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An Evaluation Framework for Supply Chains Based on Corporate Culture Compatibility

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1. Introduction

To date research focused on the role corporate culture plays when planning a supply chain management system (SCMS) has been limited. Although many executives have recognize the importance of corporate culture (e.g., Hollingsworth, 1988), research however, has only begun to review the role corporate culture plays on planning information systems to avoid cultural conflicts (Leidner & Kayworth, 2006). Therefore, without a sound understanding of the corporate culture compatibility that influence organization behaviour it will be difficult to successfully plan SCMS initiatives. The purpose of this research is to develop an initial framework based upon the SCMS planning and culture literature to identify the needs for cultural compatibility that impact planning of SCMSs.

The fundamental premise of this research is that the literature supports the view that an organization must establish a corporate culture understanding to achieve an effective performance and competitive advantage inside the organization (Chan, Shaffer, Snape, 2004) and within the boundaries of a supply chain (Mentzer et al., 2001) prior to successfully planning SCMSs. The role of corporate culture can become especially critical at the boundary-spanning level of the organization, where organizations systems interface with other members of the supply chain. Accordingly, when supply chain's organizations collaborate under cultural compatibility environment, the SCMS is more likely to be executed in a uniform and effective manner (Mentzer et al., 2001). Nevertheless, recent frameworks of SCM planning ignore the role corporate culture plays to achieve an effective collaborative performance.

In the next section we give a short review of supply chain planning and management philosophy. This is followed by a theoretical investigation of the problem by reviewing the limitation in the current supply chain models. We then outline the significance of corporate culture compatibility to improve supply chain planning and achieve the ultimate SCM performance. This outline proposes the need for a new framework that is defined in the followed section. Finally, an agent-based simulation model concerning a three-level supply chain is described. This developed model integrates the proposed framework of cultural learning to evaluate the SCM performance. The results are, then discussed and significant outcomes are outlined.

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2. Supply chain planning framework

Miller (2001) presents a three level general framework for the hierarchical supply chain planning that spans the strategic, tactical, and the operational planning levels. Figure 1 presents Miller (2001) hierarchical supply chain planning framework.

