Logistics Technology Transfer Model (LTTM)

Abdullah Said Al Hajri and Maruf Hasan

School of Mechanical and Manufacturing Engineering

University of New South Wales

z3115638@student.unsw.edu.au

ABSTRACT

This paper gives an integrative model for the transferring of logistics technology into organizations. There are three versions of this model; two for organizational technology and one for inter-organizational technology. The study makes use of previous innovation-diffusion models along with adoption and implementation studies of logistics in literature. Also, the study looks at other relevant empirical studies in logistics (questionnaires and case studies) in order to draw sufficient understanding of logistics technology and to help in forming the constructs for the integrative model. This study contributes to theory with four things. First, it decomposes the adoption stage into three sub stages. Second, it introduces the cyclical effect to the historical stage models. Third, it gives new definitions for the stages in the stage model based on current empirical studies and Lewin-Schein Theory of Change. Fourth, it gives an inter-organizational logistics technology transfer model.

Keywords: Logistics technology, stage models, diffusion theory, change management, Lewin-Schein Theory.

INTRODUCTION

Despite the existence of stage models sufficient time ago, there is still high rate of failure and uncertainty with the adoption and implementation of logistics technology. A survey of some of the famous stage models in literature shows essential differences as well as distinctive features among them (see table 1). Briefly, Thomson's (1969) model, which is composed of initiation; adoption; and implementation, is considered a first step in the stage models. Thomson's model captures the overall picture of technology transfer, but it can't be used solely to guide the technology transfer efforts as it overlooks the importance of some pre-adoption and post-adoption evaluation processes. Therefore, subsequent stage models came into existence to shed light on these processes. Kwon and Zmud's model (1987) gives more emphasis for post adoption stages as they were decomposed into four stages namely, adaptation, acceptance, routinization and infusion. Infusion is a distinctive feature in their model which reflects advanced incorporation enabling deeper and more comprehensive embedding of an innovation within an organization's operational and/or managerial work systems beyond routinization (Zmud and Apple, 1992). However, Zmud's model kept pre adoption stages unchanged and condensed implementation and tailoring into one stage namely, adaptation. Roger's model (2003)**,** on the other hand, explores the area of fit between task characteristics and technology characteristics by imposing two stages for this purpose in his model (matching and redefining/restructuring). From another point, Roger's model treated the basic adoption stage as one point in time decision and also his model doesn't include an explicit implementation stage. Zaltman et al (1993) explored the issue of sustainability of implementation in his model. Still, Zaltman's model underestimated the importance of adoption stage as it is condensed in a decision sub stage. Finally, Sheirer's model (1983) is distinctive with the assessment of outcomes and diffusion of information stages. Despite this, Sheirer's model didn't raise the issue that technology should match specified tasks in the organization or vice versa. Also, this model can't be applied to logistics technology as the development of the technology is achieved after a positive adoption decision is made. Overall, the current stages used in these models were derived using case studies and questionnaires of pre

and post adoption processes in companies transferring technologies. As more case studies examining various kinds of organizations and surveys asking researching questions from different angles, the more facts and significant observations about the innovation process are gathered and disseminated. Therefore, a continuous refinement of stage models is needed.

Table 1: Stage models

Authors							
Thomson (1969)	Initiation		Adoption	Implementation			
Rogers (2003)	Agenda-setting	Matching		Redefining restructuring	Clarifying	Routinizing	
Kwon & Zmud (1987)	Initiation		Adoption	Adaptation	Acceptance	Routinization	Infusion
Zaltman (1993)	Knowledge-awareness	Formation of attitudes	Decision	Initial implementation	Continued-sustained implementation		
Sheirer (1983)	Basic research	Technology development and testing	Diffusion of information	Adoption	Implementation	Assessment of outcomes	Routinization

Based on the above, this paper attempts to advance our thoughts about technology transfer process by introducing new concepts as well as new definitions to stage theory. In addition, the paper strives to maximize the chance of successful adoption and implementation of logistics technology by unifying the transferring processes of the different logistics technologies under one model namely, the logistics technology transfer model (LTTM). The subsequent analysis of this paper is divided into two sections; model development and summary.

