Petri Net Model for Knowledge-Based Value Chain

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Abstract. In this paper a novel theoretical model is presented in which the dynamics in a knowledge-based value chain is modeled using Petri nets. From the generic scheme of a knowledge-based value chain, the various components are individually modeled. The theory of Petri nets aptly captures the evolution of knowledge in a system and the process is usually highly interactive in nature. The properties and analysis methods of various classes of Petri nets can be conveniently used to check various constraints while designing the system.

Keywords: Knowledge-Based System; Value Chain; Petri Nets.

1 Introduction

Technologies such as the intranets [1], extranets, and groupware have facilitated extensive knowledge transfer in the e-world. Knowledge portals play a key role in knowledge transfer. Various theoretical frameworks [3, 5] have been proposed for the modelling and analysis of knowledge-based systems. Theoretical approaches are popular in the context of semantic web [7] and digital library [2] also.

Various classes and numerous variants of Petri nets [6, 8] have been used to model supply chains, and other processes. In this paper, some of the general ideas and techniques are adopted to model the generic knowledge-based value chain, which is henceforth referred to as the "system".

In Section 2, some essential definitions are recalled and the schematic diagram of a generic knowledge-based value chain is presented. In Section 3, the modelling of individual components of the system is done using Petri nets. Section 4 presents some further directions for research. Section 5 concludes this paper.

2 Knowledge-Based Value Chain

A comprehensive discussion of the concepts of value chains, knowledge transfer, and related concepts can be found in [4]. The following definition provides a suitable starting point.

Definition 1: A value chain is a way of organizing the primary and secondary activities of a business so that each activity provides productivity to the total operation of the business.

The formal definition [6] of a Place-Transition (PT) net is recalled in brief.

K. Shah, V.R. Lakshmi Gorty, and A. Phirke (Eds.): ICTSM 2011, CCIS 145, pp. 292–296, 2011.

Definition 2: A PT net is a 5-tuple $N=\{P, T, I, I^+, M_0\}$ where P is a nonempty set of places, T is a nonempty set of transitions, $I, I^+: P\times T\rightarrow N_0$ are the backward and forward incidence functions, and M_0 is the initial marking. Tokens capture any quantity that flows in the system. A transition is enabled only when at least as many tokens as given by the arc weight are located on that place. Firing will destroy exactly this many tokens from that place and create in the receiving place as many number of tokens as given by the weight on the arc from the transition to the next place.

In any system, especially with respect to business, raw materials are taken as inputs. Value is added at each stage of processing. Then, the output is sold to the customers. The knowledge-based value chain is a useful way of looking at an organization's knowledge activities and at how various knowledge exchanges add value to adjacent activities and to the company in general. The schematic picture of a generic knowledge-based value chain [4] is given in figure 1.

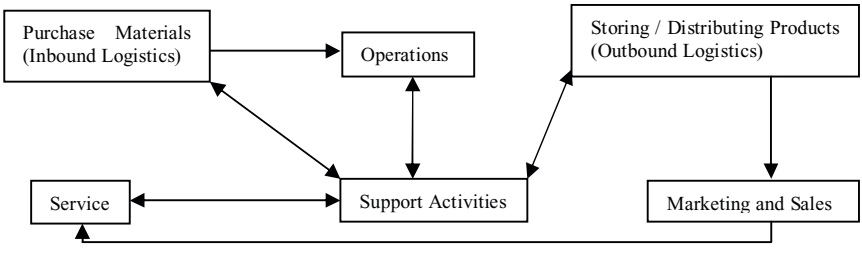

Fig. 1. A generic knowledge-based value chain

The knowledge in the system is abstracted by tokens and the flow is described by a firing sequence. In figure 1, the inbound logistics is marked initially. It is to be noted that the support activities are very "interactive" components of the system and consequently enhance the connectivity in the system. These may themselves be composed of subsystems like infrastructure, resources, and other technology [9].

3 Petri Nets for Individual Components

3.1 Inbound Logistics

The inbound logistics serves as the starting point which can be marked initially. For simplicity of modelling, the influx of raw materials is denoted by a single token which is present in this place initially. If more details are available from the system design, the generation of tokens and also the weights on the arcs can be accordingly varied. For instance, it may well be considered as a source element with respect to the system in which case the PT net of the inbound logistics cannot be both live and bounded [6].

Here, the n sources of input are denoted by n places of the PT net. If a certain quantity of some raw material is required, the constraint can be incorporated in the weights on the arcs. Also, the places may take feedback from other components, especially the support activities.