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The dynamics of Knowledge Management and Innovation in the Indian manufacturing sectors: A Systems Perspective

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***Abstract*— Innovation is vital in current organizations irrespective of the domain. In a knowledge economy, enhanced use of knowledge can lead to faster, less risky and more vibrant innovation. Innovation is a knowledge intensive process which means that the knowledge of the employees must be managed well and synergized to the optimum. This calls for the implementation of a good Knowledge Management (KM) practice. KM is a process of managing the knowledge of the people in the organization just like the other resources viz. man, material and money are managed. A successful KM practice depends on the interaction of the three basic cores viz. people, process, and technology. This study identifies the influence of the above-mentioned cores on the effectiveness of the KM processes like, Knowledge creation, acquisition, and application. Though there are several literatures in this area, there is no model which studies the influence of these parameters from a systems perspective. With the above standpoint in focus, the purpose of this paper is to delineate through System Dynamics (SD) simulation the influence of the strategic enablers of KM on innovative ability of the manufacturing firm.**

Index Terms—**Knowledge Management, Innovation, Causal loop diagram, Stock and flow diagram, Simulation, System dynamics.**

I. INTRODUCTION

In today's world, each business and enterprise is constantly required to change; to be reinvented in order to provide new capabilities and perspectives; to be able to cope with new challenges; and to renew it to adopt new approaches, keeping those that work well and discarding those that are outdated [1]. Managing change is risky and often challenging for the organizations. Only such organizations who step up to the challenges will likely survive, whereas others fail miserably. To thrive and prosper, considerable management and involvement of new professional skills such as Knowledge management (KM) are required [1]. Knowledge Management is based on the idea that an organization's most valuable resource is the knowledge of its people. Therefore, the extent to which an organization performs well will depend, among other things, on how effectively its people can create new knowledge, share knowledge around the organization, and use that knowledge to best effect. Establishing a sound practice of KM is not an easy task. Reference [2] incorporated a socio-technical perspective of KM when they integrated people, processes, and technologies as a vital component for the success of a KM initiative. In this research, the above mentioned components are studied as strategic enablers of KM and their influence on the innovative ability of the firm is studied using System Dynamics (SD). System Dynamics is built upon traditional management of social system, cybernetics and computer simulation [3]. The process includes: Problem identification, System Conceptualization, Model formulation, Simulation & validation, and Policy analysis & improvement [3]. The novelty in this research is that, it makes use of the mathematical equations that are framed using linear regression analysis after conducting a survey of around 249 respondents primarily from the manufacturing companies in India. It is different in the sense that, the weightages for the individual factors are determined based on the general perception and are borne to give more realistic results when compared to other methods.

II. LITERATURE REVIEW

For the manufacturers of today, innovation is the engine of growth. In a survey conducted by Deloitte consultancies, it was found that no other strategy for driving the world's leading manufacturing firms was more important than developing innovative new products and services [4]. Innovation is when knowledge from previously separated domains is exchanged and combined in new ways [5], [6], [7]. The result of this innovative practice is innovation when and only when this combination of domains leads to the successful diffusion of a new product, process or service [8]. There are literary evidences in support of knowledge management as an enabler to the innovation process [9], [10]. It is evident that a KM requires the integration and balancing of leadership, organization, learning, and technology in an enterprise-wide setting [11]. In this manuscript, all the above referred facts have been the key variables of interest in developing the SD model to study the influence of HR, KM and IT strategies on the knowledge creation, acquisition, and application ability of the manufacturing firm.

III. METHODOLOGY

The research has been carried out in manufacturing industries in India. The industries are classified as Public Sector Undertaking (PSUC), Private Sector Company (PRSC), and Multi-National Company (MNC) operating in India, respectively. The primary source of data is through an

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instrument, which is a self- administered questionnaire. The data has been collected using random sampling method on representative sampling basis. A total of 249 responses were obtained which were used for analysis. In this research, it was vital to develop an equation relating the independent variables viz. HRM, KM, and IT Strategy, and the dependent variables viz. knowledge creation, acquisition, application effectiveness, and innovative ability of the organization. Since there were many independent variables, multiple regression methods were used. Based on the process recommended by [12], the simulation was carried out. The regression equations that were derived for the dependent variables were used for simulation. Three different runs were carried out to study the behavior of the model. The set of values that were used in the runs are mentioned in the Table 1.