MODEL DEVELOPMENT

Problems encountered during the transferring of logistics technologies

According to Downs and Mohr (1976), it may not be possible to develop one model for all logistics technology and that a unitary theory of innovations may not exist. This is because determinants important for one innovation are not necessarily important for others. Tornatzky and Klein (1982) contradicted this point by stating that in the context of a relatively homogeneous array of innovations, it is possible to get a unitary theory of innovations. In a first glance, it may seem that these two statements actually contradict each other. However, a point of agreement can be found in that a detailed unitary theory of innovations may not work for all innovations, because each technology will have characteristics that are specific to it and characteristics common to others. Therefore, a unitary theory of innovation should be generic enough to preserve technology-specific characteristics from being violated yet detailed enough to capture the common characteristics for a homogeneous array of innovations. This statement can be strengthened by the existence of Thomson's model and Lewin-Schein theory of change, which haven't been violated till date. Following this, a survey of literature pertaining to case studies and surveys in logistics technology was performed. The objective, among other things, was to look for problems encountered during the transferring process and rate their commonality. Then, solutions for these problems will be used to refine the model and close potential gaps. Six logistics technologies were used; MRP (Material Requirement Planning), MRPII (Manufacturing Resource Planning), ERP (Enterprise Resource Planning), EDI (Electronic Data Interchange), VMI (Vendor Managed Inventory), and ECR (Efficient Consumer Response). An in-depth analysis of literature pertaining to these technologies revealed 21 problems during the different stages of the technology transfer process. According to their frequency, the problems were divided into four sets. In the first, five problems were found to be common among all the technologies. These problems are lack of understanding of logistics technology, lack of education and training of personnel, organizational resistance, lack of effective project management and lack of suitable hardware and software. In the second set, four problems were found to be common among organizational technologies. These are lack of top management support, lack of

expertise, data accuracy, and lack of support from vender. The third set contains two problems that are common to inter-organizational technologies. These are inappropriate/inaccurate performance and cost measures and loss of control of key products. The last set contains problems that are specific to each technology. A thorough analysis for each of the above problems was performed in order to capture interrelatedness of the problems and to find solutions for them. Because of their importance, solutions for problems in the first set must be shown explicitly in the stage model. For example, Lack of suitable hardware and software necessitate the existence of an explicit selection stage. Therefore, the above analysis is also aimed to showing the least obligatory stages that should be shown in the logistics technology transfer model (LTTM).

The Cyclical Nature of Stage Model

The current version of stage models is that the stages or processes are depicted along a straight line. Inferring from the analysis of Van De Ven and Poole (1995)'s article about explaining development and change in Organizations, we found that the unit of change is actually the working system and it's single. The working system is in the rules used to perform the job and in the minds of employees in their routine. The technology used is part of the working system. So every time a technology, a rule or a program being adopted and implemented, this will change the same unit (the working system) either partially or fully. Therefore, once the working system has been routinized, an inconsistency or need will exist after some time which will trigger a whole process of stage model. This process will be started from the beginning in order to accommodate newer ideas or newer technologies. Therefore, initiation is derived from the previously routinized working system.

Kwon and Zmud's Model (1987) have the feature of infusion stage in their model. While routinization was defined as the permanent adjustment of an organization's governance system (e.g. its administrative infrastructure) to account for the incorporation of these technological innovations, infusion was defined as the elaborated or advanced incorporation enabling the deeper

and more comprehensive embedding of an innovation within an organization's operational and/or managerial work systems (Zmud and Apple, 1992). This analysis leads to the conclusion that having an infusion stage after the routinization stage would extremely underestimate the importance of processes under this stage. In other words, in order to achieve infusion, a need will have to be recognized, then a match will have to be found and after that an adoption process will have to be performed. This will lead to another innovation process being made. Thus, a natural move or extension after routinization stage is to the initiation stage. Therefore, if a company decided to go to a higher level of diffusion of the current technology, then it will have to go back to the beginning of the process of stage model (initiation) and perform the whole innovation process till routinization. By this, infusion process will not be underestimated, though it still exists.

