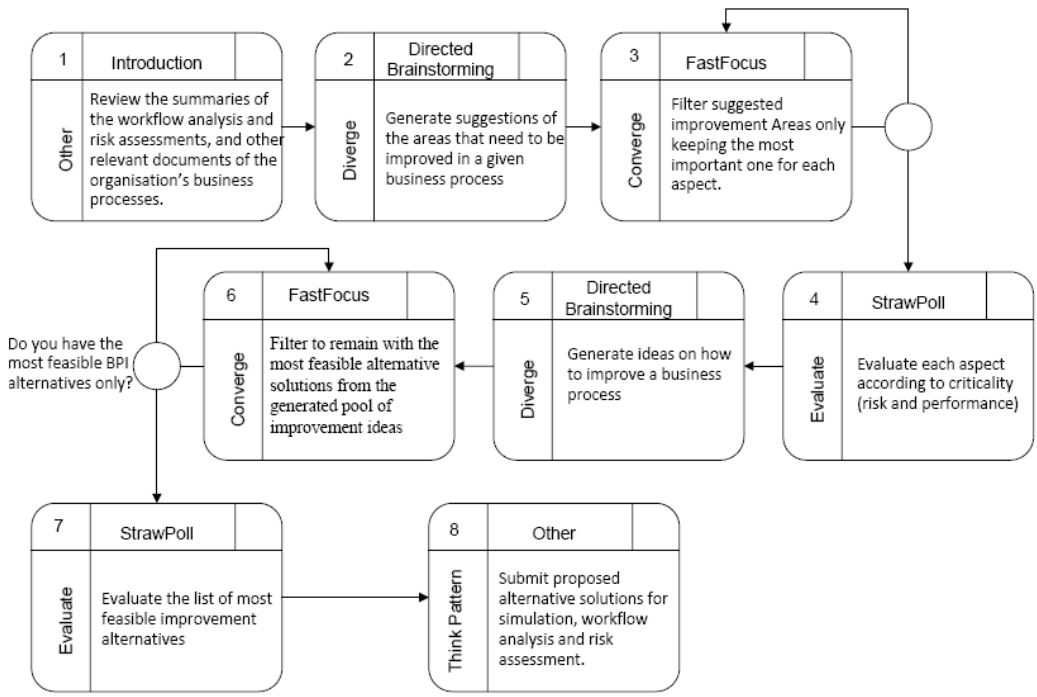

Fig. 3-14: BPIA-G Collaboration Sub-process

1. The aim of task one (introduction) is to bring about a common understanding of the business process performance, risks and the changes/issues arising from and in business environment. Stakeholders review analysis reports and any other additional information about the business process and the business environment.

2. Basing on the information provided and participant's experience and knowledge, stakeholders identify improvement opportunities through a brainstorming activity guided by the DirectedBrainstorm thinkLet.

3. The list of improvement areas/aspects generated from the brainstorming activity is then discussed following the FastFocus thinkLet to eliminate redundant ones and to refine the ideas.

4. Using the StrawPoll thinkLet, the refined list of improvement areas are ranked according to criticality, that is, the need for immediate attention. Basing on the results and the amount available for the session, the area(s) that needs immediate attention is/are selected for improvement.

5. Ways of improving the most critical areas are solicited in a brainstorming activity guided by the DirectedBrainstorming thinkLet.

6. Guided by the FastFocus thinkLet, the generated BPI alternatives are discussed and refined ones to remain with the key or most feasible alternatives.

7. Through a StrawPoll thinkLet activity, the BPI alternatives in the refined list are then evaluated to select key BPI alternatives for the respective improvement areas. However it should be noted that in cases where there are less than three BPI alternatives have been generated, this activity can be skipped upon agreement of the participants.

8. The selected key BPI alternatives are then submitted for analysis such as simulation experiments, workflow analysis and risk assessment.

Sub-process Two: BPIA Selection (BPIA-S) Service

Through this sub-process of the BPIAE collaboration process, a facilitator is supported to guide stakeholders in the selection of a BPI alternative based on simulation results, workflow analysis,

risk evaluation report and/or any other form of analysis of the proposed business process improvement (BPI) alternatives for current process aware information system. This enables the achievement of the third (an evaluation of various BPI alternatives) and fourth global variables; an agreed upon prioritized BPI alternative.

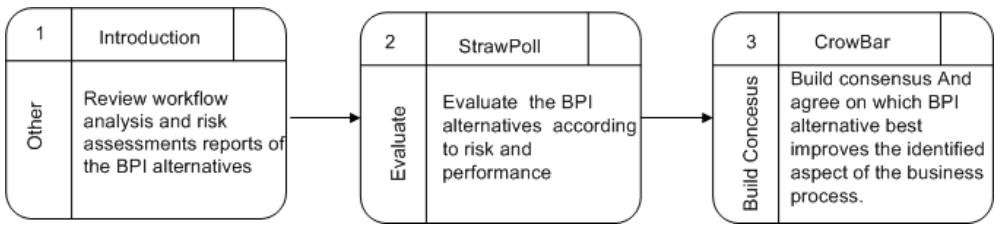

Fig. 3-15: BPIA-S Collaboration Sub-process

On receiving the risk assessment and workflow analysis reports of the proposed BPI alternatives, the group of stakeholders meet to select a suitable BPIA to implement using the BPIA-S service (see Fig. 3-15).

1. This is done by first reviewing the risk assessment and workflow analysis reports for each of the improvement alternatives to evaluate how each BPI alternative improves the identified business process aspect. During this activity, stakeholders seek clarifications where need be to clearly understand the possible risks involved and performance improvements that can be attained.

2. Using the StrawPoll thinkLet, the BPI alternatives are then ranked by the participants (stakeholders) depending on the tradeoffs between the possible risks and the expected improvement, basing on experience, individual knowledge and the availed information.

3. The next activity is an evaluation of the ranking results to assess the level of consensus among stakeholders. In cases where there is minimal or lack of a consensus, further discussions of the alternatives are conducted and another ranking activity is carried out guided by the CrowBar thinkLet.

4. Finally, the BPI with the highest average ranking that is the BPI alternative that satisfactorily improves the identified aspect of the business process in terms of risks involved and performance is selected for adoption and implementation.

BPIAE Guidelines

To provide stakeholder with guidance on how to achieve each of the deliverables, a summary of the tasks to be carried out and their corresponding thinkLets are presented in, Table 3-1, Table **3-2**, and Table 3-3. The collaboration process tasks are also represented as Facilitation Process Model (FPM) diagrams; diagrammatic representation of a sequence of thinkLets (Kolfschoten and De Vreede, 2006).

Deliverable One: *List of Aspect(s) / Area(s) of business process that need improvement*

To generate a list of aspects or areas of a business process that need to be improved, stakeholders review analysis reports and any additional information about the business process and the business environment. The activities that lead to the generation of this list are presented in Table 3-1 and in the FPM shown in Fig. 3-16.

Table 3-1: Table showing tasks, collaboration patterns and thinkLets for identifying Business Process aspects that need improvement

Task No	Task	Deliverable(s)	Collaboration Pattern	ThinkLet
1.	Evaluate the business process by reviewing workflow and risk assessment reports the as-is business process and additional relevant literature and previous improvement documentation	Understanding of the business process performance and business environment	other	
2.	Generate suggestions of the aspects that need to be improved in a given business process	List of business process aspects that need to be improved	Diverge	Directed Brainstorming
3.	Filter suggested business process aspects for improvement to only keep the most important ones.	Refined list of areas of a business process that need to be improved	Converge	FastFocus

4.	Evaluate the refined list of areas that are to be improved; according to criticality (risk and performance)	Prioritized list of business process improvement areas	Evaluate	StrawPoll

Facilitation Process Model

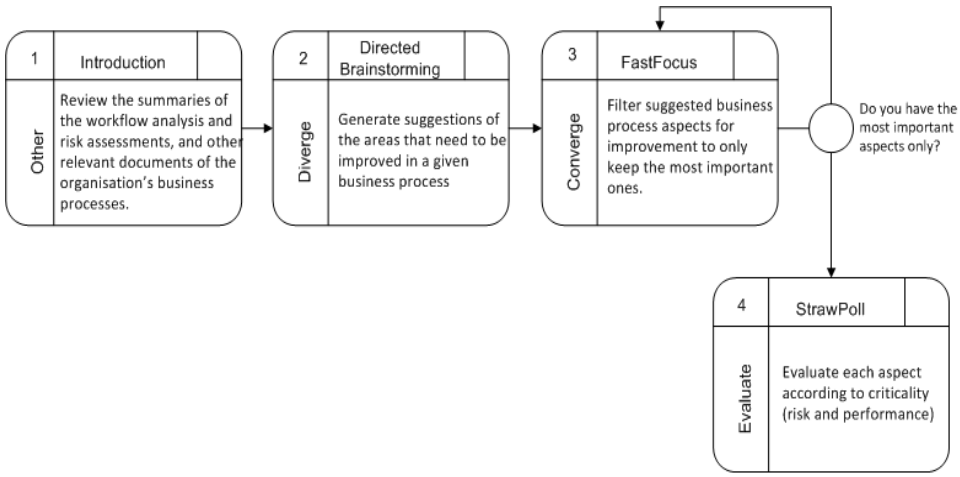

Fig. 3-16: Facilitation Process Model for Identifying Business Process Aspects to be improved

Deliverable two: *List of BPI Alternatives*

Stakeholders generate BPI alternatives for selected business process aspects. The activities that lead to the generation of BPI alternatives are presented in

Table 3-2.

Table 3-2: Table showing tasks involved in generating business process improvement alternatives

Task No	Task	Deliverable(s)	Collaboration Pattern	ThinkLet
1.	Generate ideas on how the business process may be improved	List of alternative ways of improving the business process	Diverge	DirectedBrainstorming / LeafHopper

2.	Filter to remain with the most feasible alternative solutions from the generated pool of improvement ideas	List of most feasible improvement alternatives	Converge	FastFocus/ BucketWalk & BucketSummary
3.	Evaluate the list of most feasible BPI alternatives	Prioritized list of of most feasible BPI alternatives	Evaluate	StrawPoll
4.	Submit proposed alternative solutions for simulation, workflow analysis and risk assessment.	WFA reports and RA recommendations for proposed BPI alternatives	Other	

BPI alternatives for one or more business process aspects that need improvement, depending on the time available for the session, may be generated. In the case of addressing only one business process aspect the DirectedBrainstorming thinkLet is used to generate the BPI alternatives, and the FastFocus thinkLet is used to filter the BPI alternatives (see Fig. 3-17). Otherwise the Leafhopper thinkLet is used to generate the BPI alternatives and the BucketWalk to filter the BPI alternatives.

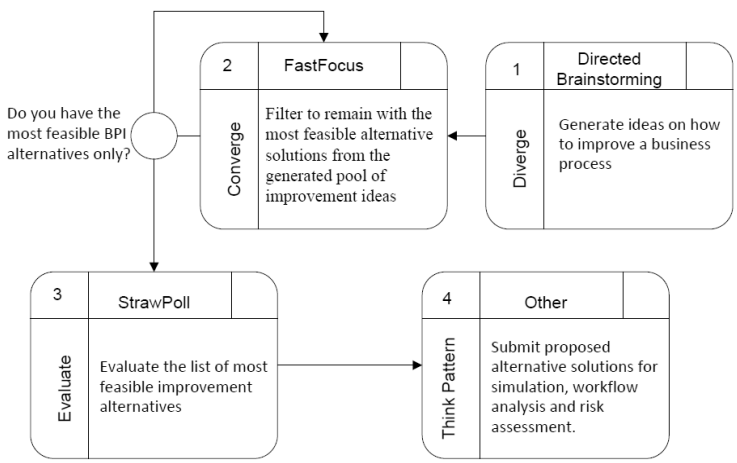

Fig. 3-17: Facilitation Process Model for generating BPI Alternatives when considering one business process aspect

Deliverable three: *Evaluation of the BPI Alternatives*

This deliverable is achieved by analysing the workflow selected key BPI alternatives and the inherent risks involved. Analysis reports containing corresponding lists of mitigation or control measure recommendations and performance indicator results for each alternative are then generated.

Deliverable Four: *Agreed upon prioritized BPI alternative*

Stakeholders review the evaluation reports and agree on a BPI alternative to be implemented by following the tasks in Table 3-3. The corresponding FPM is shown in Fig. 3-18.

Table 3-3: Table Showing Tasks Involved in Agreeing on the Business Process Improvement Alternative

Task No	Task	Deliverable(s)	Collaboration Pattern	ThinkLet
1.	Review workflow analysis and risk assessments reports of the BPI alternatives	Understanding of the BPI alternatives' performance and risks	other	Introduction
2.	Evaluate the BPI alternatives according to risk and performance	Evaluation list of each improvement alternative	Evaluate	StrawPoll
3.	Build consensus and agree on which BPI alternative best improves the identified aspect of the business process.	Shared consensus on implementation procedure	Consensus	CrowBar

Facilitation Process Model

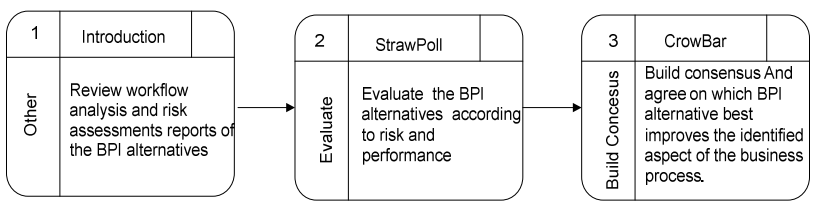

Fig. 3-18. Facilitation Process Model for Agreeing upon a Business Process Improvement Alternative

Step 5: Agenda Building

This entails the specification of the vital instantiation parameters or variables for each task or activity required for the smooth running of the collaboration process. The collaboration session agendas also highlight how much time should be allocated for the different tasks as well as indicating when breaks should be taken during the session.

General agendas corresponding to the collaboration process sub-processes were designed but were adjusted accordingly during execution at different case studies. An average of two (2) hours was allocated for the first sub-process (Fig. 3-14) and an average of one and a half (1.5) hours for the second sub-process (Fig. 3-15).

3.9. Communication Suite

This suite provides an interface through which stakeholders can communicate their decisions to the people responsible for implementing the improvement once a business process improvement alternative has been selected. A message comprised of a subject title and the BPI alternative details is composed by a responsible party. The title is extracted from the message and sent as an SMS notification to responsible stakeholders to alert them that a detail of a BPI alternative has been sent to their email boxes. Secondly the message is emailed to stakeholders' mail boxes. A summary of the activities supported by this suite are reflected in Fig. 3-19.

3.10. Summary

The findings from the literature reviewed in chapter one (1) and the exploratory study presented in chapter two (2) spell out the need for collaboration and involvement of stakeholders in BPI efforts especially in the exploration of BPI alternatives. Furthermore, it was observed that a major input to the exploration process is process analysis particularly risk assessment and process performance. Additionally, facilitating stakeholders to jointly work together to generate, evaluate and select BPI alternatives would curb the chaos that could otherwise spring out of an ill-coordinated BPI effort. Basing on this a BPA decision enhancement studio design is presented in this chapter.

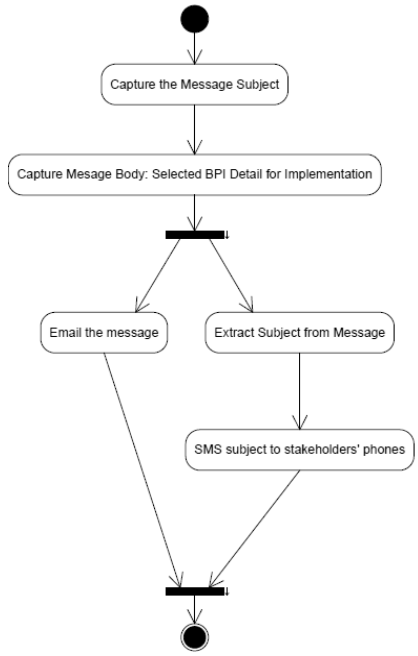

Fig. 3-19: Activity Diagram for the Communication Suite

The BPA decision enhancement studio designed to provide these requirements consists of four suites; Risk Assessment, Workflow Analysis, BPI Exploration and Communication Suites. The studio seeks to enable multiple stakeholder participation and collaboration in exploration of BPI alternatives, risk assessment, and decision making; enable in-depth workflow analysis and simulation; support business process risk assessment; provide visualization of the analysis results and provide an information dissemination medium. To verify the studio design, an instance of the BPA-DES was developed and is discussed in chapter four (4).

4. BPA-DES IMPLEMENTATION

4.1. Implementation Considerations

From the exploratory study, a number of requirements were highlighted and used in coming up with the BPA-DES design presented in chapter 3. To verify the BPA-DES design, an instantiation of the studio was developed to check its functionality. In implementing the BPA-DES instance, a number of issues were considered at the suite level as well as at the studio level.

Studio Level

At the studio level, the implementation issues considered were the choice of the programming language to use and the network architecture.

a) ***Programming language:*** The Java programming language was selected as the programming language to use in the development of the interface for the BPA-DES instance.

b) ***Network Architecture:*** To enable collaboration, a server onto which the collaboration support tools are installed is required. The different participant workstations connecting to the server should be part of the same network i.e. local area network or wireless network. All computers used in the BPA-DES should have a Windows OS (XP, vista, 2007) and Java run-time environment.

Suite Level

For each of the suites, the main implementation issue considered was what software to use to provide the services. This was an issue because it was observed from literature that a number of software tools have been developed to provide some of the services. However, in the case of the communication suite, the choice of a programming language was also considered.

WFA Suite

To support the workflow analysis and simulation services provided in this suite, open source software that provide a wide range of process mining and process analysis techniques and simulation functionality were identified. These included;

i) *Process Mining Framework (ProM)* to support business process mining and analysis (Verbeek et al., 2010; Turner & Tiwari, 2008; Dongen et al., 2005; Günther, 2008). ProM is an open source framework, providing an environment for performing different types of process mining for example, process discovery and conformance checking. It supports process mining by providing a number of plug-ins based on different techniques that can be used to extract information from event logs (Günther, 2008).

ii) *Coloured Petri Net (CPN) Tools* for business process simulation (Jensen et al., 2007). The Standard ML used in CPN Tools provides the primitives for definition of data types, creation of data manipulation and logging functions and thus enabling the creation of complex simulation models (Jensen et al., 2007). Its graphical user interface provides users with the ability to directly manipulate the process model being analyzed and thus simulation-based performance analysis is possible (Jensen et al., 2007).

iii) *PromImport Framework (ProMImport)* to support conversion execution logs from a workflow management system or simulation logs into the MXML format (Günther and Aalst, 2006). This platform consists of a number of algorithms that are implemented as import filters to convert logs from different log-producing systems; CPN tools, Ms Access Database, Apache 2, Staffware, SAP R/3, General CSV files, just to mention a few (Günther and Aalst, 2006).

iv) *XESame* for to support conversion execution logs from a workflow management system or simulation logs into the MXML format (Buijs, 2010; Verbeek et al., 2010). This tool supports the conversion of event data from different data sources to an event log format following the eXensible Event Stream (XES) standard (Buijs, 2010). It also converts generated event logs into the MXML format which is suitable for process mining. XESame enables stakeholders (domain experts) to specify how the event log should be extracted from the existing information system data by creating a mapping (Verbeek et al., 2010).

RA and BPIAE Suites

To implement these services, collaboration support tools and/or PowerPoint presentations may be used. PowerPoint presentations would be used as reference points for participants in absence of a computer tool in order to conduct the collaboration sessions manually.

However, research has shown that group meetings where computer tools were used during collaboration sessions were far more productive than those in which all activities were performed by other means (De Vreede & Briggs, 2005; De Vreede & Briggs, 2003).

In choosing the collaboration support tool to support the collaboration services provided by these suites, the cost of the existing software was considered. The commonly used GroupSystems collaboration tool Thinktank software (De Vreede and Briggs, 2005) was considered for use however because of its cost it was difficult to acquire. In light of this, the MeetingWorks version 7.0 was used in the RA and BPIAE suites to support the risk assessment and BPPI alternative exploration services by enabling the execution of the respective collaboration processes.

Communication Suite

a) ***Programming language:*** The Java programming language was selected to develop the communication suite. This was mainly for consistency purposes with the software used in the other suites.

b) ***Network Architecture:*** To enable the sending of email and SMS connection to the internet as well as a telecommunications provider is required.

4.2. BPA-DES Instantiation

The BPA-DES instance was developed by building an interface to link the suites to provide an environment in which stakeholders are supported in the BPA decision process (see Fig. 4-1). Through the interface stakeholders access the BPA decision enhancement services enabling them to explore BPI alternatives.

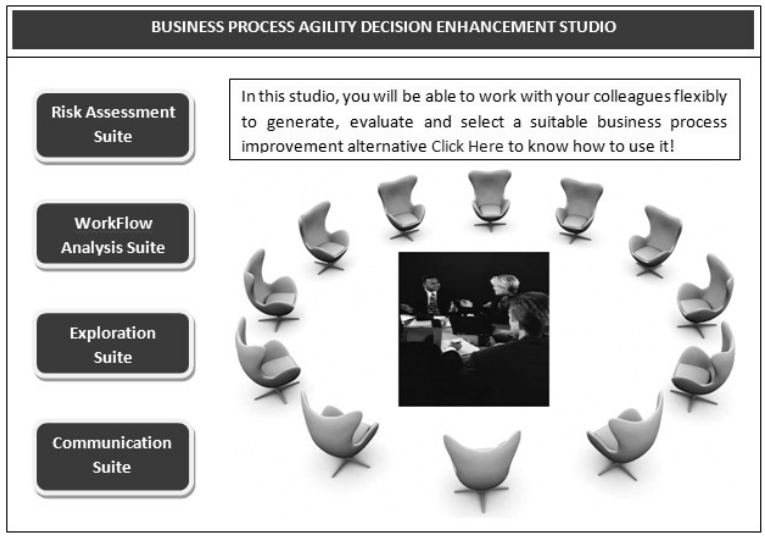

Fig. 4-1: BPA-DES Prototype Interface

In the BPA-DES instance, the selected existing software identified to support business process analysis (risk assessment and workflow analysis); BPIAE and communication during the BPA decision process interact as shown in Fig. 4-2. The suites are represented by the dashed rectangles and the software by the rounded rectangles.

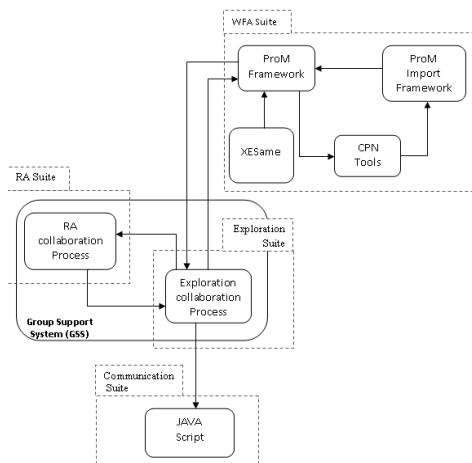

Fig. 4-2: Diagram showing the tools provided in the different suites in the BPA-DES.

WFA Suite

This suite was implemented by installing ProM, ProMImport, CPN Tools and XESame software on the computer(s) used by stakeholders to carry out business process analysis. These technologies enable stakeholder to analyse a business process and business process improvement alternatives by supporting the eight activities highlighted in section 3.6. On clicking on the *WorkFlow Analysis Suite* button on the BPA-DES interface the WFA service is started. The user is presented with a drop down menu with options to *Analyse Business Process* or *Business Process Simulation (*see Fig. 4-3). Selecting the analyse option presents the user with another drop down menu with options to define which format the event log is in i.e. "*MXML Log*" or "N*ot in MXML format*".

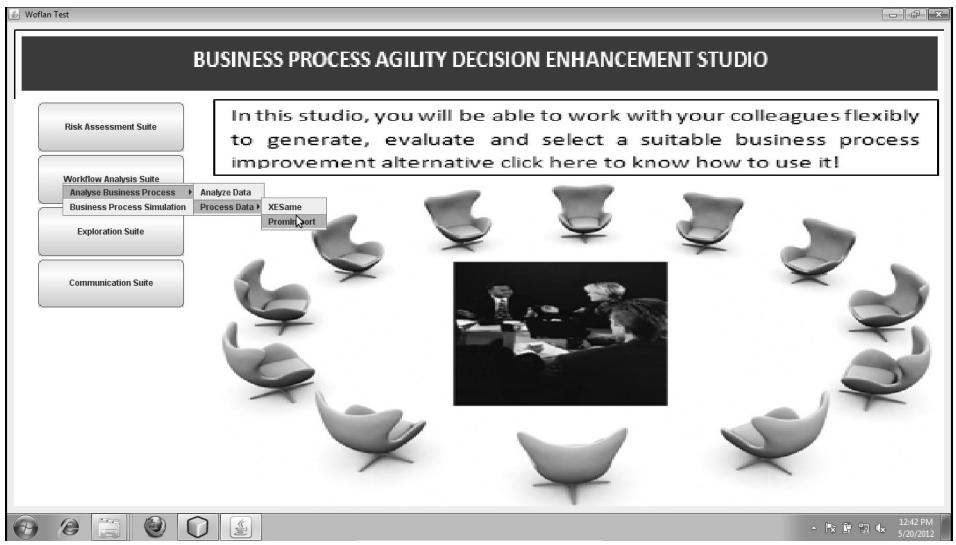

Fig. 4-3: Screen Shot Showing Implementation on WFA Suite

1. ***Processing Event log Data:*** On selecting the '*Process Data*' option (see Fig. 4-3), a user can select *ProMImport* or *XESame* to carry out the conversion. Selecting either option will automatically start ProMImport and XESame respectively. The ProMImport framework was selected for this task because of its ability to extend it by supporting quick implementation of solid and versatile solutions. It already provides filters that support a wide range of process aware information systems as mentioned above. Logs are input into

ProMImport by specifying the directory in which the logs are stored, and where the generated MXML logs should be saved.

2. ***Discovery of as-is process model:*** Clicking on the "*Analyse Data"* (see Fig. 4-3) option enables the user to automatically start ProM in case the event logs are in the MXML format. A log file containing event logs generated by ProMImport or from a log file generated by an organisation's workflow management system during process execution is opened in the ProM Framework by selecting the appropriate file type from the file menu. The log may be filtered to remove some tasks or mined as-is.

3. ***Analysis of the as-is process model:*** Analysis of the business process' performance and behaviour is done by applying analysis algorithms of one's choice as provided in the ProM framework on the mined as-is process model. To identify the bottlenecks and process flow time, the performance analysis with Petri Net algorithm is applied on a mined process model.

4. ***Generating an Analysis Report:*** To generate analysis reports, results of the analyses were exported using the export functions provided in ProM. The mined models and model analysis visualizations can be exported by selecting an appropriate file type from the *Export* menu. The individual reports are then compiled into one workflow analysis report that contains information on the performance indicators that have been analysed and their corresponding result.

The Analysis reports generated in the previous step are given to stakeholders taking part in BPI alternative exploration. Stakeholders then use this information and other additional information such as policies, laws and risk assessment reports to identify possible improvement alternatives using the BPIAE Suite. The alternatives are then analysed by first generating simulation models, running simulation experiments to generate event logs that can be used for mining and analysing the improved business process alternatives as described above.

5. ***Generate improved business process models:*** This activity involves the modelling of the improved business process alternatives i.e. the developing of different improved business process models reflecting the adjustments/modifications alternatives suggested by stakeholders. This can be done by modelling the business process from scratch as would be the case in situations where there is no workflow management system or by first discovering the initial simulation model.

