An interoperable architecture and principles for implementing strategy and policy in operational processes

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A B S T R A C T

In today's economy managers expect new strategies and policies to be implemented quickly. Yet practice shows that current systems are not able to implement changes within a short time frame. Nowadays a variety of technologies including semantic web services, business rules and software agents are available as building blocks for interoperable systems. Yet these technologies are rarely used in combination and are not adapting operational processes to changing business strategies and other requirements. A generic architecture is presented in this paper which is able to adapt processes to changing requirements based on three types of knowledge repositories (domain ontology, service description and business rule) which, when combined, allows for direct employment of strategy in business processes. The architecture is tested using scenarios. The testing shows that the architecture improves the interoperability between policy/strategic and operational level and results in a higher agility and better compliance.

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1. Introduction

Strategies and policies are influenced by all kind of developments and frequently change. Managers, customers and several other stakeholders expect changes in strategies and policies to be implemented quickly. Strategy formulation is often viewed as a conveyor belt in which opportunities and issues are recognized as problems, alternative courses of actions are formulated, and these are affected, implemented, executed and evaluated [1]. Armistead et al. [2] distinguished between operational or *horizontal* processes and direction-setting or *vertical* process (see Fig. 1). Horizontal processes are concerned with the production and delivery of products or services, while vertical processes involve strategy and policy formulation and deployment. Vertical processes are initiated by factors such as changes in customer needs, technology developments, market conditions and changes in the regulatory environment and often need to be implemented within a short time frame for reasons like competitiveness, legal compliance and dealing with changed circumstances. A lack of interoperability typically happens in the intertwinement between the vertical and horizontal processes. Both processes are often developed and executed independently, and are typically supported by different systems. The implementation of strategies and policies cannot and should not be blocked or hindered by a lack of interoperable systems, but this is often the case as shown by some examples such as the *Walvis* [3]. In this situation a new policy was made for reducing the administrative burden by simplifying the employment insurance law, but it failed in implementation in time. A main issue in this example is the need to create interoperability between the strategic level and the administrative processes executing the policy, as this facilitates fast and low-cost implementation of new policies. Interoperability is the ability to exchange information between systems [4] and is necessary for connecting the systems supporting vertical and horizontal processes. Interoperability enables strategic and operational systems to exchange information with each other (Fig. 1). Only if these are connected the horizontal processes can adapt to the changes managed and stored in the vertical systems. Our system architecture will relate systems supporting strategy and operational process using business rules models.

Interoperability should enable agility, which can be defined as the speed in responding to variety and changes [5]. Being able to respond quickly is vital in a continuously changing environment in which the systems need to be continually improved in order to reflect changes [6]. However, whereas much literature is focused on horizontal processes, scant attention has been given to the relationship between vertical and horizontal processes. The focus of this research is on the adaptation of horizontal processes to strategy and policy changes. A generic architecture and principles is presented in this paper as the solution for adapting horizontal processes to changes from vertical processes.

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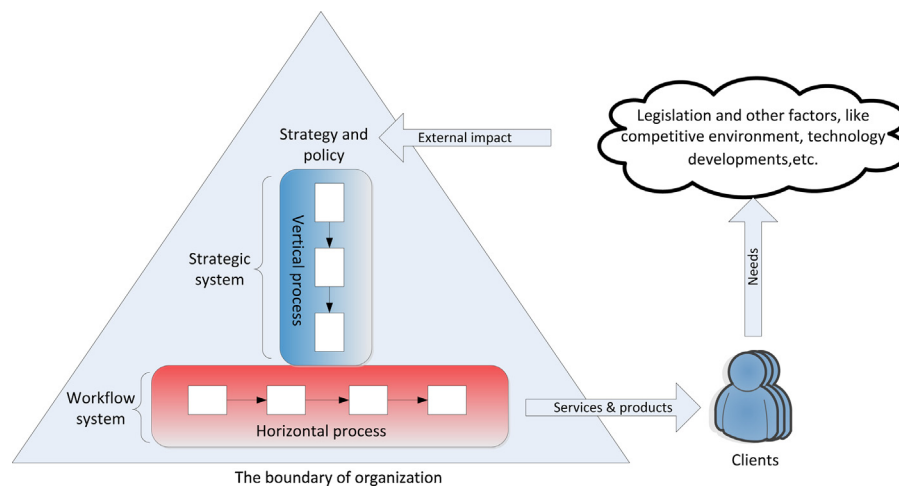 E-mail addresses: Y.Gong@tudelft.nl (Y. Gong), M.F.W.H.A.Janssen@tudelft.nl (M. Janssen).