Decomposition of Adoption stage

The discussion of past models suggested that adoption stage hasn't been decomposed. The process of decomposition is extremely important to decide on the processes that go under each general stage. In addition, this process helps in reducing uncertainties and moves the stage model toward the maximum possible standardized form of innovation process where uncertainty is almost eliminated. The effect of adoption process on subsequent implementation processes and final success of the project received very limited attention in literature. Frohlich (1998) discussed the effect of adoption strategies on the adaptation stage of Kwon and Zmud's Model. In his study, he listed three basic strategies of "learning before doing" that companies undertake when adopting Advanced Manufacturing Technology (AMT) namely, prototype learning, simulation learning and vicarious learning. Using a list of problems faced during implementation of AMTs, he tested the "learning before doing" strategies to see which one's significantly reduced those problems. It can be deduced from this analysis the existence of one sub stage under the adoption process which is Strategies of learning before doing or adoption strategies.

Another stream of study which has been indirectly discussing processes of adoption is the study of adoption factors. This is different from adoption strategies. Adoption factors' studies discuss the significant set of predictors that have a direct effect on the adoption decision. Some examples of adoption factors' studies are Williams (1994), Iskander et al (2001), Schroeder et al. (1981), Kimberly and Evanisko (1981) and Soliman and Janz (2004). Therefore, we have now another sub stage of adoption process, which is the sub stage of adoption factors. A final sub stage that is considered the product of the adoption process is the decision sub stage. This stage is already confirmed by previous literature of innovation theory (Zaltman et al, 1993).

Lewin-Schein Theory of Change

Some of the models in table 1 were developed on Lewin's change model (1952) which consists of unfreezing, change, and refreezing. The change model asserts that organization needs to be unfreezed before accommodating any change so that resistance will be reduced. Using White's paper (1980), Schein suggests three mechanisms that may produce unfreezing. The first is lack of confirmation or disconfirmation which means that the individual either receives no feedback or a negative one. The second one is the induction of guilt anxiety which means the sense of failure. The third one is the creation of psychological safety by reduction of threat or failure or removal of barriers. Among the steps that the author found to fall in the unfreezing stage of MRP implementation are 1) catalysts or needs which suggest the desirability of MRP system, 2) a task force is established, 3) the extent of top management support is evaluated and 4) a decision is made to implement an MRP system. Given the stage model, this analysis suggests that pre adoption and adoption stages form the unfreezing stage of change model. The change stage, according to the author, is the education/training and installation/implementation stage. Finally, the refreezing stage contains two mechanisms which are "integrating new responses into the personality" and "into ongoing relationships". This obviously matches with acceptance and routinization in the stage models. According to Kwon and Zmud's model (1987), the unfreezing

stage is represented by the initiation stage, change stage is represented by adoption & adaptation, and refreezing stage is represented by acceptance, routinization and infusion stages. Using White's paper, the unfreezing stage in Zmud's model should cover initiation and adoption. Change stage should match with the adaptation stage. White (1980) asserts that the most important stage in the change model is the unfreezing stage because without a "felt need" a change cannot occur. Therefore, it is important to look at pre adoption and adoption stages more closely in order to make sure that unfreezing was totally achieved. For this part, the logistics technology transfer model (LTTM) gives another definition for these stages that better match with Lewin-Schein's model.

