Virtual Process Control Modelling in Organisational Semiotics: A Case of Higher Education Admission

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Abstract. This study explores Web-based virtual process control modelling based on organisational semiotics, Web modelling language (WebML), and higher education admission process. Despite some discussions on control activities in the organisational semiotics literature, less attention has been paid to process control modelling in general and Web-based virtual processes in particular. Process controls help to implement required organisational constraints as regulatory norms that enforce established rules, procedures, and standards for meeting intended organisational goals. This study contributes to organisational semiotics research by extending the discourse on control norms to the realm of Web-based virtual process modelling in a real life situation.

Keywords: organisational semiotics · business processes · process control · process modelling · virtual processes ·WebML

1 Introduction

This study draws from the theory of organisational semiotics and Web modelling language (WebML) to model virtual process controls based on a case study of a university's admission process. Business processes consist of related activities performed to achieve organisational goals. Processes can be physical or virtual. Whereas physical processes get performed through direct, co-located interaction between agents, virtual processes remove such direct, physical contacts and replace them with mediated remote interactions [1, 2]. For Web-based virtual processes, activities occur via the Internet [3].

Within the organisational semiotics literature, three forms of activities are discussed, namely substantive, communication and control [4]. While much attention has been paid to substantive norms in business process modelling [3], relatively less research has focused on control norms, especially in virtual environments. Process controls are embedded constraints that serve as conditions for performing related activities [5]. However, the increasing migration of physical activities to virtual environments calls for urgent research attention to virtual process control modelling. Therefore, this study employs organisational semiotics [4] and WebML [5-7] to explore virtual process control modelling in a Web-based higher education admission environment.

The rest of the paper is organised as follows. Section 2 reviews related works on virtual processes, process controls and business process modelling. Section 3 discusses the relevant organisational semiotics models used for the study. Section 4 uses a university's postgraduate admission process as a case study to illustrate a Web-based virtual process model embedded with controls. Section 5 concludes the paper with a discussion on its contribution and recommendations for future research.

2 Related Works

2.1 Virtual Processes

Organisational processes consist of related activities performed to achieve intended goals. Processes can be physical or virtual [2]. Whereas physical processes require direct contact between agents, virtual processes involve remote interaction [2] through a mediating technology such as the Internet. The mediating technology can be manual such the traditional postal system or Web-based. The focus of the current study is on Web-based virtual process.

Process virtualization has begun to receive attention in information systems research. However, the focus has been on theorizing and testing for which activities can or cannot be virtualized. Less attention has been paid to process modelling in general and controls in particular. [1] and [3] are exceptions that focused mainly on substantive activities, hence the focus of this study on process controls.

2.2 Process Control

Organisations institute process controls to ensure that activities are performed in accordance with prescribed norms [8]. For physical processes, controls are recorded in documents and are expected to be enforced by human agents. However, process virtualization offers an opportunity for their automation and delegation of enforcement to machine agents such as the Internet and Web applications. For Web-based information systems, a natural means for enforcing user control is through hyperlink navigation [5]. However, Web-based agents offer opportunities for process control enforcement beyond navigation. The WebML *if condition* notation shown in Fig. 1 offers an opportunity for specifying control activities beyond navigation.

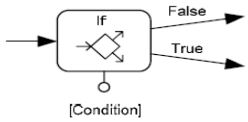


Fig. 1: If Condition Notation [5]

The *if condition* notation determines what can or cannot be done following a true/false conditional result [5]. Control norm has been extensively discussed in the organisational semiotics literature but less attention has been paid to its modelling.

Therefore the *if condition* notation offers an opportunity for control modelling as discussed in Section 4.

2.3 Business Process Modelling

Business process modelling involves the use of symbolic notations to represent organisational activities and their relationships, often in a graphical format [9]. A typical business process model graphically displays related activities and related controls [10]. Process models therefore graphically display activities and their dependencies to define order of relationships [1].

By using symbolic notations and graphical display, business process models help to communicate and provide knowledge on existing or planned organisational activities and their relationships [9]. Business process modelling is therefore expected to be a significant precursor to any business improvement initiative. In line with this expectation, this study employs organisational semiotics and WebML symbolic notations for process control modelling to support process improvement in a higher education admission system.