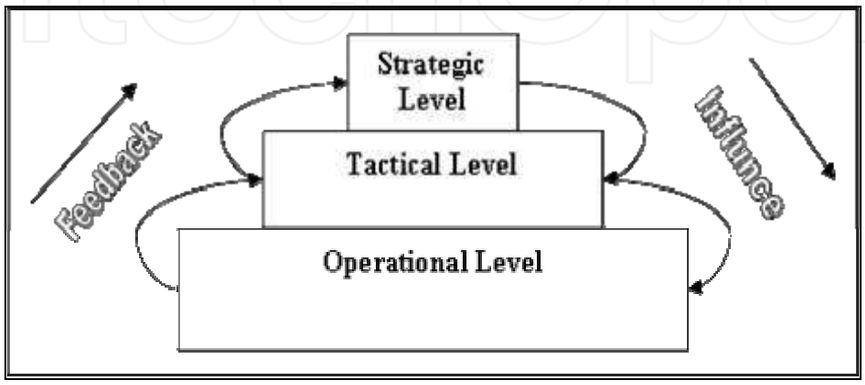

Figure 1. Miller's Hierarchical Supply Chain Framework

At the strategic level the supply chain organizations must address its overall corporate objectives, which include market share, profitability goals, production capacity, facilities to operate and its locations, the required resources and other crucial long-term decisions for the coming three to five years in future (Miller, 2001). Decisions made on the strategic level will often impact the decisions at the tactical level (miller, 2001). Therefore, the tactical level has decisions with more details about the planning activities. For example, organizations at this level allocate the production capacity and available resources to production lines, and decide about the inventory management plan. Therefore, the plans at the tactical level is not long term plans, rather it is a mid-term plans for the next twelve to eighteenth months. In a similar way to the strategic level, the decisions outcomes at the tactical level influence the decision-making process at the operational level, because it might add some constraints on the organization's operations. Furthermore, decisions at the operational level often involve weekly or at most monthly planning activities like forecasting the products stock keeping unit level, or the production schedule. Nevertheless, the operational level is the base level where infeasibilities of higher levels plans are revealed, because what might appear to be feasible at the strategic level or tactical level may contains infeasibilities at lower level. Therefore, Miller's hierarchical supply chain planning framework suggested feedback loops from operational level to tactical level and from tactical level to strategic level subsequently. Nevertheless, as supply chain members move through a closed loop process whereby they identify their strategic, tactical, and operational planning activities. This closed loop process involves an *influence* and *feedback* processes to enhance the supply chain plans, thus this closed loop is called "*Supply Chain Evolution*" (Miller, 2001).

3. Current supply chain management planning model

In order to model Miller's framework (2001), a number of agent-based model's approaches has been suggested. Several authors propose agents to simulate the supply chain management system planning, for example Fan et al., (2003) provide a theoretical design that could plan the supply chain activities at the operational level, while HinKKanen et al., (1997) focus on optimization of resource allocation within a manufacturing plant at the tactical level. A rule-based approach has been proposed by Fox et al., (2000) which is concentrate on coordination problem at both the tactical and the operational levels. Furthermore et al., (2000) performed preliminary researches to design an agent-based model to optimize the collaborative inventory management. Moreover et al., (1998) designed an agent-based approach to simulate the dynamics in supply chains and the control variables at the strategic level as well.

We may conclude that current simulation approaches lack some modeling capabilities that are required for successful supply chain simulation, because it cannot handle the computational complexity of supply chains. In reality supply chain organizations require to achieve a compatibility level of corporate culture prior to commence their operations (McAfee et al., 2002). Mostly, previous models facilities strongly focus on the operational and tactical levels with few others at the strategic levels, leaving the planning at the organization's cultural level implicit. As net result corporate culture compatibility is often ignored because it is hidden, intangible, or the analyst's choice is to build a visualized model and corporate culture is too difficult to capture.

Nevertheless, we argue that the aforementioned agent-based model must recognise a moral issue about these planning activities; (ii) make some kind of moral judgement about that issue; (iii) establish a belief system to act upon that judgement; and (iv) finally, actually act according to their beliefs. Therefore, there is influence on the supply chain planning decision process that is associated with *cultural* factors, such as socialization processes, which shape what is regarded as right and wrong in a given organisational situation. There is considerable evidence to suggest that cultural factors understanding have a considerable impact on the supply chain planning decision making (Cooper & Ellram, 1993; Lasser et al., 1995; Cooper et al., 1997; Mentezer et al., 2001; McAfee et al., 2002; Min et al., 2004).

However, to date there has been little research investigating how exactly these factors interact together to shape a common understanding of corporate culture between all supply chain organizations. Such needs for cultural sensitivity and meaning drive a need to add a cultural level to the hierarchical supply chain planning framework that must involve the individual understanding of the organization's corporate culture to achieve a common understanding (or compatibility) of corporate culture between all organizations. Hence, we need a new framework that proposes an organization's cultural level together with the strategic, tactical and operational levels.

4. Significance of corporate culture compatibility to supply chains

Prior to discuss the crucial role that corporate culture compatibility play we will firstly define the concept "corporate culture". The succinct definition will then followed by theoretical proofs from the literature about the significance of corporate culture compatibility to sustain effective supply chain relationships between partners.