Modelling from Scratch

Clicking on the "*Business Process Simulation*" option (see Fig. 4-3) from the WFA drop down menu, the CPN tools software is automatically started. Using CPN tools, the user can model the build the initial simulation model of the as-is business process, make the adjustments according to the proposed improvements and run simulation experiments.

Discovering Simulation Model

By selecting the "*Analyse Data*" option (see Fig. 4-3) ProM is automatically launched and is used to discover the initial simulation model (CPN model) from the MXML event logs by following the steps described in Rozinat et al. (2009). The discovered model is then exported and stored at a location of one's preference in the computer.

The discovered CPN simulation model is then modified to reflect the proposed improvement alternatives (To-Be process models) by;

(i). Clicking on the "*Business Process Simulation*" option (see Fig. 4-3) from the WFA drop down menu, CPN tools is automatically started. The discovered initial simulation model is then open using CPN tools.

(ii). Make the necessary adjustments to the business process model such as change branching rules (business rules), add tasks, remove tasks, create parallel tasks etc.

The generated simulation models are then verified to ensure that they are sound and live. A sound business process is one where there is always a proper completion of business process instances (cases) (Verbeek and Aalst, 2000). Verification of soundness entails

checking whether a business process is *Live* and *bounded* (Aalst, 1997). Being live means that a process can move from one state to another and another activity can be performed in that state (a transition being enabled as a result of moving from state A to state B) (Aalst et al., 2011). This measure works to ensure the absence of 'livelocks' and 'deadlocks' in the process model; a deadlock being the non-live sequence of reachable activities in a workflow model or net (for more information see Verbeek and Aalst, 2000, Aalst et al., 2011)

6. ***Simulation Experiments:*** Using CPN tools, the simulation experiments are run so as to generate test logs that can be used in analysis of the BPI alternatives through process mining. This approach has been used by other researchers (Maruster and Beest, 2009, Medeiros & Günther, 2000). The generated CPN simulation models are then executed to simulate the working of the business process by clicking the play buttons that appear in the CPN tools' simulation tool box. Event logs are logged during the execution of each improved business process alternative (simulation experiments) using logging declarations and logging functions specified in the simulation model.

7. ***Discovering improved business process model alternatives:*** Discovering the different improved business process model alternatives from the event logs generated by their respective simulation experiments is carried out by first processing the data using ProMImport as described above to convert the cpnxml files into MXML format (see *Processing Event log Data* section). The resulting file is then opened in the ProM framework and the process model discovered using a process mining algorithm (refer to *Discovering as-is process model* section).

8. ***Analysis of improved business process alternatives:*** The performance and behaviour of the different mined to-be or improved process models are analysed to identify the bottlenecks, process flow time, resource utilization and performance in the same way as the as-is process model is analysed in *Analysis of the as-is process model* section above. The analysis reports are also generated as mentioned above in *Generating an Analysis Report*

RA and BPIAE Suites

To execute the RA and BPIAE collaboration processes, the thinkLets or collaboration tasks are implemented as tasks in an agenda. During a collaboration session, the agenda is used as a guide enabling the facilitator to lead the stakeholders jointly carry out the risk assessment and BPI alternative exploration activities together during the BPA decision process.

RA Suite

On clicking on the *Risk Assessment Suite* button on the BPA-DES interface, the RA service is began i.e. the user is presented with option "*Create Agenda*" or "*Collaboration Session*". By selecting the *Collaboration Session* option, the Chauffeur tool in MeetingWorks is started. The *Create Agenda* button starts the AgendaPlanner in MeetingWorks which the user uses to develop agendas basing on the thinkLets in the RA collaboration process.

Using the MeetingWorks chauffeur, the facilitator conducts the RA collaboration sessions following prescriptions or guidelines defined in an agenda. The participating stakeholders register and join the collaboration session at their work stations. The results of the session are saved in a file that will be an input to the exploration collaboration process. This file will be saved in a folder that is accessed by MeetingWorks as an input to the review step of the collaboration process.

BPIAE Suite

Similarly, on clicking on *Exploration Suite* button on the BPA-DES prototype interface, the BPIAE service is started. The user is presented with option "*Create Agenda*" or "*Collaboration Session*" Selecting the "*Create Agenda"* automatically begins the AgendaPlanner in MeetingWorks Version 7.0. The "*Collaboration Session"* starts the Chauffeur tool in MeetingWorks which is used to run the collaboration sessions.

Using this service, the facilitator guides a group of stakeholders to identify the areas of a business process that need to be improved; generate BPIAs and select a BPIA. Each participating stakeholder is required to register and join the collaboration sessions at their workstations. The

BPIAE collaboration sessions are directed using a pre-defined agenda developed based on the BPIAE collaboration process. Results of the session are saved in a file.

Agenda Creation

Using the agenda planner in MeetingWorks collaboration session agendas were developed in accordance to the respective RA (Fig. 3-9) and BPIAE (Fig. 3-14 and Fig. 3-15) collaboration processes. The session agenda may be created automatically by following the five step meeting agenda wizard provided in MeetingWorks agenda planner or manually by a stakeholder. The draft agenda created by the wizard is the modified to match activities specified in the respective collaboration process modules.

To create an agenda manually, the following steps were followed;

1. ***Describe Agenda***: Give the agenda being created a name; agenda description/instructions/purpose of the session; specify the author; and a file name for the log report that will be generated during the collaboration sessions.

2. ***Build the agenda items***: This was done by adding the different tasks to be done.
   a. Select a corresponding collaboration pattern (discussed in chapter three) for a given collaboration task from the Edit->Add menu.
   b. Give the description or specification of the collaboration task; general detail, participant configurations, and the list of topics, instructions to the public (step options) and facilitator notes if any.

3. ***Save Agenda***: Once all the agenda items have been added, the complete agenda is saved at a location of one's choice.

Collaboration Sessions

The MeetingWorks Chauffeur is used to execute the developed agendas during collaboration sessions to assess business process risks and to explore BPI alternatives. Before running the meeting, participants must be registered and the mode of the session set. The different modes of the participation relate to the time and location aspects. They include; same place-same time (local participation on a Local Area Network (LAN)), different time, and same time participation (see Fig. 4-4). Participants may be able to participate while at different locations through the internet.

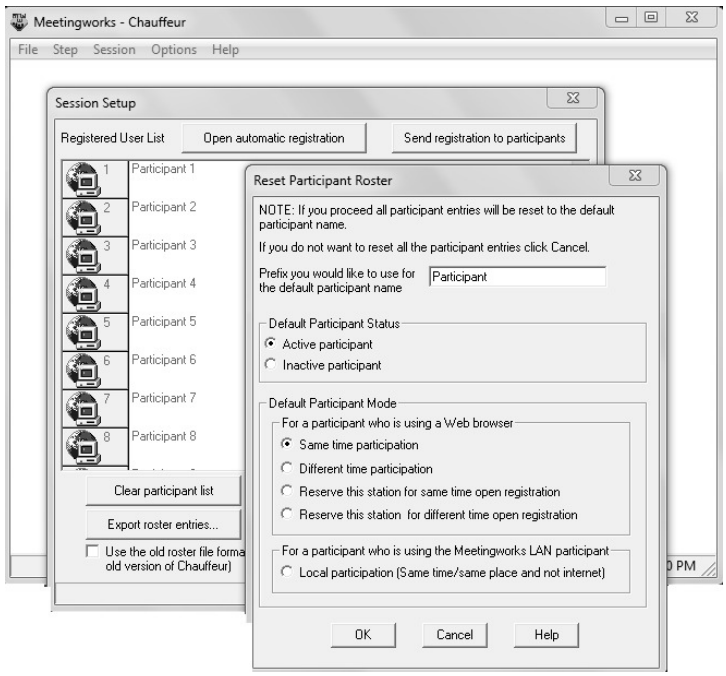

Fig. 4-4: Screen Shot showing MeetingWorks Chauffeur-Participant Registration Setup

Invitations to the participants to join the collaboration sessions may be sent before or after loading the agenda by clicking on the send registration to participants. Participants register by selecting a given participant name (see Fig. 4-5)

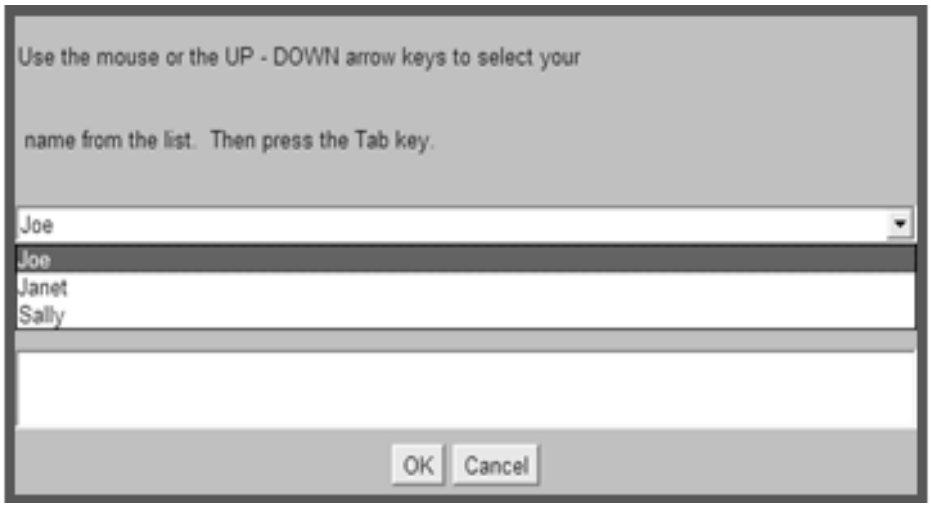

Fig. 4-5: Screen Shot showing Participant Registration

The respective collaboration process agenda is loaded into MeetingWorks chauffeur using the open option in the file menu. Once the agenda has been loaded, registered participants will be able to view the agenda on their work stations. The facilitator guides the group through each task by selecting and running each task to be carried out.

During the execution of a given task, instructions to the participants on the purpose of a given task and how to perform are displayed on their screens.

Communication Suite

When the *Communication Suite* button is clicked, the communication service is began (see Fig. 4-6). The service enables stakeholders to share information through a Short Message Service (SMS) and email service. The user is presented with an interface, in which a message giving detail of a made decision is written. The title of the message is extracted and sent to the recipient's phone to inform them about the message that is sent as an email.

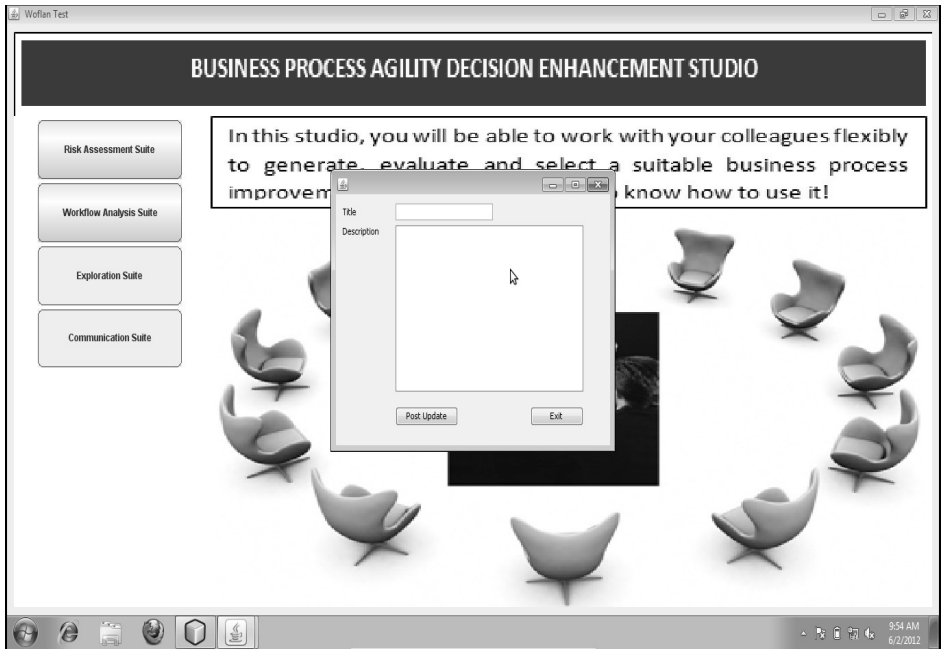

Fig. 4-6: Screen Shot Showing the Communication Suite

4.3. BPA-DES Verification

Verification of the BPA-DES instance involved six staff members from the ICT and Business department of the Faculty of Economics and Business, University of Groningen (RUG), six staff members from the Faculty of Computing and Informatics Technology (FCIT), Makerere University and six PHD students from FCIT, Makerere University. The verification process focused on three suites of the BPA-DES that is the communication, WFA, and BPIAE suite. Assessment of risks was done by carrying out interviews with relevant stakeholders to gather information about the risks involved in the selected business process.

a) ***Communication Suite***: verification of this suite was done to ascertain that it is working as required i.e. sending a SMS to a participant's phone and an e-mail. It was verified by four participants. The verification checks are highlighted in Table 4-1. It was verified in Uganda using the Orange telecommunication network as the service provider to support the sending of SMSes to participants.

b) ***WFA Suite***: verification of this suite was aimed at checking whether the suite was working as intended in terms of supporting the activities specified in section 3.7. In other words the verification assessed the ability of software tools to enable analysis of business processes, and support the creation of a simulation model, modification of the model and simulation of the business process to enable evaluation of different improvement alternatives. The staff members at RUG took part in the verification of the suite. The WFA suite was verified through one-on-one meeting sessions where the participants checked the aspects described in Table 4-1.

c) ***BPIAE Suite***: Verification of the BPIAE suite was done to ascertain whether BPIAE think patterns and thinkLets used in collaboration process were appropriate for the attainment of the specified deliverable as described in section 3.8, and whether the time allocated for the various collaboration tasks was sufficient. In other words, assessing whether the BPIAE suite enables efficient BPIA exploration by supporting the tasks discussed in section 3.8. The verification process was done by carrying out walkthrough sessions at RUG involving participants from FCIT and RUG. Seven participants took part in the first BPIAE session and thirteen in the second BPIAE session. The feedback received from participants is presented in Appendix E.

Table 4-1: Table showing the verification checks for the BPA-DES

Suite	Verification Checks
WFA	• Can the business process be analysed to identify bottlenecks and the processing time? • Is manipulation of business process models supported? • Is the creation of a business process simulation model supported? • Is the modification of a business process simulation model supported? • Can simulation experiments be conducted to generate event logs? • Can event logs be processed (converted into MXML)

BPIAE	• Do the selected think patterns and thinkLets enable identification of areas of a business process that need improvement? • Do the selected think patterns and thinkLets enable generation of BPIAs? • Do the selected think patterns and thinkLets enable identification of areas of a business process that need improvement? • Do the selected think patterns and thinkLets enable selection BPIAs? • Is the time allocation for different tasks sufficient? • Is stakeholder collaboration supported?
Communication	• Is the user interface intuitive? • Is it easily to learn and use? • Can a message be composed? • Is the SMS containing the title of message being sent and received? • Are email messages being sent and received?

The feedback received during the verification process was used to refine the BPA-DES instance before subjecting it to real world cases as described in the vignette in section 4.4.

4.4. Vignette of BPA-DES: Student Registration Process

A student registration process at a university was considered as a test scenario for the BPA-DES. Before the introduction of the college system, undergraduate students at the Faculty of Computing and Informatics Technology (FCIT) registered locally while the graduate students registered both at the Graduate school and faculty. Initially, this process was completely manually done however with the increase in the student population, this became a very tedious process characterised by long student queues. An online registration was introduced as a solution to the problem but not much prior testing and evaluation was done to ensure that it works as required e.g. not all categories of students can register online.

The BPA-DES was used to analyse the student registration process and to explore ways of improving it. As described in chapter 3, workflow analysis and a risk assessment were carried out to identify the areas that needed to be improved.

Workflow Analysis

Considering that the student registration process was supported using a workflow management system and the logs generated by the ARIS were not available, the BPA-DES simulation service was used to build a simulation model basing on data collected about the process.

Using CPN Tools, the major activities, different possible states a student can be in, and conditions of the registration process were identified from the data. Using this information, the Petri Net model representing the registration process was developed in CPN Tools (See Fig. 4-8). In building the simulation model, the different tasks performed in the student registration process and the inherent business rules were identified. Basing on these business rules e.g. a first year student in the first semester was to register following the manual process, the ordering of the tasks was identified. The business rules were implemented as guards (see Fig. 4-8.) at tasks e.g. at the LogOn task, a guard was implemented to ensure that only continuing students on normal progress register following the online registration process.

- fun newstudent(id) = {sdtRegId = id,
  YOS = year.ran(),
  Semester = Sem.ran(),
  Program = Prog.ran(),
  AStatus = AS.ran(),
  Level = level.ran(),
  FStatus = integer.ran()}
- fun newform() = {formId = "F_"^Int.toString(fNo.ran())}
- fun studentForm(s:student, f:Form) = {fm=f, st=s}
- fun newcertificate() = {cId = "C_"^Int.toString(cNo.ran())}
- fun newEFInstance() = {formId = "EF_"^Int.toString(fNo.ran())}

Fig. 4-7: Extract of Functions to create new instances of Students, Forms and Certificates

The tasks were represented as transitions in the simulation model as shown in Fig. 4-8. The available resources, such as the faculty registrars (8) and registrar at the graduate school, were represented by putting the initial markings at the respective places.

Also sub-processes to generate students, forms and certificates at a given time intervals were modelled. The create transitions or tasks were used to create new instances of students, forms and certificates randomly using the functions newstudent, newform, newcertificate respectively as shown in Fig. 4-7.

At each task in the registration process, a function to capture information about the task whenever it's executed during a simulation was defined by specifying the input and action to be taken as shown in the code extract in Fig. 4-8. The action specifies that an event should be added in the log file using the "fun add" function (which takes arguments file_id, worfklowElement, Eventype, TimeStamp, Originator and Data) defined in the loggingFunctionsMultipleFiles.sml (see Fig. 4-8 and Appendix H).). The model was verified by a walk-through the model with the Faculty registrar and changes were made to obtain the final model.

Using the Log Declaration (see text box in Fig. 4-8) logging functions that enable the generation of a log file, where the first line is the path and name file for the generated log file; the second line is the file extension for the generated log file; and the third line is the path to file containing logging functions being referenced in the process model. A number of simulations of the registration process were run and event log files for each of the process instances (see Fig. 4-9) representing a registered student were stored. Once the event logs had been generated using the simulation model, the student registration process was analysed following the guidelines or steps prescribed in chapter 3.

***Processing Event log Data**:* The simulated event logs generated during the process simulations run in CPN Tools were converted into the MXML format. ProMImport was used for this task particularly making use of the CPN Tools filter.

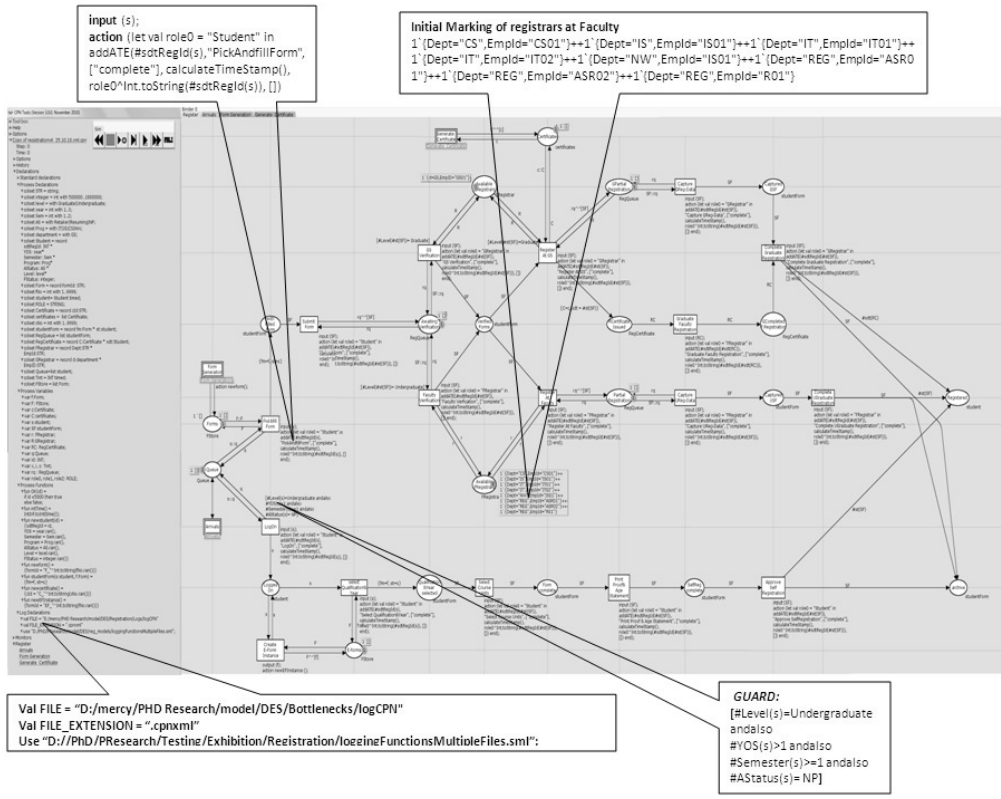

Fig. 4-8: Simulation Model of the As-Is FCIT Student Registration Process

The simulated event logs (see Fig. 4-9.) were input into ProMImport by specifying the directory in which the logs are stored (Example: '*CPN log files directory*' property/field for the simulation log (see Fig. 4-10). The folder/directory in which the MXML log file should be saved is also specified in the '*to*' field.

```
1
<AuditTrailEntry>
<WorkflowModelElement>PickAndfillForm</WorkflowModelElement>
<EventType >complete</EventType>
<Timestamp>1970-01-01T03:00:00.000+01:00</Timestamp>
<Originator>Student1</Originator>
</AuditTrailEntry>
<AuditTrailEntry>
<WorkflowModelElement>SubmitForm</WorkflowModelElement>
<EventType >complete</EventType>
<Timestamp>1970-01-01T03:00:00.000+01:00</Timestamp>
<Originator>Student1</Originator>
</AuditTrailEntry>
<AuditTrailEntry>
<WorkflowModelElement>Faculty Verfication</WorkflowModelElement>
<EventType >complete</EventType>
<Timestamp>1970-01-01T03:00:00.000+01:00</Timestamp>
<Originator>FRegistrar1</Originator>
</AuditTrailEntry>
```

Fig. 4-9: Extract of Simulation Log for Process

Fig. 4-10: Screen Shot of Converting CPN simulation logs to MXML using ProMImport