Logistics Technology Transfer Model (LTTM)

The developed model aimed at reducing the inconsistencies observed from past stage models presented in table 1. Also, it aimed at explaining for management the potential stages it will go through. It is possible that one organization might not need to go through each and every stage. For example, the redefining/restructuring stage. For this, the technology and organization may not need to be reconfigured as they naturally match. However, if needed, then management won't be misled. Another issue that this model resolves is the time horizon of the project. A problem that has been cited in literature is the lack of a reliable time horizon of the project. Sometimes, it's too short and sometimes it's too long. Revealing all the potential stages and sub stages that a project will go through, gives a better estimate of the time needed to finish the project. Although, lack of education and training and lack of effective project management were often cited in literature as serious problems, they haven't been incorporated in the stage model. Our previous analysis in the problems encountered section shed light on the seriousness of these issues. Therefore, a least thing that a stage model should present is a link to those two factors. A

second step in this direction is to show the constructs and sub-constructs of effective education and project management.

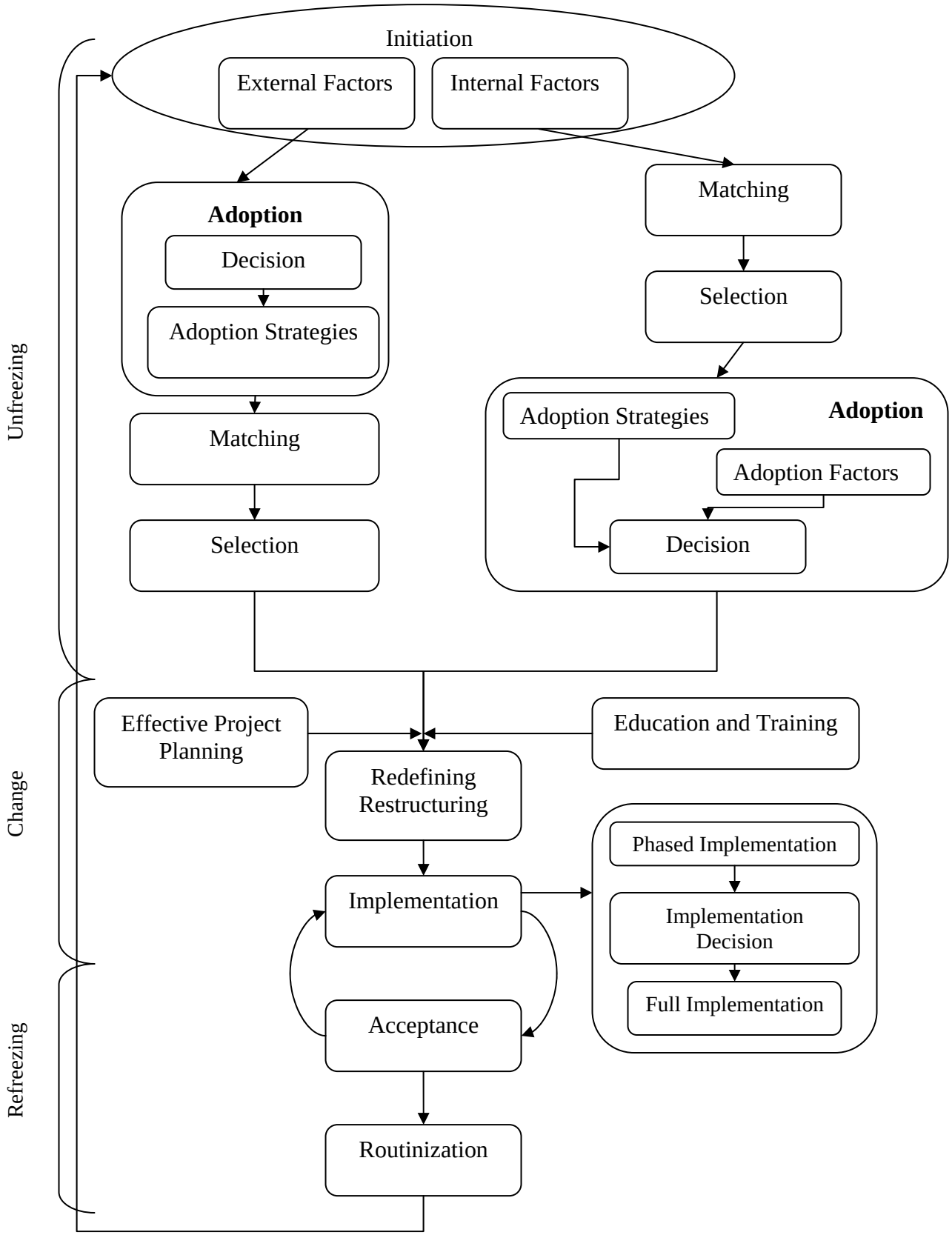

Figure 1: Logistics Technology Transfer Model (LTTM)