4.1 Corporate culture definition

A basic definition of corporate culture is necessary to provide a point of departure in the quest for an understanding of the phenomenon. Deal & Kennedy (1982, p.23) state that "*shared values [that] define the fundamental character of the organization, the attitude that distinguishes it from others…create sense of identity for the organization [and these] values are a reality in minds of most people throughout the [organization]*". In other words, corporate culture includes those qualities of the organization that give it a particular identity, climate or feel. As a result the distinct qualities of an organization may manifest through four dimensions, namely the tough-guy/macho culture, the work-hard/play-hard culture, the bet-your company culture and the process culture (Deal & Kennedy, 1982). Schein (1985, p 9) defines corporate culture as "*a pattern of basic assumptions invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration that has worked well enough to be considered valid, and therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems*". This description highlights that corporate culture is created assumptions, which are accepted as a way of doing things and are passed on to new members of an organisation. Nevertheless, the main source of corporate culture is the organisation's leadership. Leadership in this context refers to the influential individuals, often the founders who have a major impact on the creation of the organisation's early culture (Schein, 1985). However, this pattern of values, norms, beliefs, attitudes, principles and assumptions may be unwritten or non-verbalised behaviour that describe the way in which things get done; to give the organisation its unique character (Brown, 1998). In other words, corporate culture includes those qualities of the organisation that give it a particular identity, climate or feel. Martins & Martins (2003, p 380) state the general definition of corporate culture as "a system of shared meaning held by members, distinguishing the organisation from other organisations". Furthermore, Arnold (2005, p 625) indicates that *"[corporate] culture is the distinctive norms, beliefs, principles and ways of behaving that combine to give each organisation its distinct character"*. These definitions present corporate culture as a distinct factor that identifies an organization from other organizations.

4.2 Corporate culture significance to supply chain systems

When supply chain management system (SCMS) projects experience significant configuration problems, several researchers argue that the existence lack of cultural compatibility (sometimes called alignment) between the supply chain organizations' corporate culture is a major contributing factor (Hollingsworth, 1988), because corporate culture is a pre-requisite for a successful collaboration business (Gardner & Copper, 1988). Cooper & Ellram (1993) consider corporate culture compatibility as a key characteristic that distinguishes SCMSs from other short-term collaborative systems, because corporate culture compatibility are less important for short-term relationships that for long-term. Cooper and Ellram (1993), however, highlighted that Incompatibility on corporate culture may exits between certain supply chain members, but this often challenges the long-term relationship between partners. Culture compatibility on SCMSs dose not assume similarities on operating strategies, procedures and agreement on every issues, but it simply implies a harmony on the essential directions to sustain an effective collaborative relationships (Cooper & Ellram, 1993; Bucklin & Sengupta, 1993). Initial research has shown that many organizations consider corporate culture compatibility to be the most-important evaluation criterion they used to measure the collaboration successfulness (Lasser et al., 1995), and a

"bridge-building" when individual organizations decide to move from a stand alone toward a collaborative business as supply chains (Cooper et al., 1997). Recent studies, in addition, introduce "*supply chain orientation"* as a new term that "*defines the organization capability to recognize the strategic implications and tactical activities utilized to facilitate the various flows in a supply chain*" (Mentzer et al., 2001). Mentzer et. al. (2001) and his colleagues define corporate culture compatibility in a supply chain as a mean of achieving a supply chain orientation by all supply chain members.

5. Definition of the new framework

The foundation of this framework comes up from our deep literature review of corporate culture and in particular the process of changing corporate culture. Brown (1998) identified the needs for pre-selection step prior to change corporate culture. This step *explores* the space for new changes on cultural values amongst the supply chain organizations. Afterwards & Brown (1998) culture change process *evaluates* the opportunities to integrate the new corporate culture changes with the current culture. Furthermore, the changing process of corporate culture performs an influencing step throughout a socialization process, to *embed* the new produced corporate culture changes into the new and current supply chain members. Therefore, to learn about changes on corporate culture an organization must go through these three stages of *exploring, evaluating, and embedding* corporate culture.

