Chapter 22
An Optimal Control Problem of Knowledge Dissemination

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ABSTRACT

In this chapter, the authors develop an optimal control model of knowledge dissemination among people in the society. The knowledge transfer system is formulated in term of compartmental model, where the society members are categorized into four classes based on knowledge acquisition and their willingness to disseminate. The model is equipped with a set of control variables for process intervening, namely technical training for ignorant-immigrants, information dissemination through social media for solitari-ants and enthusiants, and technical training for solitariants. Optimality conditions in terms of differential equations system was derived by using Pontryagin minimum principle leading to the characterization of optimal control strategies that minimizing the number of solitariants, enthusiants, and ignorants simultaneously with the control efforts. The sweep method and the fourth order Runge-Kutta algorithm was implemented to numerically solve the equation systems. The effectiveness of the control strategies toward a set of control scenarios was evaluated through examples.

INTRODUCTION

Knowledge management is a framework to maximize the value and application of knowledge. It refers to a multidisciplinary approach to achieve the objective of organization by making the best use of knowledge in distributing and sharing. As a part of knowledge management system, knowledge dissemination (also known as knowledge transfer or knowledge exchange) plays crucial roles in ensuring the availability of

knowledge to those who may need it. Knowledge dissemination can be as simple as posting a news into social media, or it can be a time-consuming activity such as seminar and training. The right pathway for knowledge dissemination can be decided according to the format of knowledge, the user, the speed of change, and the speed of sharing. Milton's approach in classification of systems for capturing and disseminating knowledge includes formal-informal dimension on how supply of knowledge to users is conducted in either structured format or conversational text, as well as connect-collect dimension on how knowledge is recorded or communicated (Milton, 2010). The pros and cons of knowledge dissemination systems within each of Milton's four quadrants of learning approaches was highlighted by Kingston (2012). Four knowledge dissemination techniques were also examined in this report: informal-connect, formal-connect, informal-collect, and formal-collect. Communities of practice can be seen as an informal-connect approach in term of conversation among those who need knowledge and those who have knowledge. Formal-connect approach includes knowledge portals in information technology systems. Knowledge codification as a formal-collect strategy can be conducted by revealing additional indexing features of knowledge. While mentoring and training can be treated as either informal-connect or formal-connect.

A number of qualitative and quantitative models have been developed to describe various aspects of knowledge dissemination in knowledge-based organizations, with or without intervention (see for instance, Kelliher et al. (2010), Chen et al. (2014), Su et al. (2018), Li et al. (2017), and Liu et al. (2017)). In the field of operation and supply chain management, it has been identified opportunities and challenges of knowledge creation and dissemination for the future development. A review of the major developments during the past 25 years has been conducted and ways to accelerate some of them have been proposed (Roth et al, 2016).

Knowledge dissemination intervention can be defined as an active intervention to communicate information, data, or knowledge to a target audience through certain channels, using designed strategies such that it creates a positive impact on the acquisition of knowledge, attitudes, and practice (Lafrenière et al. 2013). A number of researchers in community empowerment have proposed different knowledge dissemination techniques. Some of these studies have demonstrated the success of intervention strategies using various media including audio-visual aids. Bell et al. (2005) introduced a knowledge dissemination model in education of Tanzanian smallholder farmers about mastitis in their dairy cattle. The effectiveness of interventions in the forms of diagrammatic handout, video, and village meeting (and their combinations) were evaluated against a control group of no intervention. Analysis using generalized linear mixed models suggested that all five interventions are more effective than no intervention.

Motivated by the same urges, this chapter aims at developing a dynamical intervention model of knowledge dissemination in a society. The authors adopt an approach generally used in epidemiological model by classifying society members into four different compartments based on knowledge acquisition and the willingness to share. To assess the effectiveness of the intervention strategies, the model is formulated in an optimal control problem. Therefore, it enables us to characterize the optimal intervention strategies in term of model variables and parameters.

The rest of this chapter is organized as follows. In Section 2 the authors overview some previous works carried out by other researchers, especially those relate to knowledge dissemination model and mathematical models of information transfer. Compartmental model of knowledge dissemination as well as its optimal control version proposed by the authors are respectively presented in Section 3 and Section 4. In Section 5, an example is pointed out to illustrate the effectiveness of control strategy. The authors conclude in Section 6.

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