By clicking the start button (see Fig. 4-10) the simulated event logs were converted into the required MXML format. The resulting MXML log containing an aggregation of all the process instance logs is illustrated in Fig. 4-11.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- MXML version 1.0 -->
<!-- This is a process enactment event log created to be analyzed by ProM. -->
<!-- ProM is the process mining framework. It can be freely obtained at http://www.processmining.org/.  -->
<WorkflowLog xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                        xsi:noNamespaceSchemaLocation="http://is.tm.tue.nl/research/processmining/WorkflowLog.xsd"
                        description="CPN Tools simulation log">
<Source program="CPN Tools simulation"/>
    <Process id="DEFAULT" description="Simulated process">
            <ProcessInstance id="1" description="Simulated process instance">
              <AuditTrailEntry>
                <WorkflowModelElement>PickAndfillForm</WorkflowModelElement>
                <EventType >complete</EventType>
                <Timestamp>1970-01-01T03:00:00.000+01:00</Timestamp>
                <Originator>Student1</Originator>
              </AuditTrailEntry>
              <AuditTrailEntry>
                <WorkflowModelElement>SubmitForm</WorkflowModelElement>
                <EventType >complete</EventType>
                <Timestamp>1970-01-01T03:00:00.000+01:00</Timestamp>
                <Originator>Student1</Originator>
              </AuditTrailEntry>
                .....
            </ProcessInstance>
            <ProcessInstance id="10" description="Simulated process instance">
                ....
            </ProcessInstance>
            ...
    </Process>
</WorkflowLog>
```

Fig. 4-11: MXML Log extract generated by ProMImport from various CPN simulations

Discovery of as-is process model: The log file containing event logs generated by ProMImport was opened in the ProM Framework (see Fig. 4-12) by selecting the 'MXML Log file' from the file menu. The log may be also be filtered in ProM to remove redundant tasks i.e. those that have not been completed. This cleans up the event log before one mines it however, it is possible to discover a business process from a raw or un-filtered log.

Fig. 4-12: Student Registration MXML Log opened in ProM

To discover the as-is business process model from event logs, a mining algorithm is selected from the Mining menu and one must specify whether it should be applied to the filtered log or the raw unfiltered log. In the case of the student registration process, the Alpha mining algorithm was used to discover the as-is business process model from the raw MXML log in Fig. 4-11 generated from ProMImport. Fig. 4-13 shows the mined process model.

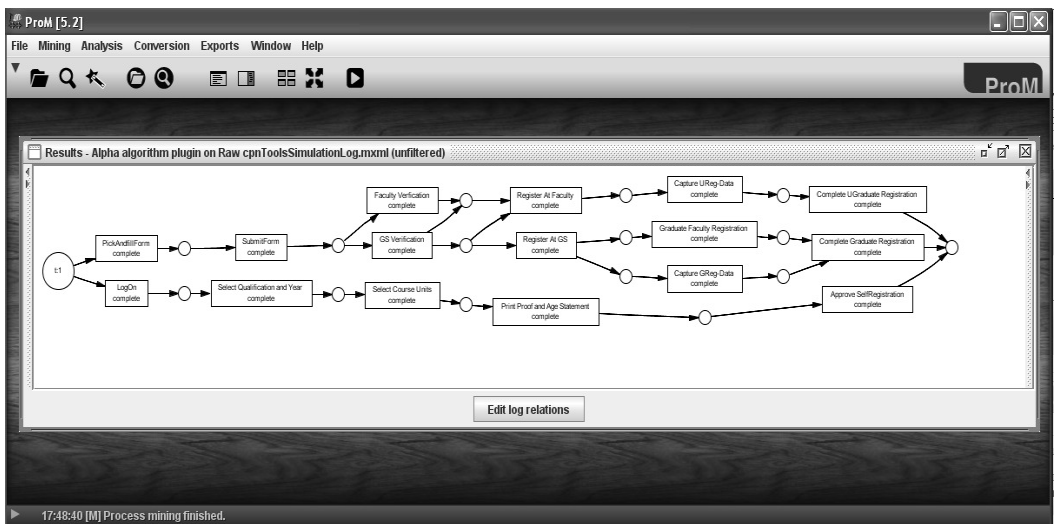

Fig. 4-13: Mined As-Is Student Registration Business Process Model

Analysis of the as-is process model: Analysis of a business process' performance and behaviour is done by applying one or more analysis algorithms provided in the ProM framework.

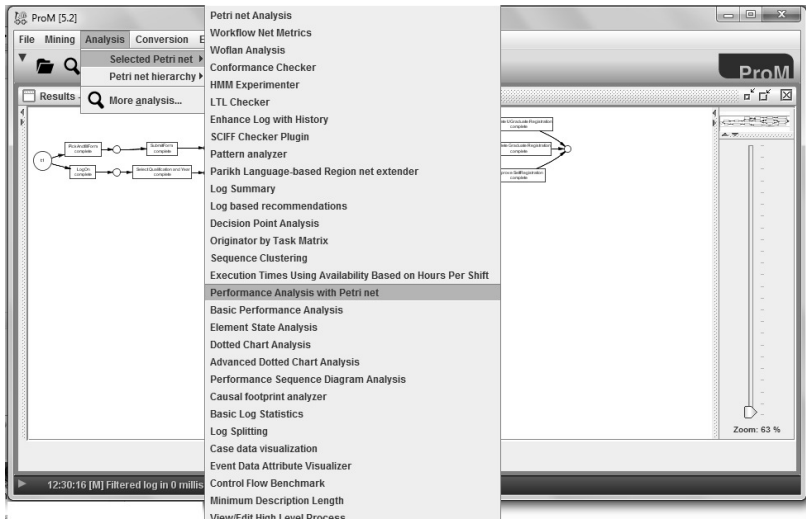

Fig. 4-14: Screen shot of showing analysis algorithms provided in the ProM Framework

In the case of the student's registration process, the performance analysis algorithm (see Fig. 4-14) was applied on the mined as-is process model to identify the bottlenecks and process flow time (see Fig. 4-15). The analysis in Fig. 4-15 shows that the process takes an average of 28 seconds which in real life is about 28 minutes. The analysis shows that there is a bottleneck between logging in and selecting ones qualifications which may be attributed to the bandwidth challenges facing developing countries like Uganda.

Generating an Analysis Report: Analysis reports were generated by exporting the results using the export function provided in ProM. The mined models and model analysis visualizations can be exported by selecting and appropriate file type from the *Export* menu as shown in Fig. 4-16. The throughput times can be exported as .CSV files that can be opened using Ms. Excel by clicking the '*Export Time Metrics'* button (see Fig. 4-15). The individual exported reports may be compiled into one workflow analysis report that contains information on the performance indicators that have been analysed and their corresponding result.

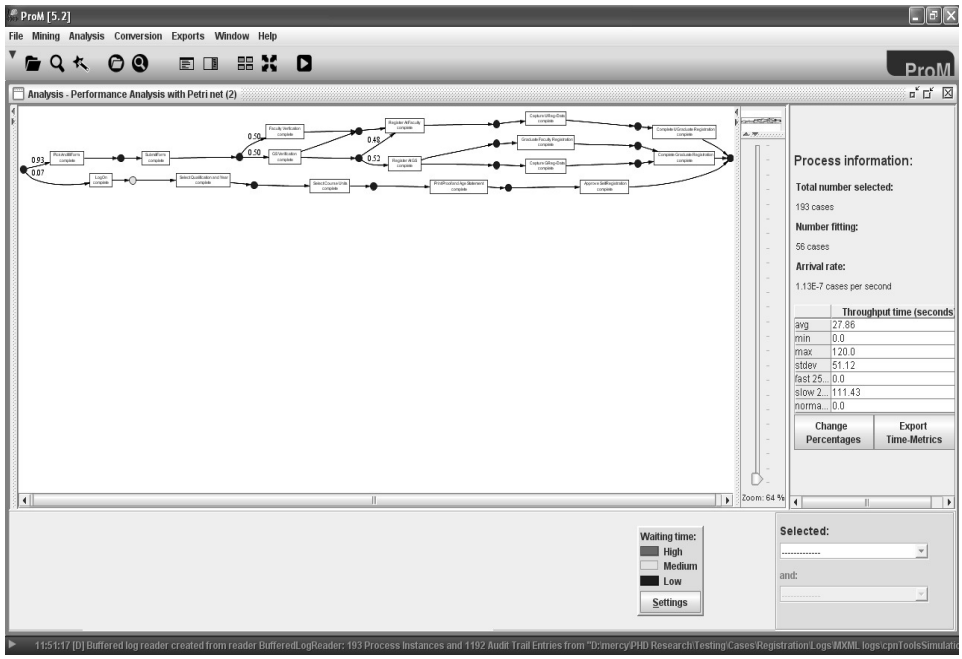

Fig. 4-15. Screen Shot of Performance Analysis of Makerere University Student Registration Process Showing Bottlenecks and Throughput time.

Risk Assessment

In order to assess the risks of the student registration process, the researcher interacted with different stakeholders to identify the risks inherent in the process. A risk assessment agenda was developed using the agenda planner in MeetingWorks and a PowerPoint presentation was prepared to be a reference point for participants during the collaboration session. The identified risks are presented in Appendix D.

BPIA Generation

The Analysis reports generated in the workflow analysis and risk assessment steps were given to stakeholders taking part in the exploration of BPIAs. Stakeholders reviewed the reports and other additional information such as policies and laws, to identify possible improvement alternatives using the BPI Exploration Suite.

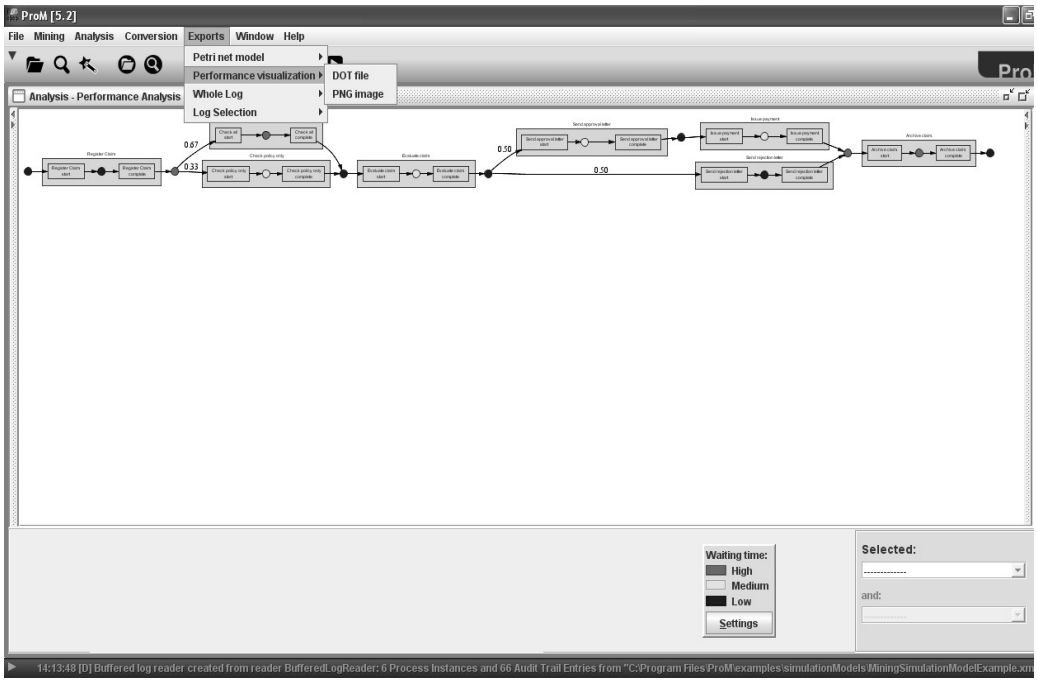

Fig. 4-16: Screen Shot Showing the available export commands in the Export Menu in the ProM 5.2 Framework

The alternatives are then analysed by first generating simulation models, running simulation experiments to generate event logs that can be used for mining and analysing the improved business process alternatives as described above.

Using the MeetingWorks agenda planner, the BPIA generation agenda was developed basing on the BPIA-G sub-process of the BPIAE collaboration process. In other words, the thinkLets representing the collaboration tasks in the BPIA-G were implemented as tasks to be done in the agenda. The tasks were carried out in the collaboration session held to generate possible BPIAs for a business process aspect identified to be improvement (see Fig. 4-17**).**

Also, a PowerPoint presentation was prepared to be a reference point for participants during the collaboration session and where necessary to conduct the collaboration session manually in the absence of MeetingWorks.

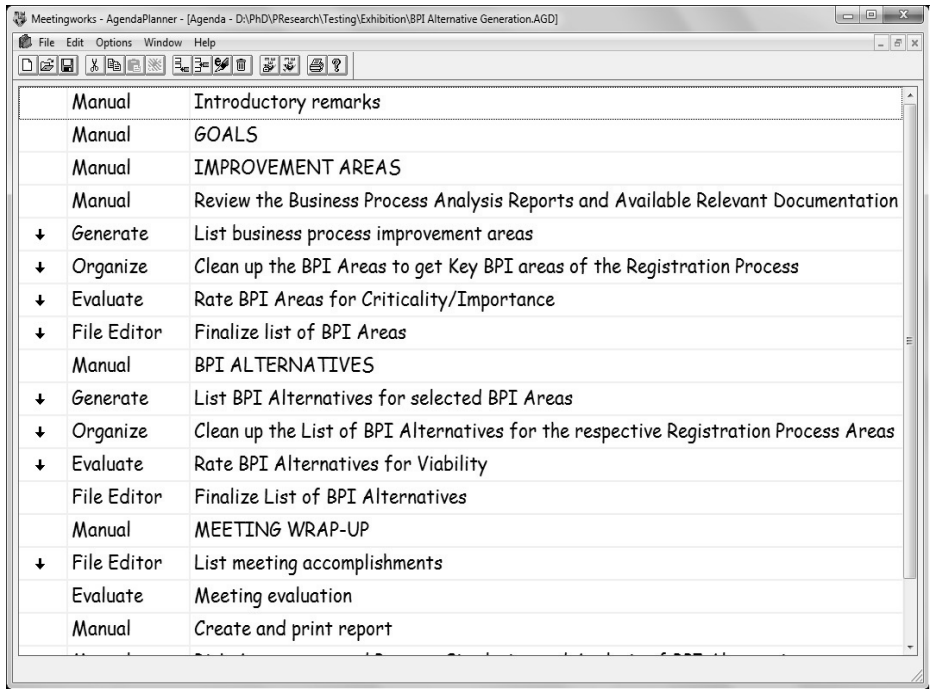

Fig. 4-17: Agenda for BPIA Generation for Student Registration Process

BPIA workflow Analysis

Generate improved business process models: The simulation model shown in Fig. 4-8 was used as the initial simulation model of the student registration process. The adjustments representing the improvement alternatives were implemented to the model. The models were verified by using walkthroughs with the process owners.

Simulation Experiments: The simulation experiments are conducted using the button in the simulation tool box that runs simulations without showing intermediate markings (see Fig. 4-18)

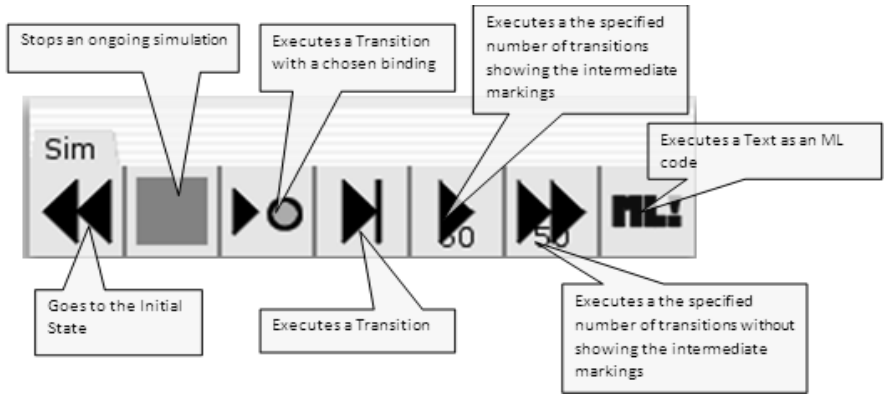

Fig. 4-18: Simulation tool box in CPN tools

Discovering improved business process model alternatives: The different improved business process model alternatives were discovered from the event logs generated from the simulation experiments. Fig. 4-19 is an example of the mined or discovered BPIA model for the student registration process

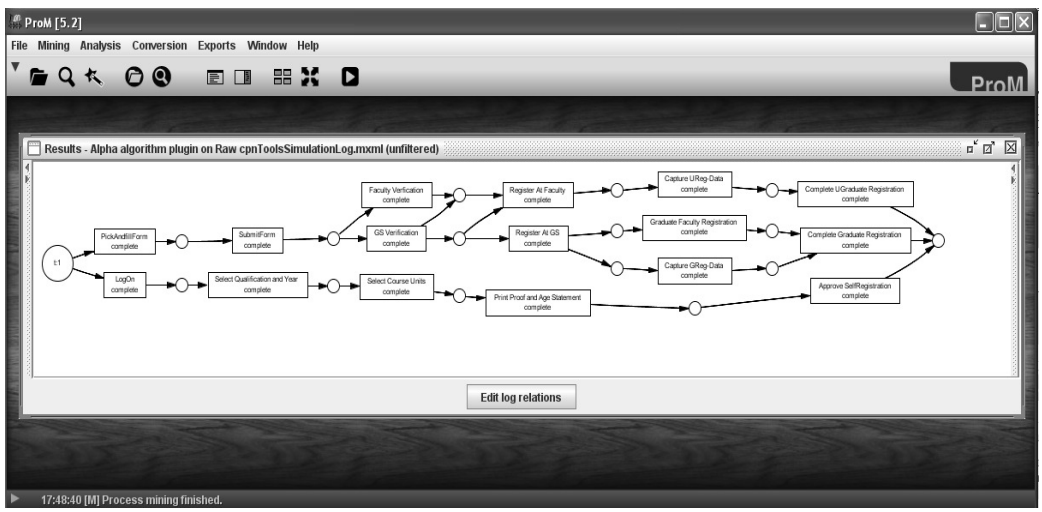

Fig. 4-19: Mined BPI Alternative 1 of Student Registration Process

Analysis of improved business process alternatives: Using the performance analysis with Petri Net algorithm. The bottlenecks and process flow times were identified. Fig. 4-20 shows the results.

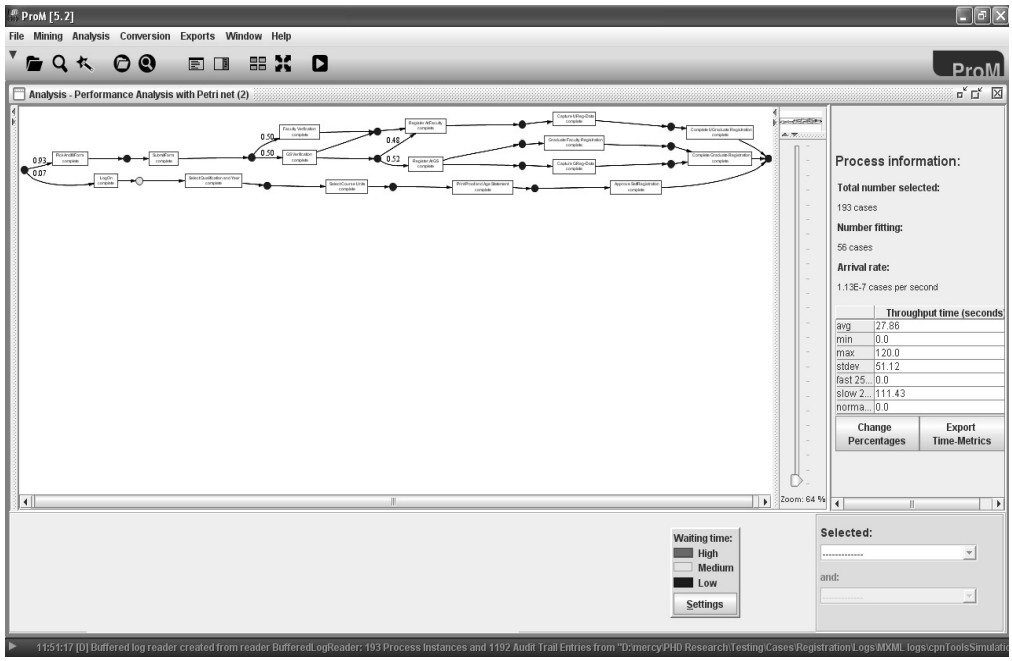

Fig. 4-20: Performance Analysis of BPI Alternative 1 of Student Registration Process

BPIA Risk Assessment

The same agenda developed for assessing the risks in the as-is business process was used to assess the risks in the proposed BPIAs.

BPIA Selection

In a similar way as the development of the BPIA-G agenda, the MeetingWorks agenda planner was used to develop the BPIA selection agenda basing on the BPIA-S sub-process of the BPIAE collaboration process (see Fig. 4-21). The tasks were carried out in the collaboration session held to select a suitable BPIA.

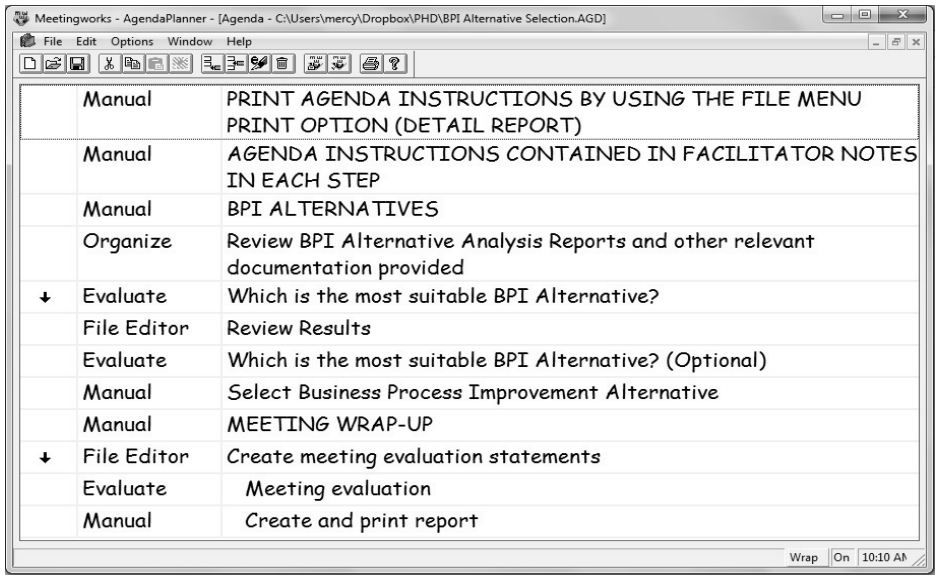

Fig. 4-21: Agenda for BPIA Selection of BPIA for Student Registration Process

Communication

Contact information of five participants representing different stakeholders of a selected business process was collected and input into an XML file (contacts.xml file) which acted as the data source. Contact information included their phone numbers which were on different networks and their email addresses that were also on different domains were used.