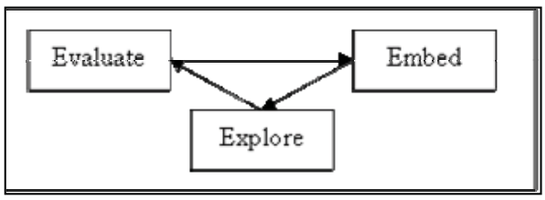

Figure 2. The Corporate Culture Learning Framework

5.1 Constitutes of the framework

The learning framework of corporate culture in figure 2 contains three interrelated processes Exploration, Evaluation, and Embedding. The framework processes form the glue that binds the structure together, there are, therefore three key facets of the framework. The first process of the framework begins with an Exploration process to search for the corporate culture changes. This process needs to check for possible culture changing patterns between supply chain organizations. The corporate culture is, for example, represented by management practices and strategies, what behaviour is rewarded, condemned or ignored (e.g. risk taking, training and helping new employee, applying regulations), and how an organization values their people (e.g. the best is the most creative, the ordered, or the supportive people). The second process of the framework is the Evaluation process. In this stage the organizations start evaluating the outcomes of the exploration process to validate its appropriateness to the current corporate culture. The Embedding process attempts to integrate the evaluated new corporate culture and influence current and new organization's members and partners about the required changes on corporate culture to increase their

gains and improve the organizational performance. Thus, future members of the organization's system can benefit from these experiences associated with any corporate culture changes. Therefore, this theoretical learning framework sustains a continuous improvement to the strategic relationships amongst the organization's members and partners, and concurrently evolves the internal beliefs of this organization. The framework learning process occurs over an evolution path that possesses a feedback process represented by the Evaluation step and an influence process represented by the Embedding step. Therefore, the framework can easily integrated to Miller's framework with Evaluation step and Embedding step correspond to feedback process and influence process respectively (see figure 3).

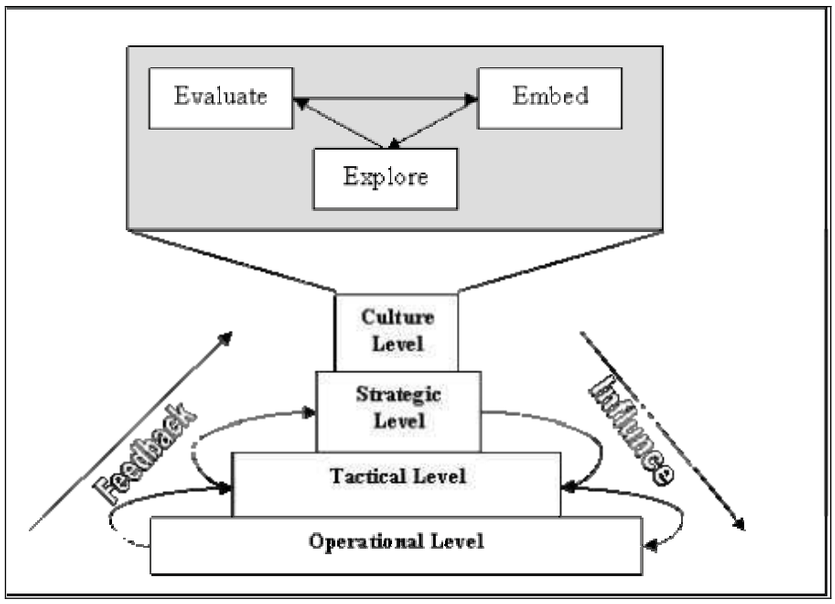

Figure 3. The Supply Chain Management Planning Framework

5.2 Modeling the new framework

We model the framework by using the Gaia methodology for agent-based model analysis and design proposed by Zambonelli et al., (2003). The agents' model describes the different agent classes based on their roles. However, the designer might choose to package closely related roles in a single agent class to optimize the design or attain more design coherence by utilizing a one-to-one strategy and map each single role to an agent class.