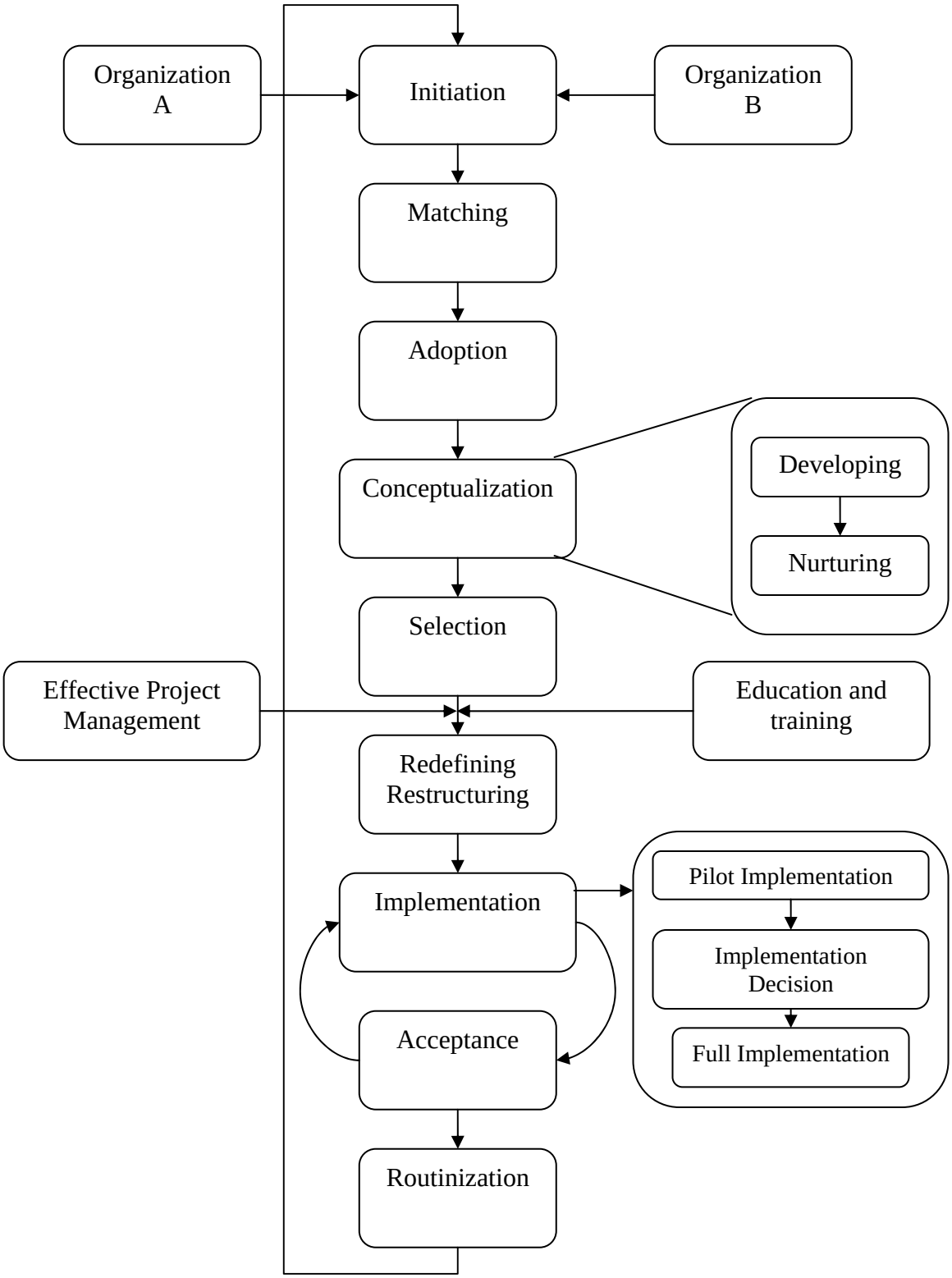

Figure 2: Inter-organizational Logistics Technology Transfer Model

Three versions of logistics technology transfer model were developed. The first two, as shown in figure 1, refer to organizational technology. The third version is for the inter-organizational technology (figure 2). Historical stage models, when developed, were based on organizational context. The LTTM model looks at both contexts; the organizational and inter-organizational. In figure 1, organizational technology transfer process can be initiated by either of two different situations; internal factor and external factor. In the internal factor situation, the organization internally identifies needs and inconsistencies in the working system which inhibit further improvement and development. Therefore, the organization searches for solution(s) to these problems. Through a matching process, a set of some or all of these problems is found to be solved by a technological change. In external factor situation, a logistics technology becomes so famous that each company plans to get it. The need for this technology is initiated by external factors to the company such as competition or an order from headquarters to adopt the technology. As a response to such factors, top management decides to adopt the technology in the organization. In figure 2, either of two situations occurs; equal power situation or unequal power situation. In equal power situation, the same procedure occurs as the internal factor situation except that there are two companies in here and both initiate the process simultaneously (Holmstrom, 1998). In unequal power situation, one company tends to have more power over the other (Kurnia and Johnston, 2003, Williams, 1994). As a result, the powerful company tends to force its adoption decision on the other company.

The product of the initiation process depends on the way it is initiated. In internal factor and equal power situations, the product of the process is a list of needs assessment, which will be used later in the matching process. In external factor and unequal power situations, the product of the initiation process is a decision to adopt. From a practical point of view, in unequal power situation, the company might lose business with the powerful company if it refused to adopt the technology and it might or might not have time to do a quick matching process.