```
<?xml version="1.0"?>
<contacts>
    <contact>
            <firstname>David</firstname>
            <lastname>Musoke</lastname>
            <email>mdavidz2000@yahoo.com</email>
            <phone>256718321904</phone>
    </contact>
    <contact>
            <firstname>Grace</firstname>
            <lastname>Sebs</lastname>
            <email>gssebinywa@gmail.com</email>
            <phone>256782184446</phone>
    </contact>
</contacts>
```

Verification was done by typing a message with information about a selected BPI alternative in the description field of the communication suite interface as shown in Fig. 4-22. On clicking the 'post update' button on the interface, the typed message was sent to the list of individuals whose names appear in the contacts.xml file i.e. the selected BPIA (the description of composed message) was sent to stakeholders as an email and the title of the message was sent to the stakeholders' phones as an SMS.

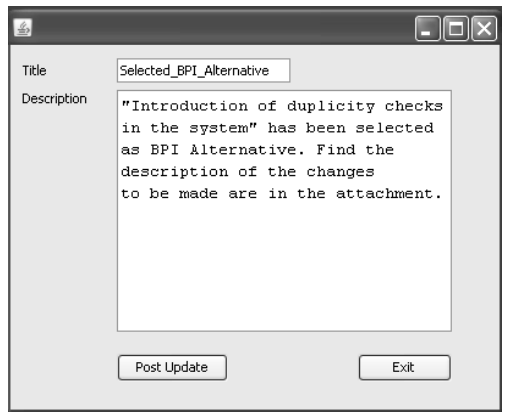

Fig. 4-22: Message of Selected BPIA for Students Registration Process

4.5. Summary

This chapter describes how an instance of the BPA-DES was implemented. Using the instance, the functionality of the different BPA-DES suites was verified by carrying out the BPA decision process activities using the suites as described in the vignette in section 4.3. The BPA-DES suites were checked to see whether they enabled the analysis of business processes, simulation of BPIAs, collaboration among stakeholders during the risks assessment and BPIA generation and selection, the sending and receiving of emails and SMS by stakeholders.

5. BPA-DES EVALUATION

Evaluation of design science artefacts deals with the building of criteria against which the artefact is assessed (Pries-Heje et al., 2008). There are two perspectives for evaluating a design science artefact; the *ex-ante* and the *ex-post* perspectives (Baskervile et al., 2009, Pries-Heje et al., 2008). In the former, the artefacts are evaluated before they are chosen and acquired or implemented, while in the latter they are evaluated after they have been acquired or implemented (Pries-Heje et al., 2008). On the other hand, the ex post evaluation perspective categorizes the methods that can be used according to setting and how computation of quality measures (CoQM) are generated. The setting may be real or abstract while CoQM may be generated automatically from fundamental data or based on human subject opinions (Pries-Heje et al., 2008).

The BPA Decision Enhancement Studio (BPA-DES) was evaluated after being implemented, following the ex-post evaluation perspective. The BPA-DES was tested using artificial settings as well as natural settings. The natural settings comprised of two case organisations; Makerere University (Mak) and Uganda Revenue Authority (URA) described in section 5.1. At the time of carrying out the testing sessions, the case organisation used during the exploratory study (NSSF-UG) was undergoing re-structuring therefore stakeholders were not able to take part in the evaluation phase. Hence new case organisations were used during the evaluation of the BPA-DES. This was possible since the BPA-DES was not designed specifically for NSSF-UG. The evaluation metrics used to assess the BPA-DES are discussed in section 5.2. Opinions from participants who took part in the testing sessions were collected and used to assess the BPA-DES as presented and discussed in section 5.4.

5.1. Description of Case Studies

Case 1: Makerere University (Mak)

Makerere University is a national public university that was established on the 1st of July 1970. Since then it has a steady growth in the number of students as well as the number of undergraduate and postgraduate courses/programmes being offered. The current student population is about 36,000. These are distributed among the 9 colleges and 1 stand alone school.

Initially registration was only done manually however with the increase in the student population, this became a very tedious process characterised by long student queues. Recently, online registration was introduced as a solution to the problem. First year students in their first semester follow the manual registration process. The online registration process is followed by the continuing students on normal progress including first year students in their second semester. However, online registration is not available to all categories of students of continuing student. These exceptional cases include students with retakes, who have been advised to stay-put and those resuming study after a withdrawal (dead year).

Case 2: Uganda Revenue Authority (URA)

Uganda Revenue Authority (URA) is a government organisation charged with a mandate to collect taxes from individuals, companies and other organisations on behalf of the government of Uganda. Uganda Revenue Authority is a government institution that was established in 1991 with a mandate to assess and collect specified revenue, administer and enforce the laws relating to such revenue and to provide for related matters. These operations were to be done within the boundaries of the Uganda Revenue Authority Statute that incorporates all the laws regarding tax collection in the country. In addition, URA is also responsible for the collection of any income on behalf of Government i.e. non- tax revenue. The organisation thus has a duty to ensure that all legible tax payers are registered and pay their taxes.

Originally registration and all activities related to the collection of taxes and other government income was carried out manually. This came with a number of challenges such as very long registration periods (2 or more months), difficulty in tracking taxpayers' returns, generation of more than one Tax Identification Number (TIN) for an individual etc. that necessitated the need for business process re-engineering under the e-Tax project. The e-Tax project is an on-going project in which the different processes in the organisation are being modeled and used to configure a workflow management system to support the organisation's business goals. Our focus in this case was the e-Tax registration process. The process consists of three (3) activities, Application, TIN Approval and Account Creation.

5.2. Evaluation and Measurement

The evaluation criteria used to evaluate the BPA-DES were usability and usefulness. Davis (1989), defined *usefulness* and *usability* (ease of use) as "the degree to which a person believes that using a particular system would enhance his/her job performance" and "the degree as to which a person believes that a particular system would be free of effort" respectively.

In this research, we thus define *Usability* as the degree to which the BPA-DES improves BPA by providing support to stakeholders to perform a given BPA decision process task with as little as possible effort. *Usefulness* is defined as the degree to which the BPA-DES enhances stakeholder's effectiveness in the BPA decision process through the use of services provided.

Considering that the activities in the BPA decision process are conducted in a somewhat sequential format i.e. identification of the improvement areas/opportunities through business process analysis is conducted before generation of BPIAs. Likewise the selection of a BPIA occurs after the evaluation of the generated BPIAs through analysis. The output of analysing the as-is business process is thus an input into the BPIA generation activity, the output of the BPIA generation activity is an input into the evaluation activity, whose output is an input to the BPIA selection activity. The selected BPIA is finally and input into the communication activity. We therefore argue that the success in using one suite directly impacts the usability of another suite, and likewise the usefulness of each suite. The BPA-DES' usability and usefulness were therefore evaluated considering the usability and usefulness of each suite in the BPA-DES. Usability and usefulness at the suite level were therefore, defined as shown in table 5-1.

From the BPA decision enhancement requirements highlighted in chapter 3 (section 3.4) evaluation criteria were developed for assessing the usability and usefulness of the different suites in providing and supporting the required services. Questionnaires were used to collect participants' opinions on the various evaluated aspects. Furthermore, observation guides were used during the collaboration sessions to gather information on participants' experiences. Interviews were also conducted to gather more information that could otherwise be missed out and to verify the responses got from the questionnaires.

Table 5-1: Definitions of Usability and Usefulness at Suite level

Evaluation Measure	Suite	Definition
Usability	WFA	the degree to which the WFA suite and guidelines support and ease stakeholders' analysis the performance of a business process
	RA	the degree to which the RA suite and guidelines support and ease stakeholders' identification, analysis and control or risks in a business process
	BPI Exploration	the degree to which the BPIAE suite and guidelines support and ease stakeholders' generation and selection (exploration) of BPI alternatives for a business process
	Communication	the degree to which the communication suite and guidelines support and ease stakeholders' dissemination of information
Usefulness	WFA	the degree to which the WFA suite and guidelines enhance stakeholders' effectiveness in analysing business processes.
	RA	the degree to which the RA suite and guidelines enhance stakeholders' effectiveness in assessing business process risks.
	BPI Exploration	the degree to which the BPIAE suite and guidelines enhance stakeholders' effectiveness in exploring BPI alternatives for a business process
	Communication	the degree to which the Communication suite and guidelines enhance stakeholders' effectiveness in dissemination of information

Work Flow Analysis Suite Evaluation Criteria and Measurement

Usability

The usability of the WFA service was assessed by evaluating the *Ease of use* and *Efficiency* of using the service for business process analysis.

a) *Ease of use*: The ease of use was viewed as the extent to which the WFA suite enabled stakeholders or users to analyse as-is and simulated business processes to gain insight of their performance and behaviour. Furthermore to be able to identify areas of the as-is business process that need to be improved, to manipulate the business process models and carry out simulation experiments.

b) *Manipulation of business process model* in this research was defined as the ability to interact and change different aspects of business process models while e*nablement of the simulation* refers to the ease of building simulation model and carrying out the simulation experiments. The latter was measured by assessing the time taken to build simulation models and the ease with which it was done.

c) *Efficiency:* Efficiency with respect to workflow analysis was defined as the degree to which the time resource is saved during the analysis of business processes.

Usefulness

The usefulness of the WFA suite was measured by getting stakeholders' (participants') opinions as to whether it improved their performance in analysing business process and identifying areas for improvement. Furthermore, the suite's ability to enable stakeholders in carrying out workflow analysis was used as a measure of the suite's usefulness. In light of this, observations made with regard to suite's usability were used.

BPIAE Suite Evaluation Criteria and Measurement

Evaluation of the BPI alternative exploration suite focused on assessing the usability and usefulness of the designed collaboration process (CP) and the supporting computer tool.

Usability

The evaluation criteria used to measure the usability of the BPIAE suite included; *Ease of understanding, Appropriateness of the collaboration tasks, Efficiency*, and *Ease of sharing of information and knowledge.*

a) *Ease of understanding:* Ease of understanding which referred to the extent to which the stakeholders share meaning of improvement opportunities and, generated and selected BPI alternatives. It was assessed using two viewpoints that is, stakeholder contributions and clarifications sought.

Ease of understanding in the former viewpoint was measured by comparing the contributions made by the participating stakeholder with expected output (contributions that were directly in line with the topic being discussed). In the latter viewpoint, it was assessed by measuring the number of clarifications sought for by individuals during the execution of the CP. Observers would take note of whether a task was performed immediately by the participants without any verbal or written clarifications or after seeking clarification.

b) *Appropriateness of the collaboration tasks*: Appropriateness of the activity/task sequence refers to the suitability of the ordering of the collaboration process tasks for BPI exploration (generation and selection of BPI alternatives). It was evaluated by measuring stakeholders' judgment of their ease in performing the prescribed tasks to generate and select BPI alternatives.

c) *Efficiency:* Efficiency defined as the degree to which there is saving in the resources used to generate and select BPI alternatives. Efficiency was restricted to the time resource. The amount of time spent in carrying out the various collaboration tasks as well as the whole process was logged by MeetingWorks and was also noted by the observers. The measurements were used to assess whether the CP provided an optimal way of using the available time to generate and select BPI alternatives. In other words, whether the CP reduced the time spent in generating and selecting BPI alternatives. This was done by comparing the time taken to complete an individual task as well as the whole process, and the amount of time taken using the current method in a case organisation.

d) *Ease of sharing of information and knowledge:* Ease of sharing of information and knowledge which was referred to the extent to which stakeholders are willing to share information and knowledge that can be used to generate and select BPI alternatives. It was evaluated by monitoring the number of contributions made by each stakeholder and their verbal communication.

Usefulness

The criteria used in evaluating the usefulness of the BPIAE suite included; the stakeholders' participation reflected in their *willingness to share information and knowledge* and thus the *accommodation of stakes*, *their experience in using the suite particularly MeetingWorks*, and their *stakeholders' perceptions*

a) *Stakeholder perceptions*; these are stakeholders' opinions/judgements on whether the BPIAE suite enabled them to effectively generate and select BPIAs. They were gathered from stakeholders using a questionnaire.

b) *Stakes accommodation:* Stakes accommodation in generated and selected BPI alternatives referred to the extent to which the resulting BPI alternatives reflect each stakeholder's contribution or perception. A BPI alternative is affected by a stakeholder's willingness to share information and knowledge which in turn affects the number of contributions made per stakeholder. In order to encourage stakeholder participation, it is important to accommodate their interests or issues of concern brought out in their contributions.

   This criterion was measured by monitoring stakeholders' interaction with MeetingWorks to evaluate whether they are actually making a contribution. Additionally, their verbal and non-verbal communication was also monitored as other avenues for making contributions to the topic being discussed. Furthermore, assessment of accommodation of stakeholder interests (stakes) could be done by measuring the number of contributions per stakeholder versus the total number of contributions.

c) *Experience with MeetingWorks:* This criterion was measured by taking note of stakeholders' verbal and non-verbal communication as well as written feedback.

RA Suite Evaluation Criteria and Measurement

Usability

The evaluation criteria used to measure the usability of the RA suite included; *Ease of understanding, Efficiency*, and *Ease of sharing of information and knowledge.*

a) *Ease of understanding:* Ease of understanding referred to the extent to which the stakeholders share meaning of the identified business process risks and the corresponding controls. The criterion was assessed using the same measures described under the evaluating of the BPI exploration alternative suite.

b) *Efficiency:* Efficiency defined as the degree to which there is saving the time resource during the risks assessment task. It was measured by calculating the amount of time spent in carrying out the various collaboration tasks and the whole process in general from the time logged by the MeetingWorks as well as that noted by the observers. Additionally, stakeholder's opinions on the time management aspect were used to evaluate the efficiency of the suite.

c) *Ease of sharing of information and knowledge:* This criterion focused on assessing the extent to which stakeholders were willing to share information and knowledge concerning risks related to the business process under analysis. It was evaluated by monitoring stakeholders' spoken contributions as well as those made through the collaboration support computer tool.

Usefulness

The criteria used in evaluating the usefulness of the RA suite included; the stakeholders' participation reflected in their *willingness to share information and knowledge* and thus the *accommodation of stakes*, *their experience in using the suite particularly MeetingWorks*, and their *stakeholders' perceptions.*

a) *Stakeholder perceptions*: Stakeholders' opinions about the suite's usefulness were sought by getting their judgment on how the suite enhances their ability to identify, measure and control risks.

b) *Stakes accommodation:* This criterion was defined as the extent to which the resulting list of business process risks and controls reflect each stakeholder's contribution or viewed issues of concerns. This criterion was measured by monitoring stakeholder interaction with MeetingWorks to evaluate whether they were actually making contributions. Furthermore, their verbal and non-verbal communication and consensus on issues were also observed.

c) *Stakeholder's experience with the MeetingWorks*: This criterion was measured by taking note of stakeholders' verbal and non-verbal communication during the collaboration sessions as well as written feedback.

Communication Suite Evaluation Criteria and Measurement

The communication suite was evaluated by measuring usability by measuring the ease of using the suite. Secondly its usefulness i.e. the degree to which the Communication suite enhances stakeholders' effectiveness in dissemination of information

Usability

The ease of use was evaluated by testing whether the messages were being sent and received by the stakeholders, and by collecting stakeholders' opinions on the difficulty or simplicity of understanding and using the suite as well as the efficiency.

Usefulness

The usefulness of the communication suite was measured by collecting stakeholders' judgements or opinions as to whether the suite enhances communication during the BPA decision process, that is, the effectiveness in dissemination of information.

In summary of the evaluation criteria used to evaluate the BPA-DES is presented in Table 5-2.

Table 5-2: Summary of Sub-Criteria Used to Evaluating the BPA-DES.

Suite	Evaluation Criteria	Sub-Criteria
WFA	Usability	✓ Ease of use ✓ Efficiency
BPIAE	Usability	✓ Ease of understanding ✓ Efficiency ✓ Ease of sharing of information and knowledge ✓ Appropriateness of the collaboration tasks
	Usefulness	✓ Stakeholder perceptions ✓ Stakes accommodation ✓ Experience with MeetingWorks
Communication	Usability	✓ Ease of use ✓ Efficiency
RA	Usability	✓ Ease of understanding ✓ Efficiency ✓ Ease of sharing of information and knowledge
	Usefulness	✓ Stakeholder perceptions ✓ Stakes accommodation ✓ Experience with MeetingWorks

5.3. Evaluation Procedure

The BPA-DES was evaluated by assessing the usability and usefulness of individual suites. The individual suites were tested in either one case study, at both case studies, or in an artificial setting.

WFA Suite: The WFA suite was tested using black box testing using data from both cases; however different approaches were followed at each case. This was because at Mak does not have a workflow management system in place while at URA, the e-Tax registration is supported by a workflow management system.

a) ***Mak*:** In this case, information about the process was gathered from different stakeholders; faculty registrars, registrars at the graduate school, deputy academic registrars and students. The gathered information was used to build a simulation model (section 4.4) to generate event logs of the as-is student-registration process. The generated event logs were used to analyse the process as described in section 4.4 following the evaluation procedure defined in Table 5-3.

b) ***URA*:** In this case, real life event logs generated by URA's e-Tax registration workflow management system were used as test data in evaluating the WFA suite. The event logs from their e-Tax workflow management system were received as an excel (.xls) file and were not in the MXML format and thus needed to be converted before being input into ProM.

The conversion was guided by the work of Buijs (2010) and was done in a number of steps as described below.

i) *Breaking up the file records into two records each representing a single event*: The excel file record contained data on the entry number (Sr.No), RefID (number given to each applicant/application), the ProcessName, UnitName (the name of a given task in the process), the start date and end date and the username (representing the role/resource that carried out the task). To convert this file into the MXML format, each record was broken up into two records; one representing the start task event and the other to represent the end task event i.e. to ensure that each record in the resulting file contained information about exactly one task event (start or end). The new excel file had contained the fields; Sr.No, RefID, ProcessNAME, UnitNAME, EventType, Timestamp, and UserName. The eventype held values of the task events, and the timestamp held the date values corresponding to when the events took place.

ii) *Conversion of excel file into CSV format*: The refined excel file was then converted into a Comma Delimited (CSV) format by saving the excel file with the .csv file extension. The CSV file was opened using notepad where all the commas used to separate the string of

characters were changed into semicolons in order to be read by XESame e.g. Sr.No; RefID; ProcessNAME; UnitNAME; EventType; Timestamp; UserName.

iii) *Creation of Mapping*: In XESame a mapping for converting the created CSV file data into a MXML format was created. The mapping was created by giving it a name and description; configuring a connection to the data source; and including all the Extensible Event Stream (XES) extensions required (Günther, 2009) e.g. the lifecycle, concept, organisation and time standards under the setting tab. Under the definition tab, the actual mapping is defined. In the mapping definition contains the definitions for the Log, trace (process instance) and the events in the process. The definition for each of these aspects contained specifications of the attributes, the properties and classifiers.

- *Log definition*: The Log name was defined in the attribute tab by specifying the field in the CSV file that held the data i.e. the ProcessName field. The data source was defined under the properties tab by specifying the name of the CSV file and its alias i.e. "URARegEvents.csv AS URARegEvents".

- *Trace Definition*: the trace definition include the data sources and the TraceID. The data source was defined by specifying the CSV file name and alias. On the other hand TraceID was defined by specifying the field in the CSV file that contained the identifier for each applicant/application i.e. "RefID". Under each trace there is an event thus an event ("Generated_Event") was also created under the trace by highlighting the Trace and clicking on the add event icon.

- *Event definition*: The event definition specifies the contents of events in the generated MXML log file. The attributes (instance, name, transition, resource, timestamp) of the Generated_Event were defined by specifying the fields in the CSV file that held the corresponding data. Also the data source, TraceID and the EventOrder ("TimeStamp" field in CSV file) were specified see Fig. 5-1.

Fig. 5-1. Event Definition in XESame

iv) *Generation of MXML log file*: Under the execution tab, the specific configuration settings were specified. This included where the event log file should be stored as well as the type output file. The "output to MXML instead of XES" option was chosen. By clicking on the Execute Conversion button, the mapping was verified; any errors encountered were displayed in the console panel and rectified, and the conversion performed.

The generated MXML file was then input into ProM 6 where the process model was mined and process analysed following the same procedure as described in section 4.4.

BPIAE Suite: The BPIAE suite evaluation was done following the action research steps (Zuber-Skerritt, 1991) by carrying out collaboration sessions at both cases. The case organisations were visited prior to the collaborations to build rapport; gain understanding of the business process(es) for which BPI alternatives were to be sought; and to identify the relevant stakeholders that would take part in the sessions. During the collaboration sessions, each participating stakeholder, except the observers, was provided with a computer through which they interacted with the MeetingWorks. Information gathered from the risk analysis and workflow analysis steps above were combined into an analysis report that was presented to the different stakeholders participating in the collaboration session.

In Mak the collaboration sessions had seven (7) participants and two (2) observers, while at URA there were eight (8) participants and three (3) observers. In both cases the researcher played two roles of the facilitator and the chauffeur. Participants were provided with a computer through which they interacted with MeetingWorks. Participants reviewed the analysis report following the collaboration activities in session agenda's developed described in section 4.4.

After the second collaboration session, a questionnaire (see APPENDIX F) was administered to the participants to get their feedback on the usability and usefulness of the BPIAE suite basing on the evaluation criteria defined (section 5.2). The average rank or score for each question and variance between respondents' responses to the questions relating to the evaluation criteria were computed.

The communication suite was tested using black box testing in an artificial setting. Risk assessment was carried out through interviews because of clashes in stakeholders' time schedules to permit conducting collaboration sessions.

Table 5-3 gives a summary of the general procedure followed in evaluating the BPA-DES. The procedure generally describes the input, the people, the evaluation setting, the sessions or method used for evaluation, the expectations and the expected output from a given suite.

Table 5-3: General Evaluation Procedure

Suite	Aspect	Description
WFA	***Input***	Event logs generated during the execution of the business process or during simulation experiments
	People	2 participants from each case organisation i.e. a business domain expert, a business process analyst , and the researcher were used in testing this suite
	Evaluation Setting	Artificial setting: simulations experiments and use of data gathered from a real case to model business process models Naturalistic: Event logs got from the case studies

WFA	***Approach***	Evaluation was done in two stages. <u>1st Stage</u> Event logs were gathered and analysed in informal settings and experiences discussed with the researcher o Participants got acquainted with technologies provided in the suite to understand how they are used o Participants used the suite to analyse the as-is business process to gain insights into its performance <u>2nd Stage</u> Models were built and analysed in informal settings and experiences discussed with the researcher o Simulation models were built and simulations of the proposed BPI alternatives ran o Performance of proposed BPIAs were analysed
	Expectations	Evaluation of the usability and usefulness of the suite.
	Output	Business Process Analysis Reports
RA	***Input***	Description of and any other related information (e.g. policies) for the selected business process
	People	9 participants took part in assessing the risks in the selected business processes.
	Evaluation Setting	<u>Artificial setting</u>: Interviews seeking to understand the risks/challenges faced by the stakeholders in the process were conducted.
	Approach	Interviews were used to gather information on the risks involved in the as-is business processes and the potential risks in the case of proposed BPIAs
	Expectations	Evaluation of the usability of the suite and usefulness of the RA suite.
	Output	Risk Analysis Reports
BPIAE	***Input***	Performance Analysis and Risk Analysis report and any other relevant information for a selected business process
	People	A total of 15 participants including the researcher, and 4 observers took part in evaluating the BPIAE suite. All the 14 participants were business domain experts; 3 of them were line managers.

BPIAE	***Evaluation Setting***	Naturalistic setting: User Opinion Studies using the Human subject CoQM
	Approach	Testing was done in two sessions. Session 1: o Participants reviewed documents showing the current risks involved in the selected business process, the current performance of the business process and additional relevant information o Participants identified aspect(s) and agreed on which to focus on o Participants generated ideas on how to improve the specified aspect(s), discussed and refined the ideas to remain with a prioritized list Session 2: o Participants reviewed the analysis reports of the BPI alternatives and additional relevant information. o Participants selected a suitable BPIA
	Expectations	• Participants to work together during the sessions following defined steps in collaboration process under the guidance of a facilitator. • The participant's evaluation of the BPIAE suite using questionnaire issued at the end of session 2
	Output	Selected BPIA
Communication	***Input***	Provided by the user i.e. the title of the message to be sent and its content also known as the body of the message.
	People	4 participants were used to evaluate the communication suite
	Evaluation Setting	Artificial setting: virtual users & test data
	Approach	No formal session was carried out. This was evaluated during suite development; the functionality of the suite was tested during its development. • Message to be sent to stakeholders is composed and sent e.g. A selected BPIA is communicated to responsible parties.
	Expectations	Evaluation of the usability of the suite and usefulness of the communication suite.

5.4. Evaluation Results

Following the evaluation procedure described in the previous section, the BPA-DES was evaluated by testing the individual suites using the evaluation criteria defined in section 5.2. This section presents the evaluation results for the usability and usefulness of the individual suites.

Communication Suite

Usability

The suite's usability was evaluated by assessing the ease of using it. The researcher observed the four participants who took part in the evaluation of this suite taking note of their verbal and non-verbal communication. Once given minimal instructions of how to use the interface, the four participants typed out messages on the description field provided on the suite's interface. Upon sending the messages, participants were asked as to whether they received a Short Text Messages (SMSes) on their phones as well as email of the sent message. All four participants testified as having successfully received the Short Text Messages (SMSes) and emails sent from the suite with the prefix 'comm.suite' tagged to them.

When asked about their experience with the communication suite, all the four participants commented verbally that the suite's interface was simple and easy to understand and required limited training since it had few features. One of the participants reported that when he clicked on the close icon on the interface, the whole studio application closed. Also, when asked for suggestions for improvement, one of the participants suggested that it would be good to provide a functionality to enable sending attachments. This suggestion was put into consideration and implemented in the updated version of the communication suite.

Usefulness

Considering the success in sending SMSes and emails using the communication suite, the four participants that took part in the testing sessions agreed that the suite was fairly usefulness for information dissemination. For example some of the comments they made were"; "It is a pretty simple tool".

Additionally, they were happy with the SMS feature by commenting that it would be a good way to notify a stakeholder of an important email. This is evidenced from the comment such as “It is good to receive an SMS which alerts you of important emails”. “This can even be used by people without internet enabled phones”.

However, participants stated that the communication suite could be improved by incorporating other functions chats and discussion For instance, one of the participants mentioned that it would be better if more functions like attaching files would be added to the communication suite.

The observations presented above, show that the communication suite provides stakeholders with a simple, easy to use communication service that would enhance the flow of information among stakeholders. The communication suite was seen as a means to disseminate information regarding identified changes and BPIAs. Therefore it provided a way to address the challenge of poor information flow facing stakeholders in the BPA decision process. Furthermore, notwithstanding the suggestion for adding more functionality to the communication suite, it was noted that other communication functionalities such as the chats were provided for in the collaboration tool existing in the BPIAE suite.

WFA Suite

As indicated in the evaluation procedure, 3 participants were involved in evaluating the usability and usefulness of the WFA suite. The 2 participants were identified from the case organisations. The third person was the researcher who gave instructions to the participants explaining how the suite is used, and made observations of participants verbal and none verbal communication

Usability

a) Ease of use

During the 1st stage of getting acquitted with the suite, the participants reported to have found it challenging to learn to use particularly those from Mak. This difficulty was attributed to the fact that the suite contained tools that they had never used before. More so, the participants from Mak had never taken part in modelling their business processes to come up with a workflow management system. This was a new experience which they later came to appreciate. This is

shown in the feedback they gave for instance, one said that she better understood the registration process better and was able to see the loop holes such as the security risks involved in the registration process.

On the other hand, although the participants from URA had not actively taken part in business process modelling and workflow management system development, they did not have the opportunity to go through this experience because that job was outsourced to an Indian company. This was because there was already an existing workflow management system for the e-tax registration process that was analysed during the evaluation stage of this research.

Regardless of the challenges in modelling the student registration business process from scratch at Mak, once the business process event logs were generated, the two participants who took part in the testing sessions found it fairly easy to use the WFA suite to analyse the business process and identify the bottlenecks and throughput time. Likewise, the two participants from URA, once the event logs had been converted into the MXML format, found it fairly easy to use. For example it was possible to identify the delay points in the respective registration processes at the click of a button. For example, in Fig. 4-15, delay areas in the student registration process (tasks at which the process took long) are clearly highlighted.

Participants in both cases commented that the visualization of these delay points (bottlenecks) facilitated the identification of the improvement areas. The participants from URA also observed having a from the URA case that a wide range of cases covered in an event log file, could provide better analysis results by giving providing a better picture of the performance of their business process.

Additionally, it was observed in both cases that the participants who took part in the testing sessions were able to build and make changes to the simulation models. For example, in the Mak case, the participants were able to build a simulation model using CPN tools of the registration process based on the information gathered about the process (see section 4.4). However, they commented that using the simulation tool (CPN tools) was difficult for them since they were novice users. One participant from Mak suggested that a graphical user interface to be developed

to enable the building and interact with simulation models. Such a graphical user interface may be developed using Access/CPN (Westergaard and Kristensen, 2009).

Nevertheless, the participants from both case studies anonymously agreed that once one has mastered the software provided in the WFA suite, the analysis and manipulation (improvement) of business processes and BPIAs would be easier. From these observations it can be said that the WFA supports business process analysis however more training should be given to users.

b) Efficiency

At Mak, a lot of time was taken in the building the process model that was used to simulate the as-is registration process, in order to generate logs that would be used to analyse the current process. As a result, analysis of the business process took longer than the usual 5-10 minutes.

On the other hand, the presence of a workflow management system at URA saved on time that would otherwise have been spent on building a simulation model of the e-Tax registration process. More time was spent on developing a mapping in XESame (Buijs, 2010) that would convert the excel log file into an MXML format. The amount of time was further reduced by adopting ProM 6.1 which supports the conversation of CSV files using the concept of key value sets that works on a similar concept as XESame.

Usefulness

Participants made comments such as “I’m glad that I can be able to view bottlenecks in the business process at the click of a mouse”, “Am I able to also check to see who how long it took to complete the registration of e-tax payee?” These positive remarks made by showed that the suite enabled them to analyse their business processes. The participants also commented that the analysis results provided an opportunity for them to identify areas in their business processes that need improvement. For example a participant from URA said “With this we can be able to follow up delayed registration cases, these analysis results give a good place to start.”

Participants’ ability to simulate business processes facilitated visualization or envisioning of the performance of proposed BPIAs. They found this functionality to be useful to them because it

would enable them to avert costs that would otherwise be encountered in case of a failed improvement implementation.

Furthermore, when asked whether they found the WFA suite to be useful for business process analysis activities, participants responded in affirmation. Remarks like "it is useful in that it enables quick evaluation of the performance of business processes" and "It is good to see bottleneck areas of the business process. This would help to know where to start from in case of dealing with backlog applications", were observed as an affirmation of the suite's usefulness.

Participants from both cases mentioned that the suite enabled them to take a relatively short time to analyze the average throughput time and identify bottleneck. They also noted that the suite provided them with an option to export the results which would be very useful in report generation.

These results showed that the participants found the WFA suite to be useful for business process analysis and that it facilitated the identification of business process areas that would require improvement.

BPIAE Suite

Usability

a) Ease of understanding

This criterion was evaluated by measuring stakeholders' contributions verses the expected output, and the session logs recorded by MeetingWorks. Also questions asking for the participants to give feedback on the ease of understanding and using MeetingWorks, and ease of understanding and carrying out the collaboration tasks were asked. The results are shown in Feedback to *Questions*:

i) *Rate how easy it is to understand and carry out the collaboration process tasks*.

   In Mak it was observed that the 3 participants that gave responses on the ease of understanding the collaboration process' tasks gave an average rank of 4.7 with a variance of 0.3.

The variance between the responses indicates that participants differed in opinion regarding the degree of ease but none found it difficult to carry out the tasks. This result shows that the participants were able to understand what was required of them at each task with little to no difficulty. They in turn were able to perform the tasks with little or no difficulty as shown by the average rank weight (4) given (see Table 5-4) they awarded the ease of carrying out the collaboration tasks.

Results from URA (see Table 5-4) show that participants found it easy to understand what they were required to do in each task. This was supported by the affirmative comment given by the observers; "Good understanding reflected by the URA staff". Moreover, assessment of the easy in carrying out the actual tasks showed that participants found them fairly easy to perform.

Table 5-4

ii) *Analysis of the Session Logs:* From the logs generated from the collaboration sessions held at Mak it was observed that the participants took long to understand the goal of the collaboration session. This was evident during the brainstorming activity on improvement areas of the registration process. Participants' contributions were majorly to seek clarifications and to give additional information about the process rather than what needed to be improved.

On the other hand, analysis of collaboration session logs from URA revealed that participants understood the goal of the collaboration session reflected in the kind of contributions made by the participants; contributions focused more on the brainstorming topic of discussion. For instance, all the contributions in the list of improvement areas generated from the brainstorming task in BPIA-G sub-process of the CP were in line with the expected output.

Furthermore, in the FastFocus step that followed, participants at Mak discussed the derived areas of improvement from the generate lists of brainstorm contributions. The discussion boosted their understanding shown by their gestures (such as nodding of their heads) and comments they made like "Yes; that is an important area for improvement", "that is what I meant to say". This was reiterated by the session observers who observed that a lot of time

was spent on introduction of the task. Similarly, at URA, discussions were more tailored to how relevant or critical the suggested areas of improvement were rather than clarifications on what the contributions meant.

iii) *Feedback to Questions:*

i) *Rate how easy it is to understand and carry out the collaboration process tasks.*

In Mak it was observed that the 3 participants that gave responses on the ease of understanding the collaboration process' tasks gave an average rank of 4.7 with a variance of 0.3.

The variance between the responses indicates that participants differed in opinion regarding the degree of ease but none found it difficult to carry out the tasks. This result shows that the participants were able to understand what was required of them at each task with little to no difficulty. They in turn were able to perform the tasks with little or no difficulty as shown by the average rank weight (4) given (see Table 5-4) they awarded the ease of carrying out the collaboration tasks.

Results from URA (see Table 5-4) show that participants found it easy to understand what they were required to do in each task. This was supported by the affirmative comment given by the observers; "Good understanding reflected by the URA staff". Moreover, assessment of the easy in carrying out the actual tasks showed that participants found them fairly easy to perform.

Table 5-4: Table Results on Ease of Understanding and Use of BPIAE Suite

EVALUATED ASPECT	Responses										Mean		Variance	
	Mak					URA								
	1	2	3	4	5	1	2	3	4	5	Mak	URA	Mak	URA
Ease of Understanding MeetingWorks	0	0	2	2	1	0	0	0	6	1	3.8	4.143	0.7	0.14
Ease of using MeetingWorks	0	0	2	2	1	0	0	1	4	1	3.8	4	0.7	0.4
Ease of understanding MeetingWorks' Interface	0	0	2	2	1	0	0	2	4	1	3.8	3.857	0.7	0.476
Ease of understanding the CP tasks	0	0	0	2	1	0	0	0	2	0	4.7	4	0.3	0
Ease of carrying out CP tasks	0	0	1	1	1	0	0	0	1	1	4	3.5	1	0.5

ii) Rate how easy it is to understand and use MeetingWorks

Participants' responses to these questions are shown in Table 5-4. In addition, observations were also made by the session observers (Appendix G).

In both cases, participants ranked their ease in understanding and using MeetingWorks as average, that is, they found it fairly easy to learn and use. The average ranking could be attributed to the fact that the participants were novice users that is, they had never used MeetingWorks before, and did not receive prior training except instructions given by the facilitator during the session. For example, one of the participants at URA rated MeetingWorks as fairly easy to understand and use, and also commented that "one needs IT skills to use it". This shows the importance of training stakeholders in using the BPA-DES before rolling it out in an organisation.

iii) Rate how easy it is to understand MeetingWorks user interface

With regard to MeetingWorks' interface, participants in both cases ranked the ease in understanding its user interface as being fairly easy to understand (see Table 5-4). Comments from participants at URA associated the average rank with difficulty in accessing and editing contributions of a previous step that had already been saved. More so, having to save each task's output before moving to the next task. Also one participant at Mak suggested that the interface should be made more user-friendly.

In addition to the above results, observers noted, the participants were able to use it to carry out the tasks in the collaboration process. It can thus be said that the BPI alternative suite enabled stakeholders to understand the improvement areas and alternatives through the discussions it facilitated. This was affirmed by the minimal variations observed in the participants' rankings of the different improvement areas and BPI alternatives, during the collaboration sessions.

b) Efficiency

The sufficiency of the amount of time given to perform the BPI exploration tasks was evaluated using Yes/No questions. The questions assessed whether the time was sufficient for the tasks or not, and whether participants thought that the collaboration process increased efficiency. The results are shown in Table 5-5.

i) As per the results in Table 5-5 all the participants in Mak found the time allocated to carry out the tasks sufficient for them. This is shown by all participants responding "YES" when asked whether the time was sufficient. However the introduction step took a lot of time as participants spent time seeking clarifications. This could be attributed to a poor reading culture among participants considering that the input documentation was sent prior to the session. It was also observed that tasks that were entirely performed using MeetingWorks were completed faster and took less time than those where participants made verbal contributions. In light of these observations, the BPI alternative exploration suite can be said to be efficient.

Table 5-5: Table Showing Participants' Response about Efficiency of BPAIE Suite

Case	Responses	
	YES	NO
Mak	5	0
URA	6	1

ii) At URA, six out of the seven participants found the time to be sufficient (see As per the results in Table 5-5 all the participants in Mak found the time allocated to carry out the tasks sufficient for them. This is shown by all participants responding "YES" when asked whether the time was sufficient. However the introduction step took a lot of time as participants spent time seeking clarifications. This could be attributed to a poor reading culture among participants considering that the input documentation was sent prior to the session. It was also observed that tasks that were entirely performed using MeetingWorks were completed faster and took less time than those where participants made verbal contributions. In light of these observations, the BPI alternative exploration suite can be said to be efficient.

iii) Table 5-5). It was also observed that a lot of time was spent on the converging and clarification steps as a result of the discussions that were sparked off during these steps in search of what to filter out.

A complimenting open question seeking suggestions of appropriate time allocations was also used to gain information. To this question, the participant from URA that said it was not enough

suggested that the appropriate time for the collaboration session should be 3 hours to permit them to exhaustively deliberate while another suggested that less time should be spent in discussion in order to speed up decision making.

Generally from the above results, if tasks were entirely performed using MeetingWorks without reverting to verbal communication they would be completed faster and take less time. From these observations, the BPIAE collaboration process was found to be efficient in enabling BPI alternative exploration. Notwithstanding the one participants' observation that more time should be allocated, careful allocation of time to each step in the collaboration process is needed in order to keep the sessions between 1 to 2 hours preferably 1.5 hours. This is because participants were observed to lose concentration after 1.5 hours. Additionally, spending more time would defeat efforts to increase efficiency in BPI exploration.

c) Ease of sharing of information and knowledge

This criterion was assessed by analysing the session log files showing participant contributions, and by observing participants' verbal and non-verbal communication as a measure of their willingness to share information and knowledge.

i) *Analysis of Session Logs*: The session logs generated particularly the logs generated during the brainstorming activity for improvement areas and BPIAs, it was noted that the ratio of contributions to number of participants was 10:8 at Mak and 10:7 at URA. These results imply that each participant was able to make a contribution.

   Additionally, the number of generated BPIAs was five at Mak and ten at URA but on discussion and further refinement participants agreed on one BPI alternative and two respectively. The generated BPIA was also evaluated and the results showed that three out of the four (3/4) participants who responded, rated its quality as very good whereas one rated it as good. This low statistic was attributed to the fact that the participants preferred to submit contributions verbally and thus were not captured by the MeetingWorks.

ii) *Verbal and non-verbal communication*: At Mak it was initially observed that participants that were senior in the organisation contributed more than others but as the session advanced all participants became active (50% were very active and 50% averagely active) in sharing information and experiences.

For instance, one participant dealing with graduate students' registration shared an experience on how it is hard to enforce deadlines on graduate students. On the other hand, at URA it was observed that participants willingly shared ideas through the vibrant discussions right from the beginning of the sessions.

Basing on these observations we observe that the BPI alternative exploration suite can be said to have facilitated the sharing of knowledge and information among the stakeholders that took part in the BPA decision process. Therefore, the BPI alternative exploration suite can be said to promote collaboration among stakeholders during the BPA decision process.

d) Appropriateness of the collaboration tasks

A Yes/No question that aimed at getting feedback as to whether the sequence of activities enabled the participants to effectively explore BPI alternatives, was used to assess this criterion (see Table 5-6). More so, the observers monitored the session to see whether the sequence of the BPIAE Collaboration Process (CP) tasks enabled the participants to generate and select BPI alternatives.

Table 5-6: Participant's Reponses on the Appropriateness of the Sequence of the BPIAE Collaboration Process (CP) Tasks

Case	Responses	
	YES	NO
Mak	5	0
URA	7	0

i) The results from Table 5-6 show that there was unanimous agreement that the sequence of tasks in the collaboration process enabled BPI exploration; all the five participants at Mak

and the seven at URA who filled out the questionnaire issued at the end of the session gave YES as a response.

ii) The observers noted that the collaboration process was appropriate and sparked off a candid discussion and consensus on what areas needed to be improved, what needed most attention, and how the selected one could be improved. For example at URA, all participants were encouraged to participate right from the start of the sessions. These discussions stimulated them to generate a number of ideas on what should be improved and how to improve the respective registration processes that they were exploring.

These results thus imply that the sequence of the collaboration tasks was appropriate for BPI exploration because it enabled stakeholders to make contributions at the same time, discuss them and jointly come up with BPI alternatives. Therefore, the CP enabled stakeholders to jointly work together to generate, evaluate and decide on which BPI alternative to select. More to that, the guidelines provided in the thinkLets and the scripts used in directing the tasks are clear and enable stakeholders in discussing, sharing knowledge, building consensus and decision making during BPI exploration.