The agent model of Gaia can be defined using a simple annotation class from (Zambonelli et al., 2003). An annotating (n) means that there will be exactly (n) agents of this agent's class in the run-time model. An annotation (m...n) means that there will be no less than (m) and more than (n) instances of this class in a run-time model. An annotation (*) means that

there will be zero or more instances at run-time, and (+) means that there will be one or more instances at run-time. The notation to reference the agent class model is as follow:

$$Agent\ Class^{(annotation)} \xrightarrow{play} (Role\ Name)^{+}$$

Hence, the agent model for this research is the following:

$$Embed\ \ Agent^{(1)} \xrightarrow{play} Embedding$$

$$Explorer\ Agent^{(1)} \xrightarrow{play} Exploring$$

$$Evaluator\ \ Agent^{(1)} \xrightarrow{play} Evaluating$$

5.3 Internal structure

Elaborating on the agent model definitions supplied in the previous section, in this section we will consider the internal structure of agents.

Explorer Agent: The explorer agent adopts the cultural dimension from Deal & Kenndy (1982) described before. Therefore, the agent speculates the behaviour of supply chain agents based on four attributes associated with the organization corporate culture. These attributes are:

- Low Risk taking: this strategy is applied when the organization is not willing to take a high risk by, for example, decreasing its investment and spending to reduce it potential lost.
- High Risk taking: this strategy is applied when the organization is willing to take a high risk by increasing its investment and boosting the spending to promote its products.
- Quick Feedback; this strategy is applied when the organization is seeking a very quick response from its participants and meeting the schedule is a crucial objective for this strategy.
- Slow feedback: this strategy is applied when the organization is expecting a regular response time from its participants and meeting the schedule is not the highest priority objective.

These attributes form a common corporate culture structure, but a loosely coupled with each supply chain agent has the capability to adjust its individual belief's contents. Therefore, for each instantiated corporate culture the value of these cultural attributes are:

- Zero which indicates that the attribute is insignificant for the organization,
- Or, one to indicate that the organization has a belief to this attribute.

Evaluator Agent: The Evaluator agent's main objective is to evaluate the collected results after the exploration process undertaken. Therefore we developed an evaluation function to measure the fitness of each individual understanding of corporate culture. The f(A) is an evaluation function such that it expresses the proposition of all relevant and available evidence that support the claim that supply chain members who possess the individual understanding of organization's corporate culture that support the corporate culture A but

to no particular subset of A. The f(A) is valued by the ratio of supply chain members holding the same corporate culture, thus f(A)is a value between zero and one inclusive.

$$f(A) = \frac{\sum_{i=0,\ Culture(i)-A=\emptyset}^{N} SupplyChainMember(i)}{\sum_{i=0}^{N} SupplyChainMember(i)} \quad (1)$$

Embed Agent: The Influencer Agent in the simulation is modelled using Roulette wheel selection technique to distribute the shared understanding of corporate culture according to their calculated fitness in equation (1). The influencer Agent has a fitness function that assigns fitness value to current shared understanding of corporate culture. This fitness level is used to associate a probability of selection with each shared understanding of culture. While candidate solutions with a higher fitness will be less likely to be eliminated, there is still a chance that they may be. With fitness proportionate selection there is a chance some weaker solutions may survive the selection process; this is an advantage, as though a solution may be weak, it may include some component which could prove useful following the recombination process. Therefore, the Influencer agent's main objective is to embed new shared understanding of corporate culture on next supply chain generations to achieve more corporate culture compatibility.

6. Experimentations and evaluation of the framework

We developed a supply chain simulation environment to simulate and encompass the challenges involved when trying to achieve corporate culture compatibility, yet, by keeping the rules simple, to ensure a competitive, stimulating and learning environment.