The matching process differs accordingly, but it is crucial that each company goes through this process as it achieves four essential benefits.

- To facilitate unfreezing the working system.
- To gain a strong argument to get a positive adoption decision.
- To increase the chance of successful implementation of the technology.
- To have a reliable time horizon for the project.

For internal factor and equal power situations, the process takes the list of needs from the needs assessment exercise in the initiation process and attempts to find solution(s) for them. It is expected that one solution will not fully satisfy all the needs and that this solution may need to be adjusted to maximize the number of needs satisfied. Also, the places in the organization where the needs exist may need to be altered to have the least clash with the solution. Therefore, the matching process should reliably differentiate those pairs (need-solution) which are naturally satisfied from those that require adjustment. This process can be used to ease the job of redefining/restructuring in LTTM. Matching in the external factor and unequal power situations, on the other hand, requires that the already known technology be matched with existing needs and problems in the working system. Matching and selection processes fall into the unfreezing process regardless if they appear before or after the adoption process. Their location depends on the initiation process. Selection process needs to be shown explicitly in the model as it solves the problems of lack of suitable hardware and software and lack of vendor support. The implementation stage is divided into two separate stages; restructuring/redefining and implementation. Restructuring/redefining is the same stage as the one in Roger's Model (2003). Several of current technology transferring processes required some changes be done either in the technology or the organization. There is a wide range of options available for technology changes especially in ERP (Brehm et al, 2001). Also, there is a significant amount of changes which could be done to the organization such as business process reengineering. An important