Usefulness

a) Stakes accommodation in generated and selected BPI alternatives

Accommodation of participants' stakes was measured by analysing the logs captured by MeetingWorks during the different collaboration sessions. Another measure used to stakes accommodation was the participants' verbal and non-verbal communication.

i) *Analysis of Session Logs*: In both cases it was observed that within the time allocated for the brainstorming activities, ten improvement areas and BPI alternatives were identified by the participants. The ratios of contributions verses the number of participants at the cases (10:7 at Mak and 10:8 at URA) thus imply that each participant was able to make a contribution through MeetingWorks. The low number of contributions was attributed to the limited time given to the brainstorming activities as indicated by the observers (see APPENDIX G)

ii) *Verbal and non-verbal Communication*: In both cases, it was also observed that participants often reverted to verbal communication to share more information on the contributions being made to corresponding topics from time-to-time during the exploration process. Such contributions could not be logged by MeetingWorks and would otherwise be lost. Therefore as a step to capture important points made verbally, the facilitator reminded and prompted participants to type their views in MeetingWorks.

From these observations, participants were able to freely contribute improvement ideas and BPI alternatives, discuss and support their contributions both verbally and electronically, and come to agreement. It is thus fair to say that the outcome of the BPI alternative exploration process (the generated and selected BPI alternatives) put into consideration the stakeholders' views.

b) Stakeholders' Perceptions

To get the users' opinion on the usefulness of the BPIAE suite, participants were asked to rate the usefulness of the collaboration process in BPI alternative exploration using a 1-5 Likert scale. In the scale 1 = very poor, 3= fairly good and 5= very good. The results are in Table 5-7.

Table 5-7: Frequency of Participants' Opinion on the usefulness of the BPIAE Suite

EVALUATED ASPECT	Cases	Responses					Mean	Variance
		1	2	3	4	5		
Usefulness of BPIAE Suite	Mak	0	0	2	1	2	4.2	0.7
	URA	0	0	1	2	4	4.2	0.7
Suitability of CP	Mak	0	0	1	3	1	4	0.5
	URA	0	0	0	3	4	4.4	0.3
Quality of BPIAs	Mak	0	0	0	1	3	4.75	0.25
	URA	0	0	0	3	4	4.6	0.3

i) *Usefulness of BPIAE Suite:* From the individual responses given, the average rank was calculated. The results in Table 5-7 show that the majority of the respondents at both Mak and URA found the BPIAE suite to be very useful for BPI exploration. Cumulatively, it was observed the respondents found the suite to be fairly useful in improving their effectiveness in exploring BPIAs by supporting collaboration through the Collaboration Process (CP).

ii) *Suitability of the CP:* To further confirm the usefulness of the BPIAE suite, participants were asked to give their opinion as to whether the CP is suitable for BPIAE. The results presented in Table 5-7 show that the participants perceived the CP as being fairly suitable for exploring BPIAs. These positive results were further affirmed by comments made by the participants such as "By all means it is useful" and "This tool is very useful and with adjustments, the CP activities can be done over and over again to improve our processes".

iii) *Quality of BPIAs*: A step further in assessing the stakeholders' perceptions of BPIAE suite, stakeholders' opinion of the quality of the generated BPI alternatives was sought. In so doing, it was observed four out of the seven respondents at URA who evaluated the quality of the final BPIAs, rated them as very good while three rated them as good. While in Mak of the four who gave feedback on the quality of the BPIAs, three found them to be very good and the other ranked them as being good. These results show that the BPIAE suite facilitated the generation and selection of good quality BPIAs.

Cumulative averages of the stakeholders' perceptions from the two cases on the CP's suitability for exploring BPIAs, and the average quality of the BPIAs were found to be 4.333 and 4.636 respectively. When compared with the cumulative average ranking of the stakeholders' perception of the suite's usefulness which was found to be 4.333, the results confirm the BPIAE suite is useful for exploring BPIAs. Furthermore, the BPIAE suite improved effectiveness in coming up with quality BPIAs that accommodated different stakeholders' viewpoints. More so, the suite supports the much needed collaboration among stakeholders in the BPA decision process.

c) Experience with MeetingWorks

A closer look at the results got in evaluating the usability of the BPIAE suite, showed that participants were able to use MeetingWorks to simultaneously make contributions when exploring BPIAs. Furthermore the results showed that MeetingWorks enabled participants to easily share information and knowledge.

From these results, MeetingWorks provided support and improved stakeholder collaboration and increased efficiency in exploring BPIAs. More to that, it increased their effectiveness in the BPA decision process by providing a means to automatically generate minutes of the collaboration sessions thus reducing the amount of time that would be otherwise spent by a secretary taking notes and typing them out.

5.5. Usability and Usefulness of BPA-DES

Basing on the results attained for the different usability criteria used to evaluate the three suites namely the WFA, BPIAE and communication, the usability and usefulness of the BPA-DES was inferred. Furthermore a number of general insights were gained from the results.

Usability

The results show that even with minimal training participants found it fairly easy to use the BPA-DES suites to analyse their business processes; generate, evaluate and select suitable BPIAs; as well as send and receive information amongst each other. This is seen in the fact that participants were able to complete the BPA decision process tasks which implies that the guidelines provided in the BPA-DES were easy to understand thus making it satisfactorily easy carrying out the tasks. For example, results in Feedback to *Questions:*

iv) *Rate how easy it is to understand and carry out the collaboration process tasks*.
In Mak it was observed that the 3 participants that gave responses on the ease of understanding the collaboration process' tasks gave an average rank of 4.7 with a variance of 0.3.

The variance between the responses indicates that participants differed in opinion regarding the degree of ease but none found it difficult to carry out the tasks. This result shows that the participants were able to understand what was required of them at each task with little to no difficulty. They in turn were able to perform the tasks with little or no difficulty as shown by the average rank weight (4) given (see **Table 5-4) they awarded the ease** of carrying out the collaboration tasks.

Results from URA (see Table 5-4) show that participants found it easy to understand what they were required to do in each task. This was supported by the affirmative comment given by the observers; "Good understanding reflected by the URA staff". Moreover, assessment of the easy in carrying out the actual tasks showed that participants found them fairly easy to perform.

Table **5-4** show that when participants at both case organisations were asked about the ease of understanding and using the BPIAE suite, they all on average rated them as fairly easy to understand and use. Also, feedback received from interviews held with selected participants who were part of the evaluation sessions showed that the simple interface of the BPA-DES made it easy to access the decision enhancement services provided by the different studio suites.

Better still, the participants were able to carry out and complete the tasks in short time periods, for instance, participants were able to identify bottlenecks within their business process within 4-5minutes when using the WFA suite. Also, participants at both cases were able to generate and select suitable BPIAs within 1.5 to 2 hours collaboration sessions.

Additionally, participants found it easy to freely share information and knowledge using BPAIE suite and through verbal discussions during the BPA decision process. Participants also appreciated the simple interface provided by the communication suite for sending and receiving information by email as well as SMS notification on their phones.

These positive results, indicate that stakeholders found the BPA-DES fairly easy to understand and thus easy to use. In light of these results, we conclude that the BPA-DES is useable for efficient exploring of BPI alternatives in response to identified changes.

Usefulness

The results attained and discussed in the previous section reveal that the BPA-DES is useful for workflow analysis, generation and selection of BPIAs, and in improving collaboration and communication among stakeholders.

With regard to workflow analysis, stakeholders found the WFA suite very useful because it provided them with services to analyse event logs that facilitated the identification of bottlenecks and process times. More so it enabled the simulation of BPIAs which increased their understanding of the would-be benefit(s) of the different proposed BPIAs. The WFA suite's output thus provided them with information that promoted informed decision making during Continuous Business Process Improvement (CBPI).

Likewise, with respect to generation and selection of BPIAs, the stakeholders appreciated the BPAIE collaboration process which provided them with guidance on how to work together to generate and select BPIAs. Also the BPIAE facilitated and improved collaboration among the stakeholders taking part in the BPA decision process. This is shown by the positive feedback they made about the usefulness of the collaboration process (see Table 5-7) for exploring BPIAs, more so all the participants in both case organisations said that the sequence of the collaboration tasks was appropriate for exploration of BPIAs (see Table 5-6). Furthermore, stakeholders were observed to have willingly and freely shared information and knowledge and worked together in generating and selecting BPIAs. For example, all participants at both case organisations anonymously contributed unique ideas simultaneously using MeetingWorks on which areas of their business process should be improved and how it should be improved during the collaboration sessions to generate BPIAs. This observed willingness to share information and knowledge encouraged and facilitated discussions, building consensus and decision making among stakeholders thus the generation and selection of BPIAs that accommodate participants' stakes or viewpoints.

The communication suite facilitated and improved communication among stakeholders by enabling the SMS notification on participants' phones as reminders that important mail has been sent to the email accounts. This service was seen to address the flow of information challenge that was identified during the exploratory study by supplementing the already existing email service.

General Insights

The aim of this research as highlighted in chapter 1 was to design an environment to enhance the BPA decision process by supporting stakeholder interaction, participation and collaboration. To attain this objective, three research questions were formulated and answered. In line with these and the preceding discussion a number of insights were gained. These included;

a) *BPA-DES supports the three main phases of BPA decision process*: From the literature and exploratory study, it is observed that the BPA decision process involves the *identification* phase where stakeholders work together to identify problems or areas in their business processes that need to be improved; the *development* phase which involves the generation,

evaluation and of improvement alternatives; and the *selection* phase where stakeholders decide on which of the improvement alternatives to implement.

The evaluation results show the BPA-DES provides a systematic approach that supports all these phases of the BPA decision process by providing guidelines that highlight steps to be on how to identify improvement alternatives and to generate and select BPIAs. This is evidenced by the positive remarks they gave regarding the appropriateness of the sequence of collaboration tasks included in the BPIAE collaboration process. For example, all stakeholders responded 'Yes' when asked whether the sequence of activities enabled you to effectively explore BPI alternatives. Also stakeholders stated that the BPIAE suite was by all means useful.

- *The BPA-DES supports the identification phase and advances the identification of improvement opportunities* by enabling stakeholders to carry out in-depth analysis of the performance and behaviour of existing business processes. This is shown by stakeholders identifying bottleneck areas in their business processes using the WFA suite and through the identification of risks. Consequently, stakeholders' understanding of improvement opportunities was improved. Also, stakeholders were able to generate the areas for improvement by using the BPIA-G service.
- It supports the development and selection phases through the BPIA Suite using the output from the WFA suite and the RA suites.

b) *The BPA-DES expedites organisations' responsiveness to identified changes in the business environment:* The BPA-DES' interfaces were found to be relatively simple by stakeholders in that they could easily access the decision enhancement services for continuous business process improvement. Also the guidelines were easy to understand and provided a systematic approach for the BPA decision process activities. As a result stakeholders were able to carry out timely analysis of their business processes in order identify improvement opportunities and in response explore BPIAs. In addition, the simulation services facilitated stakeholders' understanding of the benefits of proposed BPIAs by providing information with insight into their performance which enabled effective selection of suitable BPIAs in response to identified improvement areas.

c) *The BPA-DES supports and facilitates stakeholder collaboration and participation:* From literature and the exploratory study findings discussed in chapters 1 and 2, it was observed that stakeholder collaboration was still a challenge to achieving BPA and was commonly manifested as poor stakeholder participation. This was seen to be contributed by the minimal support for it in existing BPA approaches. The evaluation results show that the BPA-DES enables multiple stakeholder participation in the generation and exploration of BPIAs as well as promotes and boosts stakeholder's willingness, commitment and motivation to participate in the BPA decision process. This is evidenced by candid discussions that sprang up and the sizeable number of unique ideas contributed the stakeholders during the collaboration sessions. This showed that the BPA-DES enabled them to freely share information and knowledge. This increase in stakeholder participation and willingness to share knowledge and information, as shown in the results presented in section 5.4 contributes to the increase in stakeholders' acceptance of BPIAs.

In addition, it also facilitates flexible decision making by involving a wide range of stakeholders from top management to junior employees thus bridge the gap between management and junior employees. For example, participants that took part in the collaboration sessions in Mak involved both senior staff (the Academic Registrar and one of his deputies responsible for Graduate Programs) and junior staff i.e. faculty registrars, as well as a student. Therefore the BPA-DES improves collaboration among stakeholders and provides an effective approach of utilizing available resources such as knowledge, skills and time during the BPA decision process. In addition, increase in stakeholder participation further improves the success of business process improvement efforts and increases stakeholder ownership of BPIAs which leads to improved performance and service delivery.

d) *The BPA-DES increases Business Process Agility and improves the success of business process improvement efforts:* It facilitates rigorous business process analysis (workflow analysis and risk assessment) leading to prompt identification of areas that need to be improved and generation of BPIAs. In addition, supporting collaboration among stakeholders facilitates efficient generation of quality BPIAs. Better still, the simulation

services enable the evaluation of BPIAs which increases stakeholders buy-in and ownership of the BPIAs, and therefore facilitates informed decision making (selection of quality BPIAs) during Continuous Business Process Improvement (CBPI). More so, the support for good communication among the stakeholders facilitated efficient information dissemination, which improves the success in implementing BPIAs. Thus, this combination of collaboration, workflow analysis and simulation, risk assessment, and communication services, enhances the BPA decision process by increasing the ability of an organisation to identify improvement opportunities and respond to them i.e. responsiveness. This is achieved through; enablement of rehearsal of the future using the simulation services, which in turn leads to reduction of costs, and increase in acceptability of BPIAs.

Following the discussion above, the evaluation results indicate in combining collaboration, communication, workflow analysis and simulation services, the BPA-DES satisfies the identified requirements and supports collaboration during the BPA decision process. The BPA-DES offers an efficient approach on how to explore BPIAs which enhances coordination among stakeholders by providing guidelines as part of the decision enhancement services. For instance, a risk analyst at the NSSF-Uganda headquarters, in 2011, reiterated the importance of collaboration of risk assessment. Stakeholders at both cases (URA and Mak) reported positive feedback on the guidelines provided by BPIAE collaboration process. They reported that the sequence of collaboration tasks (thinkLets) enabled them to work together to identify areas of their business processes to be improved in their basing on business process analysis reports and also to agree on which BPIA to implement basing on BPIA evaluation reports. Furthermore, the collaboration, workflow analysis and simulation services it provides enhance informed decision making and support continuous business process improvement. Better still; the BPA-DES can be used to explore BPIAs by stakeholders in various business domains.

The BPA-DES is thus usable and useful for continuous business process improvement and when compared to the existing BPM suites, provides a unique solution to the increased demand for BPA in organisations. In that, it provides not only technological support for analysing and evaluating business processes but also promotes collaboration among stakeholders taking part in the BPA decision process.

5.6. Conclusion

The BPA-DES was evaluated by subjecting it to stakeholders at case organisations as recommended by the design science philosophy (Hevner, 2007). The chapter details the procedure followed, the criteria used and the results. The aim of the tests was to evaluate the usefulness and usability of the BPA-DES in enhancing the BPA decision process. The observations made from the evaluation results indicate that participants found the BPA-DES to be relatively easy to use and very useful in the exploration of business process improvement alternatives. The stakeholders valued the interactive environment the BPA-DES provided them to not only design and analyse business processes but also to share knowledge and information, and make decisions, as being very useful for continuous business process improvement. The researcher thus noted that the combination of workflow analysis, simulation, collaboration and communication services facilitate the success of the BPA decision process and business process improvement efforts in general.

It can thus be concluded that the successful testing of the BPA-DES and the positive results show that the research objective, "to *design an environment to enhance the decision making process involved in exploring BPIAs in response to identified improvement opportunities in a business environment by supporting stakeholder interaction, participation and collaboration*", was achieved.

6. EPILOGUE

The research began with a review and discussion of issues regarding the BPA in general and the approaches developed to attain it. The findings revealed that little attention had been paid to the decision process involved in exploring Business Process Improvement Alternatives (BPIAs). The main objective of the research was to design a BPA decision enhancement studio (BPA-DES) to provide decision enhancement services to support the BPA decision process activities. To this end, an exploratory study was carried out at the National Social Security Fund (NSSF) in Uganda to further understand the BPA decision process. The challenges faced by stakeholders involved in this decision process were identified. Basing on the challenges identified in literature and from the case study, requirements for the BPA-DES that would support stakeholders during the BPA decision process were derived. The BPA-DES was designed to consist of four suites that would provide business process analysis (workflow analysis and risk assessment), collaboration, and communication services to stakeholders. A prototype of the BPA-DES was implemented and tested to assess its usability and usefulness in enhancing the BPA decision process. A reflection on the research findings and approach are discussed in the subsequent sections. The generalizability of the BPA-DES and recommendations for future research are also discussed.

6.1. Achievement of the Research Objective

To guide the achievement of the research objective, the research question: "***How can the BPA decision process be enhanced*?**" was formulated as the central question.

Answering this question first required one to be able to fully understand what was involved in the BPA decision process, what approaches (if any) have been developed to support it and what challenges still exist. Thus to effectively answer this question, it was broken down into three sub questions.

Research Question One

To further understanding the BPA decision that is, the decision process followed in exploring different modifications/adjustments of a business process, the guiding question that was used was:

What is the decision process followed in exploring different modifications/adjustments of a business process?

This question was partly answered in chapter 1 and elaborated in chapter 2. Chapter 1 gave an insight on some of the characteristics the BPA decision process such as; it is continuous, and knowledge intensive meaning it requires stakeholder participation and involves multiple stakeholders. More to that it deals with decisions that matter. An exploratory study was carried out at the National Social Security Fund in Uganda (NSSF-UG) and the findings were presented in chapter 2.

It was observed from the findings that there was no structured BPA decision process. This absence of a clear definition of the BPA decision process made it necessary to identify the activities that are carried out when improving a business process in order to enhance the process. Therefore the identified activities were:

(i). *Identification of an area that requires change in a given department*: This activity mainly seeks to identify the areas of the business process that require improvement.

(ii). Review of issues and alternative solutions: In this activity, the generation and evaluation of the possible alternatives on how to improve the highlighted areas of the business process.

(iii). *Decision Making*: Basing on evaluation results for each of the possible improvement alternative, a decision was taken as to which one should be adopted.

(iv). *Adoption Definition*: in this activity, an implementation strategy and road map are drawn out by the stakeholders taking part in the BPA decision process.

(v). *Sensitization:* This activity sought to sensitize staff on the changes that were about to be carried out in regard to the selected improvement alternative in order to build acceptance among the staff.

(vi). *Rolling out of the solution*: At this stage, the selected solutions and changes were implemented in the business process.

Identification of the activities involved in the BPA decision process formed the foundation for developing the BPA-DES to provide an interactive environment to support stakeholders in carrying them out. These activities provided a guide in the development of the BPIAE collaboration process.

Research Question Two

In order to understand what kind of support should be given to stakeholders involved in the BPA decision process, it was necessary to identify the challenges they were facing in carrying out the identified activities. To achieve this, the second research question was formulated that is;

> ***What challenges are faced by stakeholders involved in the decision process followed in exploring different business process improvement alternatives?***

This question was answered partly in chapter 1 and in chapter 2. The challenges faced by stakeholders involved in the BPA decision process were identified from literature as well as from the exploratory study carried out at NSSF-UG. The challenges identified from literature were presented in Chapter 1 and included; *limited support for sense-and-respond patterns in terms of implementing EDA in BPM suites; poor stakeholder involvement and collaboration support; lack of or poor communication between BPM stakeholders; little to no attention to providing guidelines to facilitate stakeholders to effectively use technology in exploring BPIAs.* On the other hand, the challenges gathered from the exploratory study were presented in chapter 2 and are categorised into two groups namely, the external and internal challenges. The external challenges that affected the BPA decision process observed included *the fluctuation of stock prices, economic stability, political stability or influence, and directives from governing bodies*. The internal challenges observed included; *limited stakeholder participation*; *poor information flow; rigidity in the decision-making process*; *bureaucracy*; and the *lack of enough and/or current information.*

The external challenges identified in the exploratory study were in line with those highlighted by Hill et al. (2006), Sarkis (2001), and Zhang and Sharifi (1999) among other authors. These however were seen to be beyond stakeholders' control thus can only be monitored and be used as boundaries within which business process improvements could be made. Therefore in this

research, addressing the internal challenges i.e. challenges that originate from within an organisation and can be controlled by the stakeholders, was seen to be a feasible approach to enhancing the BPA decision process. The internal challenges observed from the exploratory study were observed to be in line with those identified from literature and mainly pointed to the ***need to support collaboration, communication (information flow)*** and ***business process analysis*** during the BPA decision process.

Collaboration support and provision of guidelines for exploring BPIAs were seen as the core missing ingredients in the BPA decision process considering that a number of BPM suites were already developed to support business process analysis. The lack or minimal support of collaboration during the BPA decision process was observed to consequently lead to poor stakeholder participation, rigidity in the decision process as well as poor communication among stakeholders. More to that, facilitation of business process simulation during the BPA decision process enhances business process analysis and can be used to visualize the execution of BPIAs thus would improve stakeholder participation by boosting their understanding of the benefits of proposed BPIAs. These challenges thus posed the need to provide an interactive environment to support business process analysis and collaboration among stakeholders in the BPA decision process.

Research Question Three

The third research question formulated to enable the achievement of the research objective was

How can these challenges be addressed to enhance the BPA decision process?

The first step in addressing the identified challenges was to derive the business process analysis collaboration and communication decision enhancement requirements. These were presented in chapter 2.

To address these requirements and to provide an interactive environment to support and facilitate stakeholders participating in the BPA decision process, a BPA decision enhancement studio (BPA-DES) to provide business process analysis (workflow, simulation and risk assessment), collaboration, communication services was designed following Sol's "four ways of" framework (Seligmann et al., 1989) in chapter 3.

In *way of thinking* the concepts and approach adopted in designing an environment to support and enhance the BPA decision process is described. Here we argue that the combination of careful analysis of a business process, collaboration and communication decision enhancement services provided in a studio environment, offers a unique approach to enhance the BPA decision process (see section 3.2). Most BPA approaches were observed to address the generic phases of the business process lifecycle by providing technological support. However, in answering research questions (i) and (ii), we observed that the collaboration aspect of the BPA decision process was hardly supported yet collaboration is seen to be paramount for the success of BPA. Therefore the solution provided by BPA-DES of combining collaboration, workflow analysis and simulation services to support the BPA decision process is seen to address this gap in exiting BPA approaches. The *way of modelling*, detailed the notations and modelling concepts used in the business process models, simulation models, the collaboration processes, and in describing the BPA-DES suites (see section 3.3). The *way of working* described how the BPA-DES decision enhancement services are used for exploring BPIAs during the BPA decision (see section 3.4). The *way of controlling* provided the guidelines on how to carry out the different BPA decision process activities. It also described the metrics used to ensure that the BPA-DES enhances the BPA decision process (see section 3.5*)*.

To ensure that the decision enhancement services met the identified requirements and enhance the BPA decision process, an instance of the BPA-DES was developed. To do this, implementation considerations were first identified (see chapter 4). The BPA-DES instance was verified using walk-through sessions. The verified BPA-DES instance was further evaluated in case organisations to assess its usability and usefulness in enhancing the BPA decision process (see chapter 5).

With regard to usability, the evaluation results indicate that stakeholders found the suite interfaces were simple and fairly easy to understand with minimal training. The guidelines were also easy to understand and follow. The participants were thus able to use the BPA-DES to analyse their existing business process to identify improvement opportunities; generate, evaluate and select BPIAs; and to share information amongst them. In light of these results, we conclude

that the BPA-DES is useable for efficient exploration of BPI alternatives in response to identified changes.

In the same way, the evaluation results in chapter 5 reveal that participants' perceptions towards the usefulness of the BPA-DES for exploring BPIAs were positive. The evaluation results indicate that the BPA-DES satisfies the identified requirements and supports collaboration during the BPA decision process by providing a combination of collaboration, communication, workflow analysis, and simulation services. These services were observed to enhance stakeholders' effectiveness during the BPA decision process. Therefore we can conclude by stating that the BPA-DES increase stakeholders' responsiveness to changes in the business environment, improves collaboration and communication among stakeholders as well as supporting business process simulation and analysis, thus improving operational agility.

6.2. Reflection on the Research Approach and Designed Artefact

Reflecting on the research objective and ill-structured nature of the problem following the inductive-hypothetical research strategy was found to be beneficial in that it was possible to understand the BPA decision process and the challenges therein. In that, the main objective of the research was to design an interactive environment (the BPA-DES) to support stakeholders during the BPA decision process. However the BPA decision process was not clearly defined and thus the challenges affecting the stakeholders involved were not clearly defined. The ill-structured nature of the problem thus dictated an exploratory approach to answering the research questions. Therefore, the inductive-hypothetical research strategy facilitated the identification of decision enhancement requirements as discussed in the previous section and later the development of a usable and useful decision enhancement studio for BPA.

In order to attain a useable and useful artefact (BPA-DES), design science was selected as the research philosophy because it stresses the utility of artefacts i.e. artefacts that contribute to the body of knowledge and are relevant to the community (Winter, 2008; Hevner, 2007; Carlsson, 2006; Hevner et al., 2004). It consists of three cycles, the relevance, rigor and design cycles. The relevance cycle in this research involved the exploratory study whereby interviews were conducted at NSSF-UG. This enabled the understanding of the BPA decision process and

identification of the decision enhancement requirements. The BPA decision process and the challenges identified from the exploratory study were found to be generally in line with those highlighted in literature and thus can be considered as being common to most organisations.

In the design cycle, designing of the BPA-DES was iterative. In that, the initial design was built, evaluated and refined repetitively using artificial settings and dry runs, and the final design was evaluated in natural settings using walk-through sessions at different case study organisations. This was done to ensure that the BPA-DES was usable and useful in addressing the identified decision enhancement requirements. The design was expressed using the Sol's "four ways of" framework (Seligmann et al., 1989). Basing on the evaluation results presented in chapter 5, we can conclude that the BPA-DES enhances the BPA decision process by supporting stakeholders to effectively work together to explore BPIAs.

The design science rigor cycle emphasises the development of artefacts that contribute to the body of knowledge. Therefore the rigor cycle in this research involved rigorous review of literature to ensure that the artefact was innovative and that it adds value by enhancing the BPA decision process. Considering the various issues were identified from literature as well as in practice as presented under research question 2 and in chapter 1 and 2. The BPA-DES addresses most of these issues by providing a new approach for achieving BPA that focuses on facilitating collaboration by providing guidelines and suites to enable stakeholders to explore BPIAs during the BPA decision process.

Compared to the existing BPM suites which only provided technologies to support the business process life cycle (see chapter 1) without guidelines, the new approach provides a combination of workflow analysis, simulation, risk assessment, communication and collaboration decision enhancement services, packaged as suites with guidelines deployed in a studio environment. The workflow analysis and risks assessment services provide support for timely identification of improvement opportunities by providing guidelines and suites for analysing the behaviour and performance of business processes and the inherent risks. The collaboration services facilitate stakeholders to efficiently generate quality BPIAs, and select suitable ones. The simulation

services facilitate the evaluation of BPIAs while the communication services enable flow of information through the sending and receiving of emails and SMS notifications.

Looking at the internal challenges identified during the exploratory study highlighted in chapter 2, we can say that the BPA-DES addresses them as evidenced by the evaluation results presented in chapter 5. For instance, the results indicate that stakeholders were willing to participate in the BPA decision process and share knowledge and information, which addresses the challenge of *limited stakeholder participation.* The communication service addresses the challenge of *poor information flow* by providing a simple to use interface to send emails to the stakeholders as well as a SMS notification to their phones. The results show that the SMS notification was a particularly good solution to this issue. The BPIAE collaboration process can be said to address the challenges of *rigidity in the decision-making process* and *bureaucracy* by facilitating stakeholder collaboration and multiple stakeholder participation. WFA, simulation and RA services are seen to provide more information required for in depth analysis of business processes thus addressing the challenge of *lack of enough current information* identified during the exploratory study.

The BPA-DES therefore enhances the BPA decision process by providing the much needed support of collaboration as well as addressing most of the challenges facing stakeholders involved in this process.

6.3. Generalizability of the BPA-DES

The BPA decision process activities and challenges identified during the exploratory study are common to most organisations more so in transition countries or organisations with similar characteristics. Additionally, decision enhancement requirements that formed the basis for the designed decision enhancement services provided in the BPA-DES were based on challenges identified from the case study and were in line with those highlighted in literature.

Also, during the evaluation of the BPA-DES it was also observed that most organisations in Uganda did not have workflow management systems supporting their business process. This was found to be characteristic of most transition countries. The BPA-DES was used to explore BPIAs

at an organisation that did not have a workflow management system to support the business process selected for improvement as well as at an organisation that had an established workflow management system supporting the reviewed business process. More so, it was evaluated at different business domains namely, an academic institution and a tax body.

Although we cannot fully generalize our findings, the successful application of the BPA-DES at the two cases and the positive results feedback received indicate that it has the potential of being applicable for exploring BPIAs for different business processes in different business domains, and in organisations that have and do not have workflow management systems. Based on these factors, we conclude that the BPA-DES is useful and usable for exploring BPIAs in response to identified changes in the business environment and thus enhances the BPA decision process. Nevertheless, further investigation of the BPA-DES' potential, applicability and in a wider variety of business processes and business domains is recommended.

6.4. Recommendations for Future Research

A number of issues have been addressed in this research as discussed in the previous sections of this chapter. Nevertheless, in the course of this research, while a couple of issues requiring further research arose due to constraints arising from limited time, resources and availability of stakeholders. These issues are presented in this section as recommendations.

- ***Recommendation One***: In order to evaluate *Usage,* an important aspect in ensuring the utility of artefacts as emphasized in design science and by Keen and Sol (2008), and to further evaluate the generalizability of the BPA-DES, we recommend that the BPA-DES be implemented for longer periods of time at various business domains.

- ***Recommendation Two***: An important aspect in guaranteeing effective decision making is monitoring the implementation of the action point or decision (Keen and Sol, 2008). Therefore this research can be furthered by investigating the collaborative development of implementation plans to ensure effective operationalization of BPIAs.

- ***Recommendation Three***: Interpretation and translating of BPIAs into simulation models particularly the identification of modelling aspects from logs generated during the BPIAE collaboration session was found not to be a straight forward process.

  This research can thus be furthered to support automatic mapping of improvement alternatives onto simulation models.

- ***Recommendation Four***: One of the issues highlighted in literature was the limited implementation of EDA in BPM suites. This research can be furthered by investigating the implementation of sense-and-respond patterns for BPA.

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APPENDICES

APPENDIX A

A.1: Interview Guide for Exploratory Study

INTERVIEW QUESTIONS

The continuously changing business environment and increasing competition in terms of cost and quality has increased the demand for business process agility in organisations. In order to maintain a competitive advantage it is important for an organisation to have the ability to swiftly and appropriately adjust its business processes in response to unpredictable internal and external changes that occur in a business environment, beyond the normal level of flexibility. This is the notion of Business Process Agility (BPA). This research aims at finding a way of enhancing the decision making process in order to improve BPA. The results of this research will enhance the decision process by coordinating interactions between stakeholders and the technology used in the decision process using the set of guidelines/recipes. Stakeholders will therefore be able to make effective decisions on how to improve a business process in a flexible manner thus improving business process agility. The information you give in this interview will be handed with at most confidentiality.

1. Is the concept of business process agility present in your organisation? If so, how is it being achieved?
2. What internal and external factors (if any) necessitate change in your operations or provide opportunities for improving your business processes?
3. What challenges (if any) do you face that affect your ability to be agile?
4. What decision making process do you follow when the need to make changes to your business processes arises?
5. Who is involved in the decision making process of determining what change or how the business process should be modified/changed?
6. What kind of systems or mechanisms do you have in place to enable you achieved business process agility and to support the decision making process involved?
7. What challenges (if any) do you face during the decision making process undertaken when improving or changing a business process? How do you address these challenges?
8. Do you have any suggestions as to how decision making can be enhanced in order to improve business process agility?

A.2: Summary of Interview Responses From Interviews at NSSF-Uganda

RESPONSES TO INTERVIEW QUESTIONS

Qn 1: Is the concept of business process agility present in your organisation?

BPA is a newly adapted concept of at NSSF as an organisation. As a way to incorporate it into the organisation, new departments were created to spear head its achievement. These departments are the Performance Intelligence Unit (PIU) and the Risk department. The responsibility of these departments are to monitor and evaluate the performance of the business processes, and to identify risk indicators for each process, the risk level and recommend ways to mitigate them respectively.

i. How is it being achieved?

The PIU presents reports on the performance identifying areas that need to be improved and the risk department makes recommendation based on their risk assessments. Alternatives the course of action are discussed in interdepartmental meeting. Any changes to be made are carried out within the restriction of the NSSF Act of 1985.

Regular checks (fortnightly) are carried by the Performance Intelligence Unit (PIU) to assess the performance of the business processes with the aim of improving service delivery. Focus has been put mainly on the benefits business process. These checks are done in a step wise manner in order to identify how long each claim takes at a given activity. A follow up is then done to find out the reason(s) for delays in given cases. Other business processes that are evaluated include the contributions, and investments processes.

The Risk department is carrying out an exercise to evaluate each business process to identify the predictable and anticipated risk indicators and the level of risk. The identification of these indicators is done in coordination with the responsible departments. Currently their focus is on the benefits and contribution business processes and the department involved include Operations, Audit, Finance and the PIU. Once the risks have been identified, staff in the risk department analyze and calculate the risk level. A set of recommendations to address these risks are then made. Contact people in the responsible departments are then given action points.

Qn 2: What internal and external factors (if any) necessitate change in your operations or provide opportunities for improving your business processes?

- Stock Markets/Prices
- Politics
- Regulations in the NSSF Act and Bank of Uganda directives
- Lack of capacity to carry out change. This leads to the dependency on consultants which in turn results in an increase of costs.
- Advancement Technology
- Response Time within the processes
- Increased Awareness among clients and opinion surveys
- Liberalization in the domain area by allowing competitors to join the area
- Benchmarking with sister organisations
- The way of carrying out operations other organisations
- Economic Stability (inflation, crunch)
- Unemployment

Qn 3: What challenges (if any) do you face that affect your ability to be agile?

a. Having the monopoly
b. Cost Control
c. Politics
d. Difficulty in making accurate predictions
e. Bureaucracy involved in adopting new technologies
f. Instability in management

Qn 4: What decision making process do you follow when the need to make changes to your business processes arises?

The general decision making process involves the following steps

a) Identify the area that requires change in a given department; the responsible department prepares a presentation on the issue/problem with possible solutions.
b) A committee of stakeholders is formed to review the alternative solutions.
c) Different alternatives are reviewed

d) The chosen solution is presented to the executive committee which comprises of the head of departments. Any decision that cannot be handled by the top management is handled by the board of directors.
e) Once approved, the solution is adopted
f) Sensitization of the staff members on the change to be implemented
g) The change is then implemented.

It should also be noted that decisions are first made at the departmental level. This takes place at the first step (a) in the process specified above. However, since the operations in the different department are cross cutting, there is need for interaction, coordination, and cooperation between them. This is purpose of the interdepartmental committee.

Qn 5: Who is involved in the decision making process of determining what change or how the business process should be modified/changed?

The people involved in the decision making process depends on the level at which a decision is to be made. However the categories include;

- Board members
- Interdepartmental committee that is made up of Head of departments
- Area Managers
- Executive Committee (Top Management).

Qn 6: What challenges (if any) do you face during the decision making process undertaken when improving or changing a business process?

- Rigidity of in the decision making process in some departments i.e. it is left to the heads of departments.
- Failure to appreciate the problem
- Individual attitudes
- Political Influence
- Poor Information flow; hindering the successful implementation of recommendations
- Level of awareness; Ignorance on issues by the board members
- Impact of a given decision

Qn 7: What kind of systems or mechanisms do you have in place to enable you achieved business process agility and to support the decision making process involved?

a. ***Microsoft Application such as Ms. Excel*** NSSF does not have highly specialized systems to monitor their business processes. Information is gathered from people by word-of-mouth or complaints and from the logged data from the systems. Using this data and an individual's experience, the data is cleaned (made complete), analyzed and reports generated.

b. ***PowerPoint and paper presentation;*** These are used to facilitate the decision making process. Representatives from different departments present their issues to different decision making committees as deemed necessary. Basing on the presentations, decisions are then made on how to improve the way of operation (i.e. the business process).

Qn 8: Do you have any suggestions as to how decision making can be enhanced in order to improve business process agility?

- Empowerment of staff members
- Come up with mechanisms to improve the information flow among members at all levels
- Sensitization
- Interactive management; to bridge the gap between management and junior employees

A.3: Interview Guide for Studio Design Evaluation

STUDIO DESIGN EVALUATION INTERVIEW GUIDE

An exploratory study was carried out in August 2009 and from the data collected, user requirements were identified. A number of functional requirements for the proposed interactive environment were derived and used as a basis for designing the environment.

The proposed design of the environment consists of 4 suites (sets of techniques/tools used for a given purpose) to support the activities involved in exploring business process improvement alternatives. The suites are:

- Risk Assessment Suite
- Workflow Analysis Suite
- Suite for Exploring Business Improvement Alternatives
- Communication Suite.

The purpose of this interview session is verify/validate the proposed studio design. The findings will be used to refine the studio design.

A: Workflow Analysis Suite Validation

Objectives of Interview

- *Discuss the design of the proposed environment especially the workflow analysis component with the aim of validating it and secondly getting ideas on how to improve it.*
- *Get an understanding of how your workflow or business process analysis is performed; steps taken and the tools used.*
- *Identify any missing or new requirements*

Questions

1. How do you analyse your business process?
    a. Activities involved
    b. Parameters Used
    c. Inputs into the process
2. What tools do you use for analysis?

3. Who is involved in the process?
4. Do you work together as a group in analysing your business processes? i.e. Is it a collaborative task?
5. How do you generate improvement alternatives?
    a. Factors that may necessitate the improvement of a business process (Business Process Improvement Drivers)
6. How do you implement business process improvements/changes?
    a. Are you satisfied with the implementation process in place?
    b. If not do you have suggestions on how they can be improved?
7. Do the results from the workflow analysis process feed into another process related to business process improvement?

B: Risk Analysis Suite

This suite comprises of a set of tools/techniques that will support collaborative risk assessment.

Objectives of Interview

- *Discuss the design of the proposed environment especially the risk assessment component with the aim of validating the collaboration processes and secondly getting ideas on how to improve it.*
- *Get an understanding of how your risk assessment is performed that is steps taken and the tools used.*
- *Identify any missing or new requirements.*

Questions

1. How do you identify risks in your business process?
    a. Activities involved
    b. Parameters Used
    c. Inputs into the process
2. What tools do you use to support risk analysis activities? (risk identification, analysis/assessment and risk control/mitigation)
3. Who is involved in the process?

4. Do you work together as a group in analysing risks involved in your business processes?
    a. If so, how do you coordinate the
5. How do you generate improvement alternatives?
    a. Factors that may necessitate the improvement of a business process (Business Process Improvement Drivers)
6. How do you implement business process improvements/changes?
7. Do the results from the risk analysis process feed into another process related to business process improvement?

C: Suite for Exploration of Business Process Improvement (BPI) Alternatives

This suite comprises of a set of tools/techniques that will support collaboration in the generation and evaluation of BPI alternatives.

Objectives of Interview

- *Discuss the design of the proposed environment especially the BPI exploration component with the aim of validating the collaboration processes and secondly getting ideas on how to improve it.*
- *Get an understanding of how BPI ideas are generated and evaluated to select one alternative for implementation.*
- *Get to understanding of the decision process involved and the challenges faced during this process.*
- *Identify any missing or new requirements.*

Questions

1. How do you identify areas to improve in your business process(es)?
    a. Activities involved
    b. Parameters Used
    c. Inputs into the process
2. What tools do you use to support the identified activities in (1) above during the exploration of business process improvement alternatives?
3. How do you generate improvement alternatives?

   a. Factors that may necessitate the improvement of a business process (Business Process Improvement Drivers)
4. Who is involved in the process?
5. Do you work together as a group in generating BPI alternatives?
   a. If so, how is the session/meeting coordinated and facilitated
   b. What challenges are faced during such sessions?
   c. If not, how is it done?
6. How do you select a business process improvement alternative to implement?

APPENDIX B