3 Organisational Semiotics

Semiotics refers to the doctrine of signs and their interpretations [11]. Based on this perspective, organisational semiotics views organisations as information systems where agents create and use signs to perform purposeful activities [4] that are controlled by norms [11]. Business processes are conceived as behavioural activities controlled by norms as rules and regulations that determine which activities are permitted, mandated or prohibited [4, 12] and which agents can or cannot perform such activities [13]. This study draws from three organisational semiotics models: organisational onion, organisational morphology, and norm analysis method.

3.1 Organisational Onion

Organisational onion considers activities as a taxonomy of norms classified into three layers of informal, formal and technical [4] as shown in Fig.3.

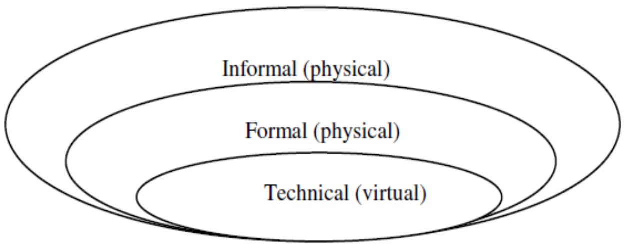


Fig. 3. The organisational onion [4]

Informal norms such as cultural values are implicit and thus not expressly documented. However, formal norms constitute documented bureaucratic procedures and guidelines. Finally, technical norms are formal norms that have been digitalized as part of computer-based systems. The three layers are however not distinct. The technical is part of the formal, which together with the informal form part of the total organisation [4]. Norms can also be transformed from one layer to another. Thus, informal norms can be documented to become formal, while formal norms can be computerized or virtualized to become technical. In this study, the technical layer constitutes the virtual environment. Therefore, process virtualization refers to transforming physical processes from the formal and informal layers into virtual processes in the technical layer.

3.2 Organisational Morphology

Organisational morphology adopts a functional view of norms and classifies them into substantive, communication and control [11, 12, 14]. First, substantive norms govern the core activities performed to achieve the basic organisational goals. Second, communication norms concern the passing of messages between agents, such as reminders, inquiries, announcements and orders concerning facts, procedures and instructions. Finally, control procedures are meant to monitor and regulate substantive and communication activities based on expected standards, values or conventions. Control activities may also sanction, reward or punish agents. As shown in Fig. 4, each of the three activities can be further extended into sub-activities following a nested tree structure.

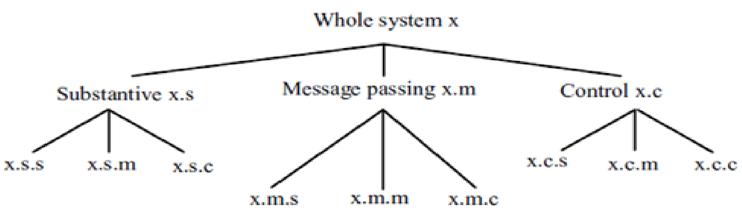


Fig. 4. Organisational Morphology [11]

The level of detail however depends on the context of the organisation or process [11]. Traditionally, all the three types of activities were performed through direct, physical interactions. However, in the modern digital economic environment, some of these activities are being migrated online as virtual activities. As noted above, [3] focused on modelling the virtualization of substantive activities but paid less attention to control norms. The current study therefore focuses on virtualizing control activities as demonstrated below.

3.3 Norm Analysis Method

Norm analysis method [12] helps to capture details of essential norms for specifying information needs [11]. The basic format for behavioural norm specification is as follows:

> **whenever** *〈context〉* **if** *〈condition〉* **then** *〈agent〉* **is** *〈deontic operator〉* **to** *〈action〉*

In order to accommodate process specification and their dependencies, [3] extended the basic format to include predecessor and successor activities as follows:

> *〈predecessor〉 〈basic norm format〉 〈successor〉*

However, their extended model focused mainly on substantive activities and not on communication and control activities. While the basic norm structure is considered sufficient for communication activity, the current study further extends it for control activities with an **else** clause as follows.

> ***whenever*** *〈condition〉* ***if*** *〈state〉* ***then*** *〈agent〉* ***is*** *〈deontic operator〉****to*** *〈substantive/communication norm〉* ***else*** *〈control norm〉*

This extended norm structure was used to define the specification for control norms of the virtual admission process in Table 1 below.

4 Case Study: Virtual Admission Control Modelling

The study is based on the postgraduate admission process of the University of Ghana. University of Ghana was established in 1948 and remains one of the oldest and leading universities in Africa. In 2011, the first author initiated an action case study to virtualize the existing postgraduate admission process. In 2013, the system was extended to include process control. The current study is an extension [3], which focused mainly on process modelling without controls. This study extends the virtual process modelling to include control norms. System and user specifications were elicited by the author through participant observation, interviews, meetings, and focus group discussions with stakeholders.