6.1 The developed simulation model

Fundamentally, the main feature of the simulation environment (table 1) involves different supply chain's organizations with dissimilar individual understanding of corporate culture whose aim is to assemble three different Televisions set, and subsequently compete against each other for customer orders, then acquire the orders and deliver the various products to the customers. The products built for customers are TVs assembled from five component types. The supply chain's organizations must respond to the customer's request for quotes giving the price of the products plus a delivery date in order to allow the customer to select the best offer. When delivery of the goods has been met wholly and adequately by the due date, then the Customer places the payment in the bank, where each supply chain organization has an access to its bank account. However, failing to deliver the products timely and adequately will incur delay penalties on the organizations' accounts. There are limitations imposed upon the organizations to make its role more difficult and to incorporate an incentive challenge. Each simulated day the retailers' are competing to acquire as many as possible customer orders, however the retailer not only has to win customer orders, and respond to demands for different types of TVs, but also must be aware

that each TV type requires different combinations of components and an assemble cycles (see table 2).

Parameters	**Limitations**
Manufacturing Capacity	500 assembly cycles/day
Supplying Capacity	500 Components/day
Retailers Delivery Capacity	500 Products/day
Delay Penalties	10% of the customer reserve price

Table 1. Simulation Environment Limitations

Therefore a retailer must establish relationships with manufacturers and suppliers. Nonetheless, all organizations must work within the capacity parameters as seen in the table above. A key issue is that the five types of components represented: Chassis, Picture Tube, Speaker, Power Supply, and Electronics all have a variety of categories, so the products are customizable (see table 3). As well as the practical limitations, the organizations must face the challenge of competing concurrently within the markets for products, for customers and for the different components produced by several suppliers. Therefore, successful organizations need to show the ability to respond rapidly and using a skilled strategy, react positively to the varieties of demand by the customer, yet, as well, sustaining better relationships with participants. The organizations should be able to perform these tasks, whilst adequately balancing the interdependencies, and, be able to act even if having only incomplete information about other organizations' corporate culture. To juxtapose such tasks successfully is demanding, yet the supply chain organizations also need to have the additional ability to adapt to the corporate culture employed by other competing and collaborating organizations, and indeed, even attempting to outwit them. The simulated demands are representative of a broad range of supply chain situations and should, therefore, offer the competing organizations an authentic challenge.

TV Types	Components	Assembly Cycles
Low-TV-1	100+(200/210)+(300/310)+400+500	3
Low-TV-2	110+(201/211)+(300/310)+(400/410)+501	3
Med-TV-1	101+(200/210)+(300/310)+410+501	4
Med-TV-2	111+(201/211)+(300/310)+(400/410)+500	4
High-TV-1	101+(200/210)+(301/311)+400+500	5
High-TV-2	111+(201/211)+(301/311)+400+501	5

Table 2. TVs Description

Component ID	Supplier	Description
100	S1	Flip Chassis
101	S1	Sany Chassis
110	S2	Sopra Chassis
111	S2	Amcor Chassis
200	S3	Sany Picture Tube
201	S3	Sonic Picture Tube
210	S3	ViewSus Picture Tube
211	S3	GL Picture Tube
300	S4	Taship Speaker
301	S4	PH Speaker
310	S4	Creator Speaker
311	S4	Blaster Speaker
400	S1	WD Power Supply
401	S2	Limited Power Supply
500	S3	Panason Electronics
501	S4	Sany Electronics

Table 3. BOM of all TVs types

According to the aforementioned simulation environment and for the purpose of this study, we have developed a three sub-chain simulation model as shown in Figure-4.