```
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<!-- This is a process enactment event log created to be analysed by ProM. -->
<!-- ProM is the process mining framework. It can be freely obtained at http://www.processmining.org/. -
->
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xsi:noNamespaceSchemaLocation="http://is.tm.tue.nl/research/processmining/WorkflowLog.xsd"
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        <Source program="CPN Tools simulation"/>
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APPENDIX C

RISK ASSESSMENT SCRIPTS

Risk Identification: The following script in table 1 was used to enable the facilitator to guide stakeholders in the risk identification process is presented.

Table 1: Script for Identifying Business Process Risks

Task No	Task	Script(Procedure)
1.	Study the business process and identify inherent risks	1. Welcome remarks, Introductions and specification of the session goal and deliverables 2. Brainstorming Qn: What impediments affect the effective execution of the [Name of business process e.g. eTax registration, Benefit processing]? 3. Ask if the question has been understood. If not, make clarification. 4. Inform participants of the time limit 5. Let the participants contribute till there are no more contributions or till the time runs out.
2.	Discuss and refine the list of identified business process risks to define key risks	1. Guide the participants in refining the generated list of impediments (risks). Ask participants to kindly browse through the generated list of impediments and comments to identify key themes that have emerged from the brainstorming" 2. To reduce the size of the list: "Please look at this list of impediments that affect the effective execution of the business process See if you can find two or more items that are related, and tell us how they are related." 3. Reframe or rephrase the related items into one final one containing the key words
3.	Categorize the risks into relevant impact areas	1. Ask participants to categorize related business process risks; Say this: "Please read through the comments on your screen. If you find two more comments that are related in some way, tell me how they are related." 2. Add a new category with the relationship as a label if the items do not fall in

		the already present categories. 3. Move items into the different categories 4. Continue the process until participants can find no more relationships; continue to ask until nobody can find any important aspect to add onto the list.
4.	Evaluate each category to check the correct categorization of each risk	Considering the different categories of business process risks generated, ask the stakeholders to check whether each risk has been placed in the right category. Do this by; 1. Select one category 2. Ask stakeholders "Are there any business process risks in this category that overlap, or are unclear, or that do not belong here?" 3. Place those that do not belong to the category to the right category and rephrase those that are not clear. 4. Remove any redundant business process risks to remain with key ones. 5. Repeat this for all the categories for as long as time will allow.

Risk Analysis: The following script in table 2 was used to enable the facilitator to guide stakeholders in the risk identification process is presented

Table 2:. Script for Assessing Business Process Risks

Task No	**Task**	**Script(Procedure)**
1.	Measure absolute business process risks	1. Ask participants whether it is possible to measure the absolute risks, if yes continue with this task. If no, go to task four. 2. Consider the list of aspects to be improved, in your opinion, which is the most crucial absolute business process risk? 3. Explain the voting muticriteria method and scale for prioritizing the absolute business process risks to the participants. 4. Let the stakeholders vote 5. Consider the results; do they warrant discussion of one or more absolute? If yes go to task two risks otherwise go to task four.

2.	Select and discuss an absolute business process risk	1. From the voting results arrange the absolute business process risks according to the level of consensus that is differences in ratings (high verses low) having those with least consensus at the bottom. 2. Discuss the absolute business process risk evaluation results to gain shared understanding of why one would rate the risk high or low 3. Take a vote to evaluate consensus on the orderings of the absolute business process risks
3.	Measure the selected and discussed business process risk	1. Explain evaluation criteria and voting scale for measuring the absolute business process risks to the participants 2. Discuss each business process risk while allowing participants to adjust their vote 3. Once all the business process risks have been discussed, get the final ratings from the stakeholders for the absolute business process risks 4. Consider the results; are there any absolute business process risks that need to be discussion? If yes go redo task two risks otherwise go to task four.
4.	Identify the existing controls for each of the business process risks	For each of the absolute business process risks, we are going to identify the corresponding control measures from the existing ones. 1. Select a control measure from the list of existing ones and place it under the absolute business process risks that you think they can be used to measure. Start with the business process risks that are of most importance to you because you may not have time to go throw all of them.
5.	Check the correct placement and clear meaning of the existing controls for each of the business process risks	1. Consider each absolute business process risks, ask stakeholders “Are there any control measures in this category that overlap, or are unclear, or that do not belong here?” 2. Place those that do not belong to this absolute business process risk to the right one and rephrase those that are not clear. 3. Remove any redundant control measures to remain with key ones. 4. Repeat this for all the categories as time will allow, if it does not, then select categories for which the time permits according the priority.
6.	Formulate a clear set of existing controls	1. For each business process risk, ask participants to read through the list of control measures control to check related controls. Say this “Please read

	for each of the business process risks	through the list of controls under this business process risk. Are there any controls in this category that overlap, or are unclear? 2. Let participants rephrase the related and/or unclear ones to formulate clear controls. 3. Continue the process until participants can find no more relationships or for as long as time allows; continue to ask until nobody can find any important aspect to add onto the list.
7.	Measure the managed business process risks	1. Consider the list of aspects to be improved, in your opinion, which is the most crucial managed business process risk? 2. Explain the voting muticriteria method and scale for prioritizing the managed business process risks to the participants. 3. Let the stakeholders vote
8.	Select and discuss the managed business process risks	1. From the voting results arrange the managed business process risks according to the level of consensus that is differences in ratings (high verses low) having those with least consensus at the bottom. 2. Discuss the managed business process risk evaluation results to gain shared understanding of why one would rate the risk high or low 3. Take a vote to evaluate consensus on the orderings of the managed business process risks
9.	Measure the selected and discussed managed business process risk again	1. Explain evaluation criteria and voting scale for measuring the managed business process risks 2. Discuss each business process risk while allowing participants to adjust their vote 3. Once all the business process risks have been discussed, get the final ratings from the stakeholders of the managed business process risks

Generate Recommendations: The following script in table 3 was used to enable the facilitator to guide stakeholders in the risk identification process

Table 3: Script for Generating Controls Business Process Risks

Task No	Task	Script(Procedure)
1.	Select the business process risks for which new controls will be identified	Considering the list of business process risks, we will sift them to select those for which new controls need to be identified. Read through the business process risks on the list and check the ones that you think merit more attention. 1. After setting the number of business process risks you want each participant to suggest, ask them to select them saying: "I have given you X checkmarks, so you can only check X items. Once you run out of checkmarks you'll have to uncheck an item before to check another one." 2. Let the group vote and display the results on the public screen. 3. Remove the business process risks that have a low vote by focusing everyone on the results, saying: 'Let's look at the results. There are a number of items that got few or no votes. Let's remove these from the list as they appear to be less crucial than the other ones". 4. Take another vote saying: "Please check the items that you feel merit more attention. I will give you Y [set the maximum number of risks you want selected by each participant] checkmarks." 5. Repeat this process until you end up with the maximum number of issues that you want to handle from that moment onward. Note that the number of iterations will depend on the length of the original list.

2.	Identify more effective controls than the existing ones for each business process risk	1. Explain the criteria for evaluating the business process risk controls to the participants. Answer any questions asked and clarifications sought. 2. Under each selected business process risk, please type the single best control measure for that occurs to you on the electronic page in front of you, then wait for you next instruction. 3. Now swap pages. On the page you received you should see an idea contributed by somebody else. Type a new control measure that will more likely manage the business process risk at [specify one of the criterion for evaluating a control measure e.g. a lower cost] than the idea in front of you. 4. Now swap pages again. Give a new control measure that will more likely manage the business process risk resulting in [specify one of the criterion for evaluating a control measure e.g. better customer relationships] than either of the two you have so far seen. 5. Now swap pages. Give a new control measure that will more likely manage the business process risk by [specify one of the criterion for evaluating a control measure e.g. shortening our processing cycles (performance, response time)] than any of the ideas have so far seen. 6. Repeat the swapping the activity for as long as time allows
3.	Check the correct categorization and clear meaning of the new controls for each business process risk	Considering the different categories of selected business process risks, ask the stakeholders to check whether each new control has been placed in the right category. Do this by; 1. Selecting one category 2. Tell stakeholders to place control measures that do not belong to a category in the right category and rephrase those that are not clear. You can ask, "Are there any control measures in this category that overlap, or are unclear, or that do not belong here?" 3. Removing any redundant control measures to remain with key ones. 4. Repeating this for the number of categories that the allocated time will allow.
4.	Measure business process	Consider the list of selected business process risks for which new control measures are being identified. Goal is to evaluate which is the best/suitable new control measure.

	residual risks	1. Explain the voting muticriteria method and scale basing on the new controls identified for the risks 2. Let the stakeholders vote; measure the risks based on the new controls
5.	Select and discuss the business process residual risks	1. From the voting results arrange according to the level of consensus that is differences in ratings (high verses low) having those with least consensus at the bottom. 2. Discuss the business process risk evaluation results to gain shared understanding of why one would rate the risk high or low, as well as the relevance of the new control measures 3. Take a vote to evaluate consensus of the relevance of the new controls
6.	Measure the selected and discussed business process residual risks	1. Explain evaluation criteria and voting scale for measuring the residual business process risks basing on the new controls 2. Discuss each business process risk while allowing participants to adjust their vote 3. Once all the business process risks have been discussed, get the final ratings from the stakeholders thus prioritized list of residual business process risks
7.	Identify the owners of the new business process risk controls	1. Please go through the new controls that have been identified for each of the prioritized list of residual business process risks. We are going to identify who should own the controls. 2. Explain the kind of ideas that the participants should contribute 3. Start with the business process risks that are of most importance to you because you may not have time to go throw all categories of risks. 4. Let participants suggest the owners of the new controls

BPI ALTERNATIVE EXPLORATION SCRIPT

To enable facilitators to effectively guide stakeholders involved in BPI alternative exploration, guidelines on how to carry out each collaboration task were developed. These are presented in the following sections.