4.1 Norm Specification

The admission process involves applicants completing online forms, uploading supporting documents and submitting them online. The web application then invites referees for reference reports. Once the references have been received, relevant departments assess each application and select recommend successful ones for admission subject to general requirements and vacancy. The admission office then vets all selected applicants based on the university requirements and notify them of the outcome. Informing the applicants ends the admission process. Decision to enrol forms part of the registration process.

With control norm specification architecture introduced in Section 3.3, Table 1 presents specifications for the substantive, communication and control norms identified from the case study.

Table 1. Norm Specification for Virtual Admission Process with Controls

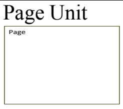
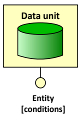
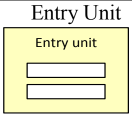
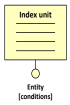
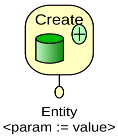
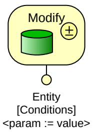
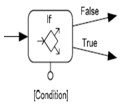
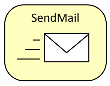
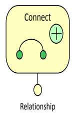
Activity	Predecessor	Specification	Norm Type	Successor
Application	<open admission>	**WHENEVER** <Admission is open> **IF** <applicant likes a programme on offer> **THEN** <applicant> **IS** <may> **To** <select the programme> and < complete the online form>and <submit the online form>	Substantive	Reference request
Reference request	Application	***WHENEVER*** *<applicant submits a form>* ***THEN*** *<Web-based admission system>* ***IS*** *<should>* ***TO*** *<request for references>*	Communication	Reference submission
Reference submission	Reference request	***WHENEVER*** *<a reference report is received>* ***IF*** <All required references are received> ***THEN*** *< Web-based admission system>* ***IS*** *<should>* ***TO*** *<link references to relevant application>* ***ELSE*** ***<****keep application on hold>*	Substantive .control	Selection
Selection	Reference submission	***WHENEVER*** *<department accesses an application>* ***IF*** *<if applicant qualifies>* ***THEN*** *<Department Head>* ***IS*** *<should>* ***TO*** *<select applicant>* ***ELSE*** *<reject applicant> AND <inform rejected application>*	Substantive .control	Vetting
Vetting	Selection	***WHENEVER*** *<applicant is selected by department>* ***THEN*** *<Admission office>* ***IS*** *<should>* ***TO*** *<vet selected application>*	Substantive	Admission
Admission	Vetting	***WHENEVER*** *<application is vetted>* ***IF****<if applicant meets all department and university requirements>* ***THEN*** *<admission officer>* ***IS*** *<should>* ***TO*** *<admit applicant>and<submit admission letter>* ***ELSE****<reject application>AND<inform applicant and relevant department>*	Substantive .control .communication	<enrolment>

4.2 WebML Notations

WebML [7, 15] is a visual modelling language that supports data and process driven web application design and development [5]. It supports both data and hypertext modelling. This study however focuses on the hypertext model to illustrate the implementation of virtual process control based on substantive, communication and control norms. Table 2 shows relevant WebML notations for this study categorised into content, operation and navigation units.

Content units publish or accept data and therefore appear on web page. However, operation units manipulate or send data/information as backend activities. Such units do not therefore appear on web pages. Arrows are used to indicate links. While content units publish or accept data and are therefore displayed on webpages to be manipulated by human agents, operation units are hidden activities that are performed by machine agents.

Table 2. Relevant WebML Notations

Content Units				
Page Unit	Data Unit	Entry Unit	List Unit	Navigation link
				
Control Units				
Create Unit	Modify Unit	If Unit	Communication Unit	Link Unit
				

For detailed explanation and other notations see [7, 15]. In the next section, the *create* and *modify units* are used to implement substantive activities; the *If unit* and the *communication unit* are used to implement control and communication activities respectively. The content units are useful for accepting/publishing data on web pages. The *navigation unit* can be used to show direction as well as message passing.

4.3 Hypertext Model

WebML notations were used for the hypertext modelling of the virtual admission process control system. Fig. 4 presents the model and illustrates an instance of the application life cycle through the virtual environment based on the norm specifications for process controls shown in Table 1 and the hypertext notations in Table 2.