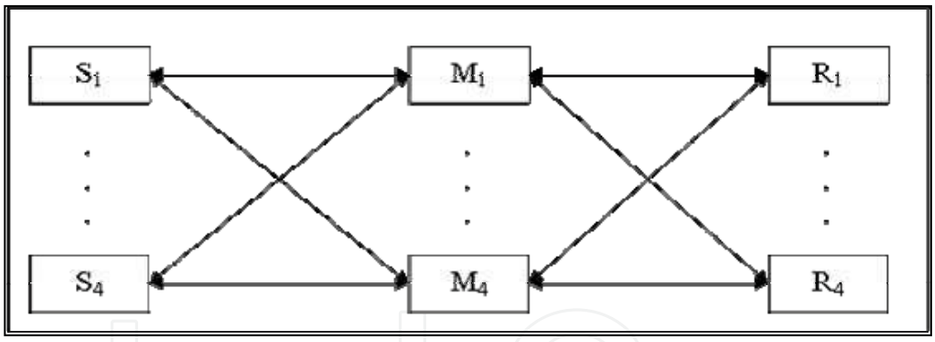

Figure 3. Three-levels supply chain model

To develop the simulation model we have utilized the RePast toolkit[1]. The RePast system is a Java-based toolkit for the development of lightweight agents and agent models. The model comprises of 4 manufacturers connected to 4 retailers and 4 suppliers. The manufacturers accept orders from retailers and request bids from suppliers indicating the product type and quantity for the required materials from suppliers. A Supplier, then either sends its quotation to manufacturers or a regret message if requests cannot be fulfilled. Based on the

[1] http://repast.sourceforge.net/

received quotation manufacturers select the most appropriate suppliers based on the minimum orders waiting time and issues the orders. Upon receiving the required materials from suppliers, the manufacturers initiate necessary actions to make the products and ship it to retailers. Furthermore, retailers will perform business with the manufacturer and will deliver the required products with the minimum waiting time to avoid incurring delay penalties. Hence, the time elapsed between the placements of an order and the receipt of products is measured as supply chain's lead-time performance.

We have added a culture component to facilitate the links between sub-chains according to the level of Culture compatibility between partners. We have suggested that corporate culture compatibility may be seen as a means towards greater organizations synchronization. Corporate culture compatibility offers alternatives that can lead to changes in the management practices, procedures and policies that subsequently can impact the flow of entities in a direction that may result in an improved supply chain model. The entities may consist of products, customer orders, information, decision and resources etc. Moreover, we have proposed four Culture types where we have assumed that Culture Type 1 is the Macho Culture, while Culture Type 2, 3, 4 represent Work-Hard culture, Bet-Your-Company Culture and process culture respectively. However, each culture type is allocated with a value that defines the time needed to perform supply chain activities under this culture type as shown in table 4.

Culture Name	Macho	Work Hard	Bet-Your-Company	Process
Culture's Strategy	High Rish and Quick feedback	Low risk and Quick feedback	High risk and Slow feedback	Low risk and Slow feedback
Culture Type	Type C_1	Type C_2	Type C_3	Type C_4
Value	-2	-1	1	2

Table 4. Culture Types Values

Therefore if two organizations have implemented the same culture by operating the same business strategy then both are performing the activities at the same time, whereas if culture type is different then there is a waiting time for one organization. Therefore the equation to calculate the lead-time performance becomes the following:

$$\sum C_i = |C_S - C_R| + |C_M - C_R| + |C_S - C_M| \quad (2)$$

Where, C_i is the aggregate culture value for all organizations type

$$\text{Lead-Time} = \sum C_i + \text{Supplier(Time)} + \text{Manufacturer(Time)} + \text{Retailer(time)} \quad (3)$$

6.2 Framework evaluation

The focus during these simulation experiments was to figure out the quality of the framework, measured in terms of Lead-Time performance, varied with the increases of shared understanding of corporate culture. We therefore, run the experiments with two

groups of supply chain organizations: group A and group B. Group A has a link with the proposed framework agents, thus their individual understanding of corporate culture is influenced by the shared understanding of corporate culture. On the other hand, group B has no link with the proposed learning framework agents and subsequently the organizations receive no influence on their individual corporate culture.