Goal Definition and Generation of BPI alternatives: The following script in table 5-4 was used to enable the facilitator to guide stakeholders in the identifying the aspects of the business process that need improvement. At the end of this activity, improving the selected business process areas/aspect forms the goal of the whole BPI alternative collaboration process.

Table 4: Script for identifying business process aspect that needs improvement

Task No	Task	Script(Procedure)
1.	Review the summaries of the workflow analysis and risk assessments of the organisation's business processes.	1. Introduce the Goal and deliverables of the session 2. Give an overview of the business process under revision and insight to documentation 3. Ask whether participants have understood the business process 4. Answer any questions that may arise
2.	Generate suggestions of the aspects that need to be improved in a given business process	1. **Brainstorming Qn**: Basing on the reports given, what aspect(s) of the business process need to be improved? 2. Ask if the question has been understood. If not, make clarification. 3. Inform participants of the time limit 4. Let the participants contribute till there are no more contributions or till the time runs out.
3.	Filter suggested aspects of improvement only keeping the most important ones.	1. Explain what belongs to public list giving examples of aspects that would qualify 2. Using the generated list, ask each participant to highlight the most important aspect to be improved in a given business process. 3. Continue to ask until nobody can find any important aspect to add onto the list.

4.	Evaluate the refined list of areas that are to be improved	1. Consider the list of aspects to be improved, in your opinion, which is the most important aspect? 2. Give the stakeholders voting sheets. 3. Explain the voting method and scale (1-5 where 5 is the highest and 1 is the lowest) 4. Take a vote, prioritizing the aspects to be improved. 5. From the voting results arrange according to the level of consensus that is differences in ratings (high verses low) having those with least consensus at the bottom. 6. Consider each aspect: discuss reasons as to why one would rate it high or low. 7. Display the final prioritized list of aspects

Generation of Business Process Improvement Alternatives: The following script in table 5-5 was used to enable the facilitator to guide stakeholders in the generate BPI alternatives for the selected aspects of the business process that need improvement.

Table 5: Script for Generating Business Process Improvement Alternatives

Task No	**Task**	**Script(Procedure)**
1.	Generate ideas on how the business process may be improved	1. Consider the most relevant aspect (scoring 1) in the prioritized list of aspects from previous task, generate ideas on how to improve to attain the desired/required level of improvement 2. Compile the generated ideas into one complete list reflecting all the stakeholders' views.
2.	Filter to remain with the most feasible alternative solutions from the generated pool of improvement ideas	1. Using the generated list, ask the stakeholders to highlight the most important aspect to be improved in a given business process. 2. Remove redundant aspects to remain with key aspects for the business process to be improved.

3.	Evaluate the list of most feasible improvement alternatives	1. Explain the voting method and scale 2. Take a vote, prioritizing the alternatives. 3. Display the final prioritized list of aspects with their desired/required level of improvement.
4.	Submit proposed alternative solutions for simulation, workflow analysis and risk assessment.	

Decision Making: The following script in table 5-6 was used to enable the facilitator to guide stakeholders in the selecting the most suitable BPI alternative.

Table 6: Script for Agreeing on Business Process Improvement Alternative

Task No	**Task**	**Script(Procedure)/ Assignment**
1.	Review the summaries of the workflow analysis and risk assessments of each BPI alternative and any other relevant additional information	
2.	Evaluate the BPI alternatives (risks and the performance)	1. Explain the voting method and scale 2. Take a vote, ranking the BPI alternatives 3. Display the final prioritized list of BPI alternatives
3.	Build consensus and agree on which BPI alternative best improves the identified aspect of the business process.	1. Discuss the ordered list to gain shared understanding 2. Take a vote to evaluate consensus 3. Agree on and select the most suitable BPI alternative

APPENDIX D

THE STUDENT REGISTRATION PROCESS OF MAKERERE UNIVERISTY BEFORE COLLEGE SYSTEM

Registration Process

Registration of undergraduate students took place at the faculty while graduate student's registration mainly took place at the Graduate school and ended at the faculty. Initially, this process was completely manually done however with the increase in the student population, this became a very tedious process characterised by long student queues. Recently, online registration was introduced as a solution to the problem but has not been made available to all categories of students.

The online registration services have been made available for;

a) Continuing undergraduate students on normal progress from first year second semester onwards (i.e. students without retakes or other exceptional cases)
b) Continuing masters students on normal progress from first year second semester onwards (i.e. students without retakes or other exceptional cases)

PhD and first year undergraduate and graduate students in their first semester follow the manual registration process. Continuing Students with exceptional cases among such as those with retakes, who have been advised to stay-put, resuming study after a withdrawal (dead year) or suspension, diploma, upgrading from one level to another e.g. diploma to degree or postgraduate diploma to masters, missing papers, and failed online registration are registered following the manual process due to process design and configuration problems in the online registration system.

Manual Registration Process

This is mandatorily followed by the first year undergraduate and graduate students in their first semester. The manual registration process involves the following activities;

Undergraduate (Faculty based)	Graduate (Graduate School & Faculty based)
1. Picking up registration forms and registers by faculty registrars from the senate building	1. N/A

2. Student picks up his/her registration form that has his/her bio-data	2. Student picks up 2 registration forms
3. Make a copy of the registration form that has his/her bio-data	3. N/A
4. Fill registration form in triplicate.	4. Fill registration form in duplicate.
5. Submit filled registration forms with attached copies of supporting documents (academic documents, admission letter, signed exam malpractice form and birth certificates, proof of payment) *N.B: continuing students only attach proof of payment*	5. Submit filled registration forms with attached copies of supporting documents (academic documents, admission letter, signed exam malpractice form and birth certificates, proof of payment) *N.B: continuing students only attach proof of payment*
6. Verify submitted documents against corresponding originals and registration forms	6. Verify submitted documents against corresponding originals and registration forms
7. Sign registration register	7. Register in the book of registered students
8. Capture data into the Academic Registration Information System(ARIS)	8. (a) Capture data into the Academic Registration Information System (ARIS) (b) Take registration Certificate to Faculty for stamping and registering in faculty book of registered students
9. Complete registration	9. Complete Registration

Online Registration Process

The Online Registration Process (ORP) may also be referred to as self-Registration. It is followed continuing students on normal progress that is with not exceptional cases as explain above. Activities followed include;

1. Log-on onto the systems through the university intranet.

2. Select year and qualification being registered for
3. Select the course units for the given semester
4. Print proof of registration and statement of account for the semester
5. Approval of registration by registrar.

Registration Process Analysis: Risk Assessment

Manual Registration Process

Table Showing Challenges of Manual Registration Process

Activity/Task	Risk/challenges	Current Mitigation
1. Picking up registration forms and registers by faculty registrars from the senate building	• Delayed start of the registration process as a result of delayed preparation of the registration forms	
2. Student picks up his/her registration form that has his/her bio-data	• Delayed start of the registration process as a result of late delivery of registration forms • Delayed registration due to missing registration Forms	
3. Make a copy of the registration form that has his/her bio-data	• High cost for undergraduate students since they have to make additional copies of the bio-data form since only one form is issued by the Academic Registrar's office • Long waiting times due to limited number of photocopiers in the university as compare to the number of students.	
4. Fill registration form copies.	• Increased filling time as a result of correcting wrong Bio-data on registration form	Student fills in correct data which is recaptured
5. Submit filled registration forms with attached copies of supporting documents	• Late submission of registration forms as a result of late payment. • Increased cost in terms of late registration fee once one misses deadlines for registration. • Long student waiting times (student: registrar ratios) • Failure to make with the schedule registration time by students from affiliated and upcountry university centres due to; long distances and Poor communication	Time-tabling

6. Verify submitted documents against corresponding originals and registration forms	• Long waiting times (student: registrar ratios) • Falsified documents and thus high concentration is needed in order to identify such documents • Failure to identify falsified documents • Failure to register students as result of students being assigned to programs they do not qualify for. • Failure to verify proof of payment documents as a result of problem in a Bank failing to transmit transaction details to the university finance information system (FINIS) • Delayed capture of data in FINIS slows down the verification of a student's financial documents (financial status) • Breakdown of FINIS, results in the standstill in the registration process since the verification of a student's financial documents (financial status) becomes impossible. • Network problems result in a breakdown in information flow and thus a standstill in the verification of documents such as proof of payment verses captured financial status • Power problems leads to inaccessibility of the registration system.	Decentralization of process; done by departmental administrators
7. Sign registration register	• Increased signing time as a student spends time looking for and writing a missing name • Duplicate entry of a student creates confusion/ambiguity not knowing whether it is the same student or not.	
8. (a) Capture data into the Academic Registration Information System(ARIS) (b) Take registration Certificate to Faculty for stamping and registering in faculty book of registered students	• Delay in capturing data from registration form as a result of a system failure thus delay in completing the registration. • Red tapping (Graduate school and faculty registration) • Long waiting times (student: registrar ratios)	
9. Complete Registration		

Online Registration Process

General process Risks

1. No Financial Control Check
2. Lack of robustness; any interruption during the registration process leads to abortion of the registration process.
3. Network and System Failure
4. Internet/Bandwidth related issues

Activity/Task related risks/challenges

Table showing challenges of Online Registration System

Activity/Task	Risk/ Challenge	Mitigation
1. Log-on	• Failure due to network Failure	
2. Select year and qualification being registered for	• Lack of up-to date registration status data since the system permits student to skip semesters without registering • Lack of up-to date registration status data due to failure to considered dead years in the system	
3. Select the course units for the given semester	• Exceeded required credit load for a given semester due to not implementing the semester Maximum Credit Load Limit in the system • Failure to register for retake course units; course unit is captured as though it is a first sitting paper and thus is not charged • Lack of up-to date record of student's done course units due to the failure to capture recess term course units in the system • No restriction on course units that can be registered for by student • Missing course units/ programs for the graduate courses due to changing codes.	• Manual Process enacted/followed • Manual Process enacted/followed
4. Print proof of registration and aged statement of account for the semester	• Delay in or failure to accessing these once network (and component e.g. printer) failure occurs	
5. Approval of registration	• Red tapping • Long waiting times (student: registrar ratios)	

APPENDIX E

Table Showing Feedback from Verification Walk through Sessions

Collaboration Session	Feedback
Session One: BPIA-Generation	**General** 1. Facilitator took up two roles that need to be separate (facilitator and problem owner) 2. Discussion was more verbal than through the GSS 3. Time Management should be improved upon; steps should not be dropped in attempt to catch up with time 4. Time allocated to brainstorming activities was not enough with respect to the cleaning up task 5. More descriptive background to problem/issue should be given at the beginning to have everyone on board; More descriptive documentation should be provided on the risk assessment and workflow analysis and business environment Comment • Agenda should be projected for participants • Goal and steps for each activity in the process should be clearly stated and projected • Give examples of the kind of feedback that is would be expected from the users **With Respect to Collaboration process** 6. Time spent for the converging thinkLet (filtering) should take on average the largest portion of the collaboration session time. 7. Onepage Brainstorming was suitable in this case because; a. The time allocated for the brainstorming task was 10minutes. b. Few ideas were expected (less than 80 ideas were generated in the session. However DirectedBrainstorming with each participant having their own page would be suitable where there are more than 5 participants brainstorming for more than 10min (until they run out of ideas) Comment (after discussion with supervisor) • Onepage is more suitable when dealing with experts in the areas and when individuals have prior knowledge of the issue at hand 8. To generate ideas on how to improve each proposed aspect of a business process, Leafhopper brainstorming was found to be suitable

Session Two: BPIA-Selection	1. If possible maintain the same group of participants in both sessions. 2. Unclear instruction lead to a lot of time being consumed during voting tasks (task 2) Recommendation • Give an explicit introduction or recap of previous session to mitigate this. • Give clear evaluation criteria (what do weights mean?) • Scope to one process at a time. • Pick an evaluation thinkLet that entails first attachment of meaning to weights then use of votes to rank based on meaning (or ref. bullet 2) 3. Maintain Flexibility in process; considering the group composition 4. Evaluate the participants and determine what information should be given/provided 5. Consider the use of sorting basing on reasoning rather than voting ***

APPENDIX F

A Questionnaire to Assess the Business Process Improvement Alternative Exploration (BPIAE) Suite

Introduction:

A Collaboration Process (CP) is an ordered sequence of activities designed to guide participants in jointly working together in a group to effectively and efficiently attain their goal. The collaboration process consists of scripts to guide facilitators in conducting such a session.

The Questionnaire aims at assessing the usefulness and usability of the collaboration process in supporting the generation of Business Process Improvement (BPI) alternatives:

Usability of the BPAIE Suite

Usability is the degree to which the BPIAE supports you in exploration (generating and selecting) of BPI alternatives. From your experience in the collaboration session, please answer the following questions.

Usability of Collaboration Support Tool

i. Is the collaboration tool easy to learn?

☐ Yes ☐ No

ii. Is the collaboration tool to use?

☐ Yes ☐ No

iii. Is the user interface easy to understand?

☐ Yes ☐ No

iv. a. Is the time given to each task sufficient?

☐ Yes ☐ No

b. If not, suggest a suitable amount of time.

……
……
……

v. Rate the usability of this suite.

☐ Very Good ☐ Good ☐ Fairly Good ☐ Poor ☐ Very Poor

Usability of collaboration process

vi. a. Rate how easy it is to understand the tasks in the collaboration process. (1 = very hard, 2= hard, 3= neither hard not easy, 4= easy, 5= very Easy) …….

b. List any challenges you may have faced?

……
……

c. Suggest ways of improving it.

……
……
……

vii. a. Rate how easy it is to carry out the tasks/activities in the collaboration process. (1 = very hard, 2= hard, 3= neither hard not easy, 4= easy, 5= very Easy) …….

b. List any challenges you may have faced?

……
……
……

c. Suggest ways of improving it.

……
……
……

viii. How would you rate the perceived gain in productivity; generation of BPI alternatives? (1 = very poor, 2= poor, 3= neither good nor poor, 4= good, 5= very good) …….

b. List any challenges that may have hindered your productivity?

……
……

c. Suggest ways of improving it.

……

……
……

ix. Can this collaboration process be used repeatedly to explore (generate and select) BPI alternatives?

☐ Yes ☐ No

x. Would you recommend this collaboration process be used by your organisation for exploring BPI alternatives?

☐ Yes ☐ No

Usefulness of the BPIAE Suite

Usefulness refers to the ability of the collaboration process (activities carried out today) to provide support stakeholders of a given business process to work together to jointly generate business process improvement alternatives. From your experience in the collaboration session, please answer the following questions.

i. Does the sequence of activities enable you to effectively explore BPI alternatives?

☐ Yes ☐ No

ii. In your opinion, does this collaboration process improve productivity of the participants?

☐ Yes ☐ No

iii. Rate the usefulness of the collaboration process for the exploration of BPI alternatives.

☐ Very Good ☐ Good ☐ Fairly Good ☐ Poor ☐ Very Poor

iv. Rate the suitability of the collaboration process for the exploration of BPI alternatives.

☐ Very Good ☐ Good ☐ Fairly Good ☐ Poor ☐ Very Poor

v. How many BPI alternatives were generated?

☐ Below 5 ☐ 5-10 ☐ Above 10

vi. How would you rate the quality of BPI alternatives?

☐ Very Good ☐ Good ☐ Fairly Good ☐ Poor ☐ Very Poor

vii. Please provide additional comments if any.

……
……
……

THANK YOU

APPENDIX G

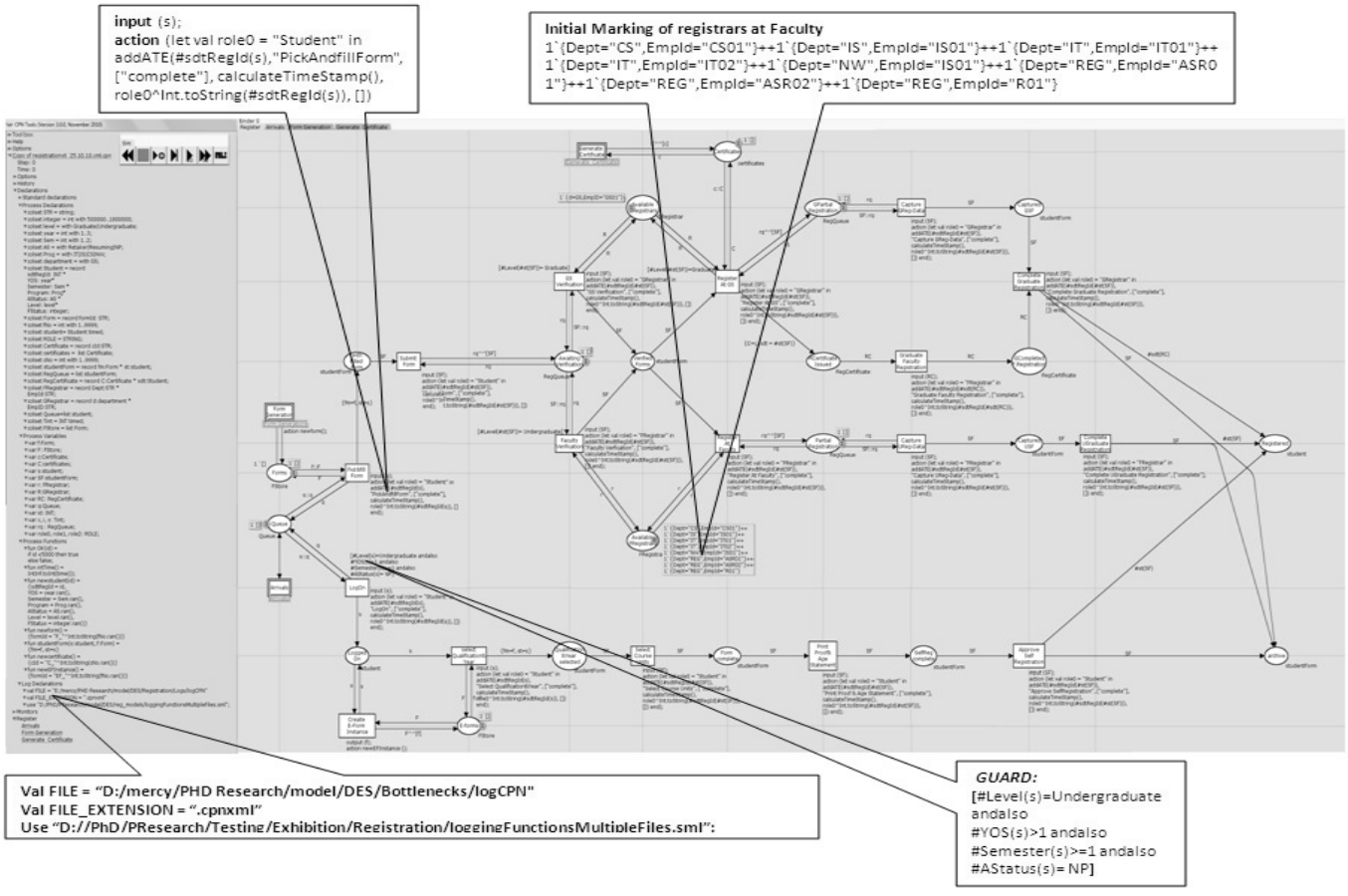
BPIAE COLLABORATION SESSION OBSERVATION RESULTS

Observed Aspect	Comments - Mak	Comments - URA
1. Time allocation and utilization	• Introduction took considerable amount of time • Rest of the tasks were done in good time • Generally the time given was ok • Delay as the start and during the identification of areas/aspects that needed improvement	• Fair • Good • Late Start but once members came in the session run well full of participation
2. Understanding of the tasks to be done	• Clearly understood by all participants • Fair understanding of the tasks to be done	• Good • Clearly understood by the URA Staff • Good understanding reflected by the URA staff from BPR Team/Participants
3. Relevance of the tasks/activities	• Quite relevant to the participants	• Good • High; there was animated interaction • Areas tackled were quite relevant to the tasks presently covered by the team
4. Appropriateness of task sequence	• Order and sequence of tasks were ok	• Good • Appropriate • Fairly good
5. Usefulness of the Collaboration Process in enabling working together in exploration of (BPI) alternatives	• Process started off discussion on how to improve the registration process	• Good • There is candid discussion and consensus • The tool was useful in the collaboration session
6. Productivity/Participation of participants	• Initially senior managers participated more, as session moved on all participants became active. • 50% were very active while the others were averagely active	• Very Good • Productivity was high since all participants are working collaboratively • High productivity and participation noted because all participants engaged in the discussions
7. Creativity of participants	• Participants generated a lot of ideas that could improve the	• Good • The participants were creative

	current process	since they gave Reponses describing many of the issues of the IS • Some participants came up with other ideas on how to shelve some ideas for further discussion
8. Usability	• Participants found the software very easy to use • Not much training was required • The participants were involved and they used the tool • Very good	• Very Good • The tool is very easy to use • The team become stormy; arguing about registration process of Government bodies especially affiliated schools etc • The tool has a high usability

9. Other	• Session was too long: How can the sessions be shortened? – may be focus on one aspect.
	• At some point the remaining participants did not clearly know how the processes are done e.g. payments at the bank and how they are connected to FINIS
	  ○ Suggestion: Have participant from the Bank or FINIS department to take part in this session.
	• Number of Participants:
	  ○ Centre: 4
	  ○ SCIT: 2
	  ○ Student: 1
	  ○ Observers: 2
	• Challenges
	  ○ Movements by participants; in and out
	  ○ Poor reading culture: some participants did not read the documentation send prior to the session
	  ○ Some participants expressed lack of motivation to take part in research activities cause of the poor implementation culture
		• Number of Participants:
		  ○ URA Staff: 8
		  ○ Facilitator: 1
		  ○ Observers: 3
		• The productivity and creativity of the participants was interesting and good; Generally good participation and contributions
		• Refreshments were served and participants were highly motivated by this incentive.
		• Several questions were raised indicating interest in the testing tool i.e.
		  ○ what happens in the event of a tie after polling
		  ○ Applicability of decentralised participation i.e. different geographical locations

APPENDIX H



Student Registration Simulation Model

LIST OF ACRONYMS AND ABBREVIATIONS

BAM	Business Activity Monitoring
BPA	Business Process Analysis
BPA-DES	Business Process Agility Decision Enhancement Studio
BPI	Business Process Improvement
BPIA	Business Process Improvement Alternative
BPIAs	Business Process Improvement Alternatives
BPIAE	Business Process Improvement Alternative Exploration
BPIA-G	Business Process Improvement Alternative Generation
BPIA-S	Business Process Improvement Alternative Selection
BPM	Business Process Management
BPMS	Business Process Management System
BRM	Business Rules Management
BPR	Business Process Re-engineering
CE	Collaboration Engineering
CEP	Complex Event Processing
CBPI	Continuous Business Process Improvement
CoQM	Computation of Quality Measures
CP	Collaboration Process
CPI	Continuous Process Improvement
CPN	Coloured Petri Net
EDA	Event Driven Architecture

ESB	Enterprise Service Bus
DE	Decision Enhancement
DES	Decision Enhancement Service
FCIT	Faculty of Computing and Informatics Technology
FPM	Facilitation Process Modelling
Mak	Makerere University
MXML	Mining eXtensible Markup Language
NSSF	National Social Security Fund
O&M	Operations and Maintenance
PAIS	Process Aware Information System
PIU	Performance Intelligence Unit
ProM	Process Mining
ProMImport	Process Mining Import Framework
RA	Risk Assessment
ROI	Return On Investment
SOA	Service Oriented Architecture
SMS	Short Messaging Service text message
TQM	Total Quality Management
UML	Unified Modelling Language
URA	Uganda Revenue Authority
WFA	Workflow Analysis Suite
WFMS	Workflow Management System
XML	eXetensible Markup Language

SUMMARY

Business Process Agility (BPA) is the ability to 'swiftly' and appropriately adjust business processes in response to identified internal and external changes in the business environment, even when there are no predefined guidelines of dealing with the change. BPA enables an organisation to have a competitive advantage in an ever changing world, and satisfy its customers. Organisations are thus increasingly seeking to become agile in their operations. This increased demand for BPA has led to a shift in Business Process Management (BPM) from management theories and practices that emphasize radical business process redesign such as business process re-engineering, to technologies that emphasize Continuous Business Process Improvement (CBPI). CBPI as a core aspect of BPM enables continuous and direct improvement of business processes, thus BPA. Coupled with the cross-cutting nature of business processes where different people from within and without organisations interface during their execution, CBPI and in turn BPA are knowledge intensive and call for multiple skills and expertise. This implies that any BPA initiative calls for the involvement and collaboration of business process stakeholders during a business process' life cycle. In light of this, achieving BPA is seen as a process that entails analysing business process to identify the areas that need improvement, exploring the alternatives and deciding on a business process improvement (BPI) alternative to implement. The selected BPI alternative is then communicated to the stakeholders responsible for its implementation. In this research we refer to this process as the BPA decision process.

In achieving BPA, many approaches have been developed to support flexibility and dynamicity of specific business process aspects; points-of-agility. These have been implemented as BPM suites; "a set of integrated technologies that enable process stakeholders and users to go quickly around the process revision cycle". Examples include; BPM Suites; Service Oriented Architecture (SOA) enabled BPM Suites; Event Driven Architecture (EDA) enabled BPM Suites; and Collaborative BPM. These BPM suites have focused on supporting the business process life cycle activities but not the BPA decision process. Notwithstanding the efforts of these approaches and BPM suites, a number the challenges facing the stakeholders involved in the BPA decision process were identified. These included; (i) The reviewed BPM suites focused on providing tools and/or techniques that support the business process lifecycle but pay *less attention to providing guidelines to facilitate stakeholders to effectively use technology* in

exploring BPI alternatives during the BPA decision process. (ii) *Poor stakeholder involvement and collaboration support* for stakeholders carrying out continuous business process improvement yet any changes in the business process would have effect on the various stakeholders (Bjorn and Ralf, 2010; Christine, 2008; Den Hengst and De Vreede, 2004). This is mainly reflected as insufficient participation of top management and/or operational users (Den Hengst and De Vreede, 2004); (iii) *Lack of or poor communication between BPM stakeholders* yet continuous adaptation to new conditions needs to be carefully managed and coordinated to avoid chaos (Muehlen and Ho, 2006; Den Hengst and De Vreede, 2004); (v) *Limited support for sense-and-respond patterns* in terms of implementing EDA in BPM suites (Christine, 2008; Lundberg, 2007).

From the preceding discussion, areas that have received limited support in the current BPM suites and a number of challenges facing stakeholders during the BPA decision process are observed. This research thus sought to address these issues by answering the question: ***"How can the decision process involved in BPA be enhanced?"*** To effectively answer this research question, we sub-divided it down into the following questions;

i) *What is the decision process followed in exploring different modifications/adjustments of a business process?*

ii) *What challenges are faced by stakeholders involved in the decision process followed in exploring different business process improvement alternatives?*

iii) *How can these challenges be addressed to enhance (i.e. increase flexibility and provide the required support to stakeholders during) the BPA decision process?*

Main objective

The main objective of the research was thus to identify the challenges facing stakeholders in the BPA decision process and build an artefact to addressed them. In so doing, a new approach that combined collaboration, communication, simulation, workflow analysis, and risk assessment decision enhancement services was developed to support stakeholders during the BPA decision process. These services were packaged as suites with guidelines provided in a studio environment.