Fig. 1. The intertwinement between vertical and horizontal processes.

In this paper a system architecture is proposed which allows agile implementation of new strategies and policies into operational processes. Along with the architecture, architectural principles that lay the foundation for the system architecture are provided. The rest of this article is organized as follows. In the next section the background and related work in the field of interoperability and architecture is presented. Next the design science research approach is presented followed by a description of the architecture. Then we present the architecture including the architectural principles. Thereafter architecture is illustrated by a prototype. The paper ends with a conclusion and prospects for future work.

2. Background and related work

Among many definitions of interoperability, the one provided by IEEE is most commonly used [7]: "*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*" [4] (p. 114). Accordingly, interoperability can be between systems or within a system consisting of subsystems. In the context of strategy and policy implementation, interoperability can be viewed as the ability to translate strategy and policy that are stored in systems into software systems that support operational processes. It concerns the use of ICTs to facilitate the coordination of work and information flows [8]. Such ability is reflected by the agility of strategy and policy implementation, namely the speed, costs and the quality (e.g. compliance) of strategy and policy implementation [3]. In the evaluation of the architecture we will look therefore at these four evaluation criteria:

1. Agility – the speed of implementing new strategy and policy [9];
2. System flexibility – the ability to adjust processes and include new subsystems or components [10];
3. Compliance – meeting the requirement imposed by strategies, policies and regulations on the tasks that are performed by organizations [3]. In essence compliance is about whether strategies, policies and regulations are reflected in operational processes;
4. Implementation costs – upfront costs for creating an executable process [11].

According to Naudet et al. [7], the need for interoperability arises when two or more incompatible systems are placed in relation. Interoperability is often studied from a *technical* perspective (cf. [12]), where different ICT applications are considered to be individual technical systems that require interoperability to connect with each other. Interoperability is often studied from a *semantic* perspective (cf. [8]), where the information exchanged between heterogeneous systems should be meaningful and all the communicating parts should interpret it in the same way. Interoperability has been studied from an *organizational* perspective (cf. [13]), where different departments are thought of as individual sub-organizational systems that require interoperability to cooperate with each other.

In literature several approaches for achieving interoperability have been developed including, standards (e.g. [14]), reference models (e.g. [15]), architectures (e.g. [16]), and frameworks (e.g. [17]) [8]. However, strategy and policy implementation rarely receives attention. General interoperability frameworks like the European Interoperability Framework [17] and INTEROP NOE [15] framework mainly help to identify and structure the knowledge of the domain e.g. "interoperability concerns" (data, services, processes and business) and "interoperability barriers" (conceptual, organizational and technological). Although these frameworks can be used to classify and structure the basic aspects of interoperability, their intent is not to provide working solutions for the implementation of strategies and policies [17]. In strategy implementation interoperability is necessary to translate strategies and policies into executable business processes. In such a situation vertical and horizontal processes are intertwined, as the outcome of vertical processes influences the horizontal processes. This intertwinement is the focus of this research. Interoperability frameworks provide structure of concepts to present problems and knowledge. In this paper we do not propose another interoperability framework but specify an architectural solution with an emphasis on technical and semantic perspective to solve interoperability problem between strategic and operational systems.

Architectural solutions for interoperability are aimed at dealing with system heterogeneity. Heterogeneity is a "double-edged sword". On the one hand, heterogeneity allows the use of technologies that can solve the problem at hand with high efficiency. On the other hand, heterogeneity in data and knowledge systems is obstacle for the interoperation of systems [18]. To find a way out of this dilemma, architectural solution is required to balance heterogeneity and interoperability (e.g. [19]). Heterogeneity can be classified into paradigm heterogeneity (two systems express their knowledge using different modeling paradigms), language heterogeneity (two systems express their knowledge in different representation languages), ontology heterogeneity (two systems make different ontological assumptions about their