Table 1: Different variables used for simulation

All parameters for HR strategy	0.5	0.6	0.7
All parameters for KM strategy	0.5	0.6	0.7
All parameters for IT strategy	0.5	0.6	0.7
Initial product score	900	900	900
Fraction of problems identified	0.5	0.5	0.5
Capacity	5000	5000	5000
Cost of problem solving	400	400	400
Initial expenses	250	250	250

The model was simulated for 48 weeks as the average time for major product re-designs are between 2 to 5 years [13]. The output is only displayed for 18 weeks as no significant changes in the behavioral pattern were observed after 18th week. Using the causal loop diagram (Fig. 1) as a starting point, the stock and flow model (Fig. 2) was set up for simulation in Ventana Systems VenSim® modeling environment. Despite the dynamic nature of system models in general, the model has some constants, which reflect the assumptions made, to provide the basis for the model (Table 1). Using constants eases the modeling, but they also create an error source of their own. Assumptions behind constants attributes should be made logically so that the model stays intact. The constants presented at Table 1 realize that they are mostly market and industry related assumptions. The numbers used in this simulation are based on rough estimates from experience from business cases, and aim to replicate a sort of general industrial firm. Thus the results are also reported mainly for the purpose of highlighting the dynamics of the model more than anything else.

IV. RESULTS

A. Descriptive statistics

Frequency tables determine the distribution of the demographics of the sample respondents. Demographic details like gender, job sector, time since joining, job position, and annual salary are mentioned. Demographic of the respondents are summarized in Table 2.

Table 2: Descriptive statistics

Demographic	Categories	Percentage
Gender	Male	27.7
	Female	72.3
Job Sector	Public Sector Company	20.1
	Private Sector Company	59.8
	Multi-national Company	20.1
Time since joining	Less than 1 year	17.7
	Between 1-3 years	38.2
	Between 4-6 years	27.7
	Above 6 years	16.5
Job position	Strategic level	1.6
	Tactical level	12.9
	Operational level	85.5
Average Annual Salary	Below 5 lakhs	1.6
	Between 6-10 lakhs	87.1
	Above 10 lakhs	11.2

B. Regression analysis

Linear regression is a method of estimating or predicting a value on a dependent variable given the values of one or more independent variables. Like correlations, statistical regression examines the association or relationship between variables. Unlike with correlations, however, the primary purpose of regression is prediction [14]. Four basic equations were derived for the same which related the influence of the strategic enablers of KM on KM effectiveness and the innovative ability of the organization (Table 3-6).

Relationship between HR Strategy, KM Strategy, IT Strategy on Knowledge Creation Effectiveness

Dependent Variable: Knowledge Creation Effectiveness
Independent Variables: HR, KM, and IT Strategy
Method: Enter
Multiple R value: 0.643 R-square values: 0.413
Adjusted R-square value: 0.406
F-value: 57.472 P-value: < 0.001**

Table 3: Regression table for HR, KM, IT Strategy on Knowledge Creation Effectiveness

	Unstd. Coefft (β)	SE (β)	Std. Coefft (β)	t-value	Sig
Constant	0.979	0.240		4.082	0.000**
HRS	0.474	0.065	0.483	7.208	0.000**
KMS	0.149	0.074	0.138	2.008	0.046**
ITS	0.103	0.064	0.098	1.605	0.110

*** Denotes significance at 1% level*

The multiple regression equation is

Knowledge Creation Effectiveness = 0.979 + (0.474 X HR Strategy) + (0.149 X KM Strategy) + (0.103 X IT Strategy)

Relationship between HR Strategy, KM Strategy, IT Strategy on Knowledge Acquisition Effectiveness

Dependent Variable: Knowledge Acquisition Effectiveness
Independent Variables: HR, KM, and IT Strategy
Method: Enter
Multiple R value: 0.675 R-square values: 0.483
Adjusted R-square value: 0.476
F-value: 76.163 P-value: < 0.001**

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Table 4: Regression table for HR, KM, IT Strategy on Knowledge Acquisition Effectiveness

	Unstd. Coefft (β)	SE (β)	Std. Coefft