As shown in Fig. 4, the admission process begins when an applicant visits the application page to view the lists of available programmes presented by the selection programmes *index unit.* Once a programme is selected, the applicant proceeds to complete the online application form and upload all supporting documents through the submit application *data entry unit* on the application page.

An instance of the application is then created as represented by the *create unit.* The system also invites referees to present reports on the application. After which the system informs the relevant department to assess the application. Once the application is created, the system sends e-mail to referees requesting them to submit their reports. Referees then access the reference forms to complete the reports which are then linked to the application.

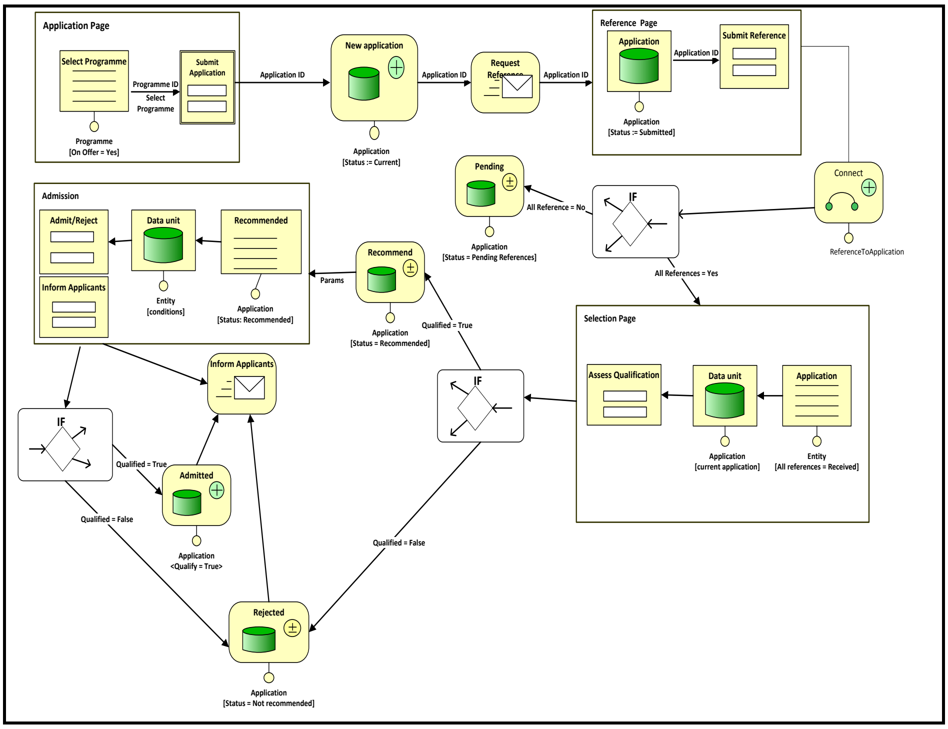


Fig. 4: Hypertext Model for Virtual Process Control

Following the implementation of the virtual admission process with embedded controls, the university's post-graduate admission process has become more efficient and responsive. Before the virtualization of the process controls, the enforcement of the controls were executed manually by human agents. However, by embedding them in the Web-based admission system, the responsibility has been transferred from human to machine agents, which are more efficient at ensuring compliance and enforcing conditions in the virtual process. Previous situations that relied on human memory often resulted in errors and failures to check the controls. However, the machine agent compliance is generally assured once the system has been tried and tested.

4 Conclusion

This study employed organisational semiotics and WebML for virtual process control modelling. The study contributes to organisational semiotics research, which has so far focused more on substantive norm modelling and less control norm modelling. Following [3], who employed organisational semiotics and WebML notations to propose a semiotic-based process specification architecture for substantive norms in virtual environments, the current paper extends the architecture to include an *if…then…else* clause that caters for control norm specification.

This study demonstrates the applicability of organisational semiotics and WebML notations to virtual process with control modelling. The resultant model demonstrates how control norms can be implemented in organisational semiotics to enforce norm-based conditions in Web information systems. In terms of contribution to practice, the proposed approach can be applied to organisational domains where process controls are critical such as in hospitals, logistics and inventory management.

A key limitation of the study is the idiosyncratic nature of virtual process control across institutions and contexts. The proposed model is therefore expected to be adapted to rather than adopted for specific contexts. Future research can extend the model beyond the higher education admission context to other process control-based domains such as banking, accounting and health systems.

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