We found that both groups commence the simulation with well performance because both groups start with adequate resources to accept customer orders. Next when customers' orders increases and resources begin to decrease as organizations utilize it, group B starts to behave inefficiently because they do not have adequate resources. Moreover the new generations on group B will inherent the individual corporate culture understanding from previous generations which make their performance somewhat stable with no significant improvements. Therefore, each organization attempts to satisfy his own needs. Group A, however, behaved inefficiently in the beginning, because each organization resisted changing of individual understanding of organization's corporate culture. Nevertheless, after a number of generations, the new organizations in group A start adapting their individual corporate culture understanding to align with the shared understanding of corporate culture and turn their behaviour back to more efficient performance. On the other hand, group B may reach a close result, but the organizations need more time to recover without shared understanding of corporate culture.

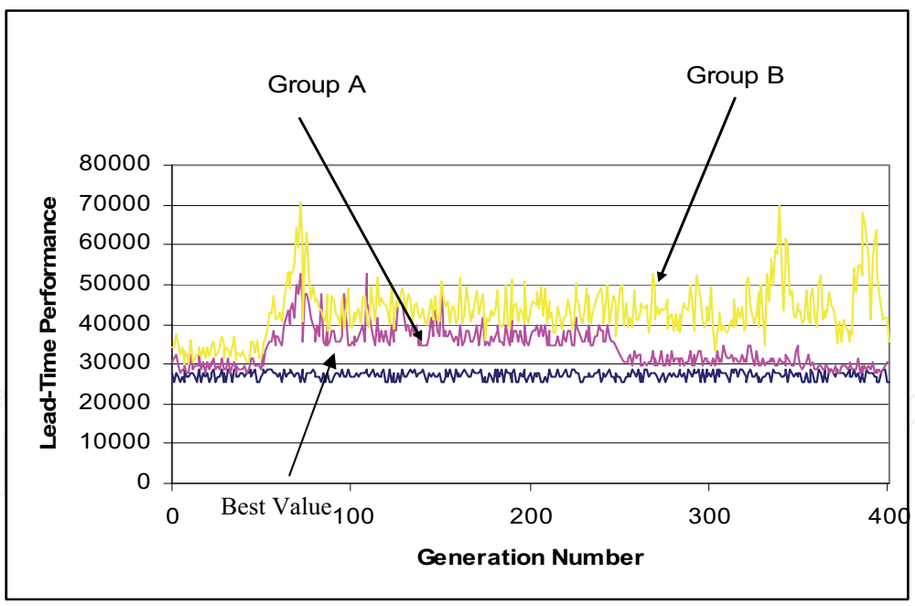

Figure 4. A comparison between Group A and Group B organizations

7. Conclusion

We have presented a framework to evaluate the lead-performance of the supply chain management based on the corporate culture compatibility system. The goal is to implement a supply chain simulation model that has the capability to measure the corporate culture compatibility of supply chain organizations to achieve an effective supply chain performance. We also described the first step towards this goal in the form of a simulation study to support our proposition. Therefore, we modelled the proposed framework as a multi-agent system.

In the near future we plan to integrate the current version of the multi-agent model of the simulation with other supply chain agent based models. According to the literature, corporate culture is defined with different views, therefore we would like to be able to measure the corporate culture of individual supply chain organization and aggregate them to form a compatible corporate culture for the entire supply chain. Furthermore, we plan to study how we can aggregate different views of corporate culture in the existence views diversity of individual organization's culture.

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Traditionally supply chain management has meant factories, assembly lines, warehouses, transportation vehicles, and time sheets. Modern supply chain management is a highly complex, multidimensional problem set with virtually endless number of variables for optimization. An Internet enabled supply chain may have just-in-time delivery, precise inventory visibility, and up-to-the-minute distribution-tracking capabilities. Technology advances have enabled supply chains to become strategic weapons that can help avoid disasters, lower costs, and make money. From internal enterprise processes to external business transactions with suppliers, transporters, channels and end-users marks the wide range of challenges researchers have to handle. The aim of this book is at revealing and illustrating this diversity in terms of scientific and theoretical fundamentals, prevailing concepts as well as current practical applications.

How to reference

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