Research Approach

In order to attain a useable and useful artefact (BPA-DES), design science was selected as the research philosophy. Design Science research involves three cycles namely, the relevance cycle, the design cycle and the rigor cycle (Hevner, 2007; Hevner et al., 2004). It was chosen because it enabled the understanding of organisational issues associated with decision making in business process management and facilitated the development of a usable and useful artefact.

The inductive-hypothetical research strategy was followed in conducting the research and answering the questions.

(i). *Initiation Stage:* In this stage, theories surrounding business process agility were studied from literature to gain an in-depth understanding of the approaches and challenges that exist in achieving BPA. Furthermore, an exploratory study was conducted at the National Social Security Fund (NSSF) in Uganda (chapter 2) in order to gain a deeper understanding of the business needs pertaining decision making and BPA.

(ii). *Abstraction Stage:* The findings from the initiation stage provided the base for identifying requirements of the kind of decision enhancement services that would be needed in the BPA decision enhancement studio as presented in chapter 2.

(iii). *Theory Formulation Stage:* Following the "ways of" descriptive framework for design approaches (Seligmann et al., 1989) the BPA-DES was designed. Basing on the identified decision enhancement requirements presented in chapter 2, literature was reviewed to identify the methods, concepts and techniques used to design the decision enhancement services. To satisfy the business process analysis requirements, workflow analysis, simulation and risk assessment services were designed.

The process mining approach of analysing business processes was adopted in the design of the workflow analysis service as well as simulation services. Guidelines in form of steps to be followed or activities to be carried out when analysing a business process were developed. Existing software was identified to support stakeholders in carrying out the prescribed activities. On the other hand, risk assessment was observed

to be a collaborative task as discussed in chapter 2 thus we adopted the risk assessment service adopts risk management collaboration process designed by Briggs, Grinsven and De Vreede (De Vreede and Briggs, 2005; Grinsven and De Vreede, 2002), to enable stakeholders to assess business process inherent risks.

Furthermore Business Process Improvement Alternative Exploration (BPIAE) services and communication services were designed to enable stakeholders to jointly generate and select BPI alternatives in response to identified changes or improvement opportunities; and promote dissemination of information among stakeholders respectively. The generation and selection of BPIAs was observed to involve multiple stakeholders. Therefore the BPIAE services consist of a collaboration process designed to provide guidelines for stakeholders to work together to; identify areas of their business processes that need to be improved; generate BPIAs and to select a suitable BPIA. The BPIAE collaboration process was designed following collaboration engineering concepts as discussed in the chapter 3. The BPIAE service also consists of a collaboration support tool to support stakeholders in carrying out the prescribed collaboration tasks.

To provide the communication service a Java application was developed. The application enables stakeholders to send information to each other during the BPA decision process as an email and an SMS notification.

These services were packaged as suites thus, the BPA-DES consists of four suites namely the Workflow Analysis (WFA) suite, the Risk Assessment (RA) suite, the BPIAE suite and the communication suite.

(iv). *Implementation stage:* A prototype of the BPA-DES (discussed in chapter four) was implemented and verified through dry runs with volunteers. The verification process focused on three suites of the BPA-DES that is the communication, WFA, and BPIAE suite. The results were used to improve the BPA-DES design before subjecting it in real world cases.

(v). *Evaluation Stage:* Two case studies were used during the evaluations, namely; Makerere University (Mak) and Uganda Revenue Authority (URA) through which walkthrough sessions. Observations were made, interviews conducted, and questionnaires administered to evaluate the usability and usefulness of the BPA-DES in enhancing the BPA decision process.

Research Findings

Information gathered during the exploratory study revealed that there was no predefined of spelt out BPA decision process. Nevertheless, the number of activities involved were identified and included; (i) *Identification of an area that requires change in a given department*; (ii) *Review of issues and alternative solutions*; (iii) *Decision Making; (iv) Adoption Definition; (v) Sensitization;* and *(vi) Rolling out of the solution*. Furthermore, the challenges faced by stakeholders involved in the BPA decision process were found to be both internal and external. The external challenges that affected the BPA decision process observed included the fluctuation of stock prices, economic stability, political stability or influence, and directives from governing bodies which were more less in line with those highlighted by Hill et al. (2006), Sarkis (2001), and Zhang and Sharifi (1999) among other authors. The research however concentrated on the internal challenges which were BPA factors that could be controlled by stakeholders in an organisation unlike the external ones. Nevertheless the external factors were considered to be boundaries within which changes to a business process should lie within. The internal challenges observed included;

i). *There is limited Stakeholder participation*: mainly attributed to lack of or limited clarity and understanding of an improvement opportunity, and the failure to clearly envision the benefits associated with a given proposed improvement alternative.

ii). *Poor information Flow*: this was observed as the failure to pass down information on decisions about changes to relevant which slowed down implementation of business process improvements.

iii). *Rigidity in the decision-making process*: this was manifested as a gap between management and junior employees which impeded implementation of business process improvements. This was because the BPA decision process was limited to a small section of the staff thus they felt their views were not considered in the proposed improvement.

iv). *Bureaucracy*: the strict organisational decision structures were observed to a tendency of slowing down responsiveness to changes in the business environment thus leading to lack of flexibility in the BPA decision process.

v). *Lack of enough and/or current information*: Stakeholders made use of Microsoft excel for data analysis which would not carry out complex analytics to readily highlight areas that needed improvement. More so, only periodic data collected from the system by a staff member was filtered into reports and used to analyse the performance of the organisation's business process. This has made the data analysis and later report writing activities within the process such as risk assessment and business process analysis slow and tedious, and decisions were made based on less current information and not real time.

In addressing the challenges, requirements for designing the BPA-DES that would support the stakeholders during the BPA decision process were derived. These requirements were categorised into three groups namely the business process analysis requirements, the collaboration requirements and the communication requirement. These were;

- ***collaboration requirements*** (*Enablement of multiple stakeholder participation; facilitation of flexible decision making in the BPA decision process; promotion and enhancement of stakeholder's willingness, commitment and motivation to participate; enablement of stakeholders to share information and knowledge; provision of an optimal way to use available knowledge, skills and time resources, in and during the BPA decision process).*
- ***Business process analysis requirements*** *(enablement of in-depth workflow analysis, and facilitation of risk assessment of business processes)*
- ***Communication requirements*** (*dissemination and sharing of the BPA decision process outcome*)

From these requirements, the services required for the BPA decision process were identified and a decision enhancement studio designed. These services include business process analysis particularly risk assessment and workflow analysis; simulation of business processes; BPI alternative generation and selection; and communication (information dissemination).

The BPA Decision Enhancement Studio (BPA-DES)

To describe the BPA-DES design, the Sol's "four ways of" framework (Seligmann et al., 1989) was used. In the *way of thinking*, we argue that the combination of careful analysis of a business process, collaboration and good communication/information dissemination among the stakeholders, offers a promising approach towards advancing support of and improvement of the decision process. That is to say, supporting continuous workflow analysis and risk assessment in conjunction with evaluation of the business environment enables stakeholders to identify improvement opportunities and inherent risks. Furthermore exploration (generation and selection) of BPI alternatives jointly promotes consensus and acceptability of the proposed improvement and thus facilitating BPA (see section 3.2). In the *way of modelling* simulation models were built using coloured Petri Nets, business process models were modelled using Petri Nets, the collaboration processes used to provide the collaboration services were modelled using thinkLets in collaboration engineering and were presented as facilitation process models. The different suites in the BPA-DES were described using activity flow diagrams (see section 3.3). As a *way of controlling* to ensure that stakeholders were able to effectively explore BPIAs, a set of guidelines were developed to facilitate them during the BPA decision process. More so, the BPA-DES was evaluated using the *usefulness* and *usability* metrics (see section 3.5). In the *way of working* as presented and explained in section 3.4, the designed BPA-DES addressed the derived requirements by providing workflow analysis, risk assessment, BPI alternative exploration, and communication decision enhancement services, in a studio environment. These decision enhancement services were respectively packaged into suites that are provided with guidelines.

- **Workflow Analysis (WFA) Suite**: It provides workflow analysis and simulation services. The workflow analysis services enable the conversion of event logs from other formats such as the excel or CSV file format into MXML format, and the analysis of event logs using process mining techniques to get in-depth understanding about the

business process performance and bottlenecks. The simulation services enable stakeholders to develop of simulation models to mimic the execution of proposed BPI alternatives in order to analyse their performance and possible bottlenecks.

- **Risk Assessment (RA) Suite**: This suite facilitates business process risk assessment by providing collaboration services to support risk identification, assessment and mitigation. The input into the suite is a process specification and additional information gathered from different stakeholders who interact with the business process. It provides guidelines on assess risks using the risk management collaboration process developed by Briggs, Grinsven and De Vreede (De Vreede and Briggs, 2005; Grinsven and De Vreede, 2002) implemented using a collaboration support tool. Evaluation of this suite showed that the process promoted information and knowledge sharing among the stakeholders. Furthermore, MeetingWorks enabled multiple stakeholder participation.

- **BPIAE Suite**: The suite provided a BPIAE services that consists of a collaboration process to guide stakeholders in generating and selecting BPI alternatives, and a collaboration support tool. As elaborated in chapter 3, the BPIA exploration process is an iterative process involving the reviewing of the analysis reports from the workflow analysis and risk assessments suites, to identify the areas of a business process that need to be improved; the generation of BPIAs, the evaluation of the BPIAs using the WFA and RA suites; and the selection of a suitable BPIA.

  From the evaluation results presented in chapter 5, the BPIAE suite was found to accommodate stakeholders' views; promote stakeholder commitment; sharing of information and knowledge among the stakeholders; facilitate optimal utilization of available knowledge, skills and time resources; and flexible decision making involving a wide range of stakeholder. The use of a MeetingWorks to conduct the collaboration sessions enabled multiple stakeholder participation.

- **Communication Suite**: The communication suite facilitates the flow of information e.g. the selected BPIA, between stakeholders by providing an interface from which they can compose and send emails and SMSes simultaneously. Upon evaluation it was found to be

simple to use and useful in terms of enhancing dissemination of information especially through the automatic sending of SMSes.

The BPA-DES was tested by conducting sessions at Uganda Revenue Authority (URA) and Makerere University (Mak). During the tests, the usefulness and usability (Keen and Sol, 2008) of the decision enhancement studio were evaluated. Stakeholders valued the interactive environment provided by the BPA-DES and generally found it easy to use and very useful for exploration of business process improvement alternatives. They were satisfied that BPA-DES promoted continuous business process improvement by enhancing their efficiency and effectiveness in identifying improvement alternatives and exploration of improvement alternatives. More so, it not only enabled them to design and analyse business processes but also to share knowledge and information, and make decisions in collaboration.

A number of insights were gained from the evaluation results and these included;

a) *The BPA-DES increases responsiveness to changes in a business environment*: Its interfaces are simple thus stakeholders easily access the decision enhancement services for continuous business process improvement. More so, the guidelines are easy to understand and provide a systematic approach for the BPA decision process activities.

b) *The BPA-DES addresses the collaboration requirements of the BPA decision process*: It enables of multiple stakeholder participation in the generation and exploration of BPIAs as well as promotes and boosts stakeholder's willingness, commitment and motivation to participate in the BPA decision process by enabling them to freely share information and knowledge. It also facilitates of flexible decision making by involving a wide range of stakeholders from top management to junior employees thus bridge the gap between management and junior employees. Therefore the BPA-DES improves collaboration among stakeholders and provides an effective approach of utilizing available resources such as knowledge, skills and time during the BPA decision process.

c) *The BPA-DES advances the identification of improvement opportunities:* This is achieved through the workflow analysis services which enable stakeholders to carry out in-depth

analysis of the performance and behaviour of existing business processes. Consequently, stakeholders' understanding of improvement opportunities is improved.

d) *The BPA-DES expedites organisations' responsiveness to identified changes in the business environment:* This is achieved through the simulation services which facilitate stakeholders' understanding of the benefits of proposed BPIAs by providing information that gives insight into their performance.

e) *The BPA-DES provides a systematic approach for exploring BPIAs*: The guidelines provided by the decision enhancement services highlight steps to be followed and how to explore BPIAs which enhances coordination among stakeholders.

f) *The BPA-DES increases the stakeholders' acceptance of BPIAs:* Stakeholders' acceptance of BPIAs is improved through the collaboration services which increase agreement and ownership of generated and selected BPIAs. This is attributed to the increased stakeholder participation, and willingness to share knowledge and information, as shown in the results presented in section 5.4. Increase in stakeholder participation further improves the success of business process improvement efforts. More so, increased ownership of BPIAs leads to improved performance and service delivery.

g) *The BPA-DES increases Business Process Agility and improves the success of business process improvement efforts:* It facilitates rigorous business process analysis (workflow analysis and risk assessment) leading to prompt identification of areas that need to be improved and generation of BPIAs. In addition, supporting collaboration among stakeholders facilitates efficient generation of quality BPIAs. Better still, the simulation services enable the evaluation of BPIAs which increases stakeholders buy-in and ownership of the BPIAs, and therefore facilitates informed decision making (selection of quality BPIAs) during Continuous Business Process Improvement (CBPI). More so, the support for good communication among the stakeholders facilitated efficient information dissemination, which improves the success in implementing BPIAs. Thus, this combination of collaboration, workflow analysis and simulation, risk assessment, and

communication services, enhances the BPA decision process by increasing the ability of an organisation to identify improvement opportunities and respond to them i.e. responsiveness. This is achieved through; enablement of rehearsal of the future using the simulation services, which in turn leads to reduction of costs, and increase in acceptability of BPIAs.

From the results discussed above, the BPA decision enhancement studio is seen to enhance stakeholders' performance (efficiency and effectiveness) during the BPA decision process by enabling timely identification of improvement opportunities through the workflow analysis and risk assessment suites. Also it enhances stakeholder participation and collaboration through the BPIAE suite which provides a collaboration process to guide stakeholders in the generation and selection of BPIAs. Additionally, it facilitates information flow among stakeholders during the BPA decision process by providing a service that enables emails and SMS sending. Therefore, the BPA-DES is usable and useful for continuous business process improvement and improves organisations' operational agility, and can be applied to various business domains.

Conclusion

In conclusion, we can say that the BPA Decision Enhancement Studio (BPA-DES) contributes a new theoretical and useful approach for achieving BPA that directly focuses on BPA decision process. The new approach to business process agility provided by the BPA-DES, combines collaboration, workflow analysis, simulation, communication, and risk assessment decision enhancement services, packaged as suites with guidelines to support the BPA decision process. Therefore the BPA-DES goes beyond providing technological support but also aligns the technology to the people involved in the BPA decision process through the guidelines on how to explore business process improvement alternatives. This enables the stakeholders to flexibly and efficiently participate in the BPA decision process to select suitable business process improvement solutions.

SAMENVATTING

Business Process Agility (BPA) is het vermogen om bedrijfsprocessen snel en correct aan te passen, als reactie op interne en externe veranderingen in de bedrijfsomgeving, ook als hiervoor geen vooraf gedefiniëerde richtlijnen voor zijn. Organisaties zijn steeds meer op zoek naar manieren om agile te worden in hun processen, en om te kunnen gaan met dynamische bedrijfsomgevingen. Deze verhoogde vraag naar BPA heeft geleid tot een verandering in Business Process Management (BPM) in de richting van technologieën die Continuous Business Process Improvement (CBPI) ondersteunen. CBPI is een kernaspect van BPM en maakt continue en directe verbeteringen van bedrijfsprocessen mogelijk. BPA wordt gezien als een proces dat een continue analyse van bedrijfsprocessen vereist om voor verbetering vatbare onderdelen te identificeren, verbeteringsalternatieven te onderzoeken en te besluiten welke Business Process Improvements (BPI) doorgevoerd moeten worden. Zodra een van de alternatieven geselecteerd is wordt dit gecommuniceerd naar de belanghebbenden die verantwoordelijk zijn voor de implementatie. In dit onderzoek wordt naar dit proces gerefereerd als het BPA Decision Process. Dit process bestaat uit kennisintensieve activiteiten en vraagt om diverse vaardigheden en expertises, gelet op het multidisciplinaire karakter van bedrijfsprocessen. Dit impliceert dat ieder BPA initiatief vraagt om inbreng en medewerking van verschillende belanghebbenden gedurende de lifecycle van een bedrijfsproces.

Een groot aantal bijdragen, zoals BPM Suites, Service Oriented Architecture (SOA) enabled BPM Suites, Event Driven Architecture (EDA) enabled BPM Suites en Collaborative BPM (IBM Corporation, 2008; BizAgi Limited, 2008; Singh and Thompson, 2008; Christine, 2008; Dan et al., 2008; Kamoun, 2007; Hill et al., 2006; Kuhr and Hamilton, 2008; Ghilic-Micu et al., 2008) zijn ontwikkeld om BPA mogelijk te maken door ondersteuning te geven in verschillende fasen van de lifecycle en door points-of-agility gedurende het proces te monitoren en aan te passen aan behoeften. Desondanks is er een aantal uitdagingen voor de belanghebbenden in BPA decision processes. Dit zijn onder andere:

1. BPM Suites richten zich op het ondersteunen van de lifecycle van het bedrijfsproces, maar besteden minder aandacht aan richtlijnen om belanghebbenden te faciliteren in het effectief gebruik van technologie in het BPA decision proces.
2. Een lage betrokkenheid van, en samenwerking met de belanghebbenden, ondanks de continue veranderingen in de bedrijfsprocessen en de effecten die dit heeft op de belanghebbenden (Bjorn and Ralf, 2010; Christine, 2008; Den Hengst and De Vreede, 2004). Dit komt meestal tot uiting door onvoldoende inzet van het topmanagement of de direct betrokkenen (Den Hengst and De Vreede, 2004).
3. Onvoldoende of slechte communicatie tussen BPM belanghebbenden, terwijl continue aanpassingen aan nieuwe werkwijzen gecoördineerd en gemanaged moeten worden om chaos te voorkomen (Muehlen and Ho, 2006; Den Hengst and De Vreede, 2004).
4. Beperkte ondersteuning voor sense-and-respond patterns bij het implementeren van EDA in BPM Suites (Christine, 2008; Lundberg, 2007).

Dit onderzoek heeft deze uitdagingen geadresseerd door antwoord te vinden op de vraag: **"Hoe kan het besluitvormingsproces rond BPA verbeterd worden?"**
Om deze vraag goed te kunnen beantwoorden zijn de volgende subvragen geformuleerd:

1. Wat is het besluitformingsproces dat gevolgd wordt bij het onderzoeken van diverse veranderingen van een bedrijfsproces?
2. Voor welke uitdagingen staan belanghebbenden die betrokken zijn bij het besluitvormingsproces, als zij onderzoek doen naar de verschillende verbeteringsalternatieven voor het bedrijfsproces?
3. Hoe kunnen deze uitdagingen gebruikt worden om het BPA decision proces te verbeteren ?

Hoofddoel

Het doel van het onderzoek was dus het identificeren van de uitdagingen waarmee belanghebbenden in het BPA decision process geconfronteerd worden en het maken van een artefact waarmee zij het BPA decision process kunnen verbeteren.

Onderzoeksmethode

Om een nuttig en gebruiksvriendelijk artefact te creeëren (BPA-DES) is Design Science gekozen als onderzoeksfilosofie. Deze kent kent 3 cycli: de relevantiecyclus, de ontwerpcyclus en de kenniscyclus (Hevner, 2007; Hevner et al., 2004). Deze keuze is gemaakt omdat het de mogelijkheid biedt de afweging te maken tussen organisatorische belangen en beslissingsproblemen in bedrijfsprocesmanagement, en het de ontwikkeling van een goed artefact faciliteert.

De vijf onderdelen van de inductief-hypothetische onderzoeksstrategie zijn gevolgd: initiatie, abstractie, theorievorming, implementatie en evaluatie (Sol, 1982). In de initiatiefase is een literatuurstudie gedaan en een onderzoek afgenomen bij het National Social Security Fund (NSSF) in Oeganda (hoofdstuk 2) om een beter inzicht te krijgen in de problematiek rond BPA.

In de abstractiefase zijn de requirements benoemd die besluitvorming stimuleren (hoofdstuk 2) en deze zijn gebruikt als basis voor het ontwerp van BPA-DES, zoals beschreven is in hoofdstuk 3. Een prototype van BPA-DES (hoofdstuk 4) is geimplementeerd en geverifieerd door testen te doen met vrijwilligers van de Faculty of Computing and Informatics Technology, Makerere University, en personeelsleden van de Faculteit Economie en Bedrijfskunde, Rijksuniversiteit Groningen. Walkthroughs, enquetes en interviews zijn gebruikt om de bruikbaarheid en gebruiksvriendelijkheid van BPA-DES te evalueren.

Uitkomsten van het onderzoek

Het eerste, explorerende onderzoek liet zien dat er geen vooraf vastgelegde BPA decision processes zijn. Desalniettemin is een aantal activiteiten naar boven gekomen en in het verdere onderzoek opgenomen:

1. Identificatie van het onderdeel dat verandering vereist
2. Review van problemen en alternatieve oplossingen
3. Besluitvorming
4. Adoptie van de oplossing
5. Acceptatie en reactie
6. Uitrollen van de oplossing

Verder is uit gebleken dat de uitdagingen zowel interne als externe oorzaken hebben. De externe uitdagingen die het BPA decision process beïnvloeden zijn onder andere fluctuaties in voorraadprijzen, economische stabiliteit, politieke stabiliteit en invloeden van leidinggevende instanties. Dit is in lijn met de bevindingen van Hill et al. (2006), Sarkis (2001) en Zhang en Sharifi (1999), evenals andere auteurs. De interne uitdagingen zijn onder andere een beperkte participatie van belanghebbenden, een lage informatiestroom, een rigide besluitvormingsproces, bureaucratie en een tekort aan voldoende en/of recente informatie. Er zijn requirements opgesteld om BPA-DES zo te ontwerpen dat het een goede ondersteuning biedt voor belanghebbenden. Deze requirements zijn verdeeld in 3 groepen: Business Process Analysis, Collaboration en Communication requirements.

De BPA Decision Enhancement Studio (BPA-DES)

Gebaseerd op de verkregen requirements zijn de diensten die het BPA-DES zou moeten vervullen geïdentificeerd en ontworpen. Deze diensten zijn respectievelijk verdeeld in 4 suites waarvoor richtlijnen zijn opgesteld, en toegepast in een studio-omgeving (de BPA-DES). De suites omvatten een Risico Assesment (RA) suite om risico-analyses te kunnen aanbieden, een Workflowanalyse (WFA) suite om de workflows te kunnen analyseren en simulaties aan te bieden, een BPIAE suite waarin samenwerkingsdiensten worden aangeboden om BPI-alternatieven te kunnen genereren en selecteren en een Communicatie suite om informatie te kunnen uitwisselen.

Om het ontwerp van de BPA-DES te beschrijven wordt gebruik gemaakt van Sol's raamwerk voor de analyse van ontwerpmethodieken (Seligmann et al., 1989). In de *manier van denken* wordt beargumenteerd dat de combinatie van analyse van een bedrijfsproces, samenwerking en goede communicatie tussen de belanghebbenden een veelbelovende aanpak is voor de ondersteuning en verbetering van het BPA decision process. In de *manier van modelleren* worden simulatiemodellen gebouwd met gebruik van Petri Nets die bedrijfsprocessen beschrijven; samenwerkingsmodellen worden gebouwd met thinkLets en gepresenteerd als facilitation process models. De verschillende suites in de BPA-DES zijn beschreven met behulp van activity flow diagrams. Als *manier van controleren* zijn richtlijnen ontwikkeld om belanghebbenden te ondersteunen bij het BPA decision process. De BPA-DES is geevalueerd

door middel van Usefulness en Usability metrics. In de *manier van werken* geeft de BPA-DES richtlijnen om belanghebbenden de mogelijkheid te geven om veranderingen of opties tot verbetering in hun bedrijfsprocessen te identificeren, Business Process Improvement Alternatives (BPIAs) te genereren, deze te evalueren, een selectie van BPIAs te maken en informatie te verspreiden.

De gebruiksvriendelijkheid en de bruikbaarheid van BPA-DES zijn geevalueerd door walkthroughsessies, afgenomen op de Uganda Revenue Authority (URA) en de Makerere University (Mak). De evaluatieresultaten laten zien dat belanghebbenden de interactieve omgeving van de BPA-DES waardevol vonden en het een gebruiksvriendelijke omgeving was. Ook vonden zij het een nuttig hulpmiddel bij het onderzoeken van bedrijfsprocesverbeteringen en –alternatieven. Ze waren tevreden met de continue verbetering van bedrijfsprocessen die door BPA-DES bevorderd wordt en door de efficientie en effectiviteit in het identificeren en onderzoeken van verbeteringsalternatieven. Daarbij gaf het hen niet enkel de mogelijkheid om het ontwerp en de analyse van een bedrijfsproces te bestuderen, maar ook om kennis en informatie te delen en besluiten te nemen in samenspraak.
Een aantal inzichten is uit deze evaluaties naar voren gekomen:

1. De richtlijnen van BPA-DES zijn gemakkelijk te begrijpen, waardoor de studio mogelijkheden biedt om BPIAs te onderzoeken, in reactie op veranderingen in de bedrijfsomgeving.
2. De samenwerkingsmogelijkheden in de BPA-DES geven een systematische aanpak voor samenwerking tussen belanghebbenden om deel te nemen in een exploratie van BPIAs. Hierdoor wordt de acceptatie van BPIAs bij belanghebbenden verhoogd.
3. De risicoassesment en workflowanalyse in de BPA-DES dragen bij aan een tijdige identificatie van verbeteringsmogelijkheden.
4. De BPA-DES faciliteert een informatiestroom tussen belanghebbenden gedurende een BPA decision process door dinesten die e-mails en SMS-berichten mogelijk maken.

Conclusie en aanbevelingen

Concluderend kan gesteld worden dat een BPA-DES bijdraagt aan een nieuwe, theoretische en nuttige aanpak voor het bereiken van BPA die focust op het BPA decision process. De nieuwe

aanpak combineert samenwerking, workflowanalyse, simulatie, communicatie en risico-assessment, verpakt in suites met richtlijnen om het BPA decision process te ondersteunen. Dit geeft belanghebbenden de mogelijkheid flexibel en efficient deel te nemen in een BPA decision process om passende oplossingen en verbeteringen in bedrijfsprocessen te vinden.

CURRICULUM VITAE

Mercy Rebecca Amiyo was born in 1983 in Nairobi, Kenya. She completed her A' level studies at Gayaza High School (GHS) in 2001. She then pursued her Bachelor's degree in Computer Science (BCSC) at Makerere University, Uganda and completed in 2005. In her final year project during her BSCS degree which was titled "*Automation of Ingredient Proportion Generation*", she sought to automate the generation of ingredient proportions for a Food processors industry. After graduating with a First Class Honour's degree, she was employed in the then Faculty of Computing and Information Technology, Makerere University as a Teaching Assistant. She embarked on her Masters in Internet and Database Systems at Makerere University in collaboration with London South Bank University (LSBU), London. Her Master Dissertation was titled "*Data Exchange between Heterogeneous Databases in Business-To-Business Systems*". She graduated from LSBU in July, 2007. In October 2007, she began her PhD studies at Makerere University in collaboration with Eindhoven University but later transferred to University of Groningen in 2009. Mercy has published part of her research in three papers which were presented at international conferences. Mercy is currently an Assistant Lecturer at the Faculty of Computing and Informatics Technology, College of Computing and Information Sciences, Makerere University, and has supervised several students undertaking their undergraduate projects.