observation from literature is that several companies are hesitant to perform the required changes or may not know how (Kulunda, 2000 and Hong and Kim, 2002). Therefore and in order to turn the attention of management to the importance of this step, a separate stage was devoted to it. The implementation stage involves actual implementation or installation of the technology. During this stage, three sub stages were often cited in literature namely, pilot or phased implementation, final implementation decision, and full implementation. Phased implementation tends to occur in organizational logistics technology such as ERP and MRP while pilot implementation occurs in inter-organizational logistics technology such as EDI and Vendor Managed Inventory (VMI). In these implementations, partial implementation is performed and evaluated. Problems arise are reported and solved using effective feedback system. In the second sub stage, the previous process is evaluated. If things went smoothly a final implementation decision is given to perform final implementation otherwise the technology transfer process stops in here. In the final full implementation sub stage, implementation for other departments and/or products is carried out. The process of acceptance stage goes hand in hand with implementation. As the technology is implemented, user resistance or acceptance is reported along with the implementation problems. Further acceptance of the system is enhanced and increased as the system is diffused among larger group of users. Four factors are hypothesized here to affect the acceptance of the users. These are users' awareness of the need to change, participation in change, communication of the change among users, and amount of education and training received by the users. Routinization is the time when the change in the working system becomes a routine or a normal activity. Naturally, routinization is achieved after acceptance of change spreads among users. Not all technology transfer efforts reach this high level of success or routinization. Two problems might occur right before routinization stage; an incomplete acceptance of the change or unsatisfied needs (lack of conformation or disconfirmation). Both of these two problems affect the refreezing stage. The first problem indicates a lack in one or more of the four factors of acceptance. The second problem indicates that users are not getting the

expected positive feedback from the new technology. This might lead the users to revert back to the old system. Therefore, it is important to eliminate the possibility of returning back to the old system and equally important to open a channel for effective feedback to solve problems of disconfirmation. As was explained earlier in the cyclical nature section is that after some time of using the current technology, one of two situations might happen; internal factor/equal power situation or external factor/unequal power situation. This will result in another technology transfer process. The change doesn't have to affect all the working system of the organization. It could be partial. Conceptualization stage in the inter-organizational LTTM is the stage where both companies get to know how the technology will precisely benefit each other and it is there where a common vision of the technology and how it will be implemented will be developed. Dorling et al. (2005) developed a framework for inter-organizational VMI relationship that consists of assessing, developing and nurturing. I took developing and nurturing from their framework and consider them as sub constructs of conceptualization. According to Dorling, developing involves building a shared vision and adopting a win-win attitude where benefits are shared between the organizations. In addition, the developing sub stage involves determining the minimal information required to implement the technology. The nurturing involves establishing confidentiality boundaries, developing respect for each other and ensuring that there is an ongoing trust.

SUMMARY

This research adds to literature of stage models with a logistics technology transfer model. The model aimed at unifying the necessary stages that should appear in the model and by this way rectifying the fragmented models in literature. In order to achieve this, the study utilized the problems encountered during the transferring of logistics technology which were reported in logistics empirical studies along with Lewin-Schein

Theory of change. Further, the study used a practical way for formulating the different scenarios expected when an organization plans to transfer logistics technology.

Through Lewin-Schein Theory of change, the study divided the model into the unfreezing, change, and refreezing stages. By this way, it will be easier for management to direct the required efforts at the right time in order to ensure smooth and successful transferring of the technology. In order to maximize the chance of successful implementation of the technology, the model reduces uncertainty facing many organizations by standardizing and decomposing the different stages of the technology transfer process.

This research is limited with two things. First, the model assumes that the technology is pull in that it has been already developed elsewhere. Therefore, the company will have either of two options; to buy an off the shelf software or develop it in-house. The technology push case where a company introduces a revolutionary idea and transforms it into software is not included. Second, the model assumes that the company will consider only one technological solution for their needs or problems in the matching process. If the company decided that the available needs require the transferring of at least two technological solutions, then this model doesn't discuss the interactions of transferring processes of these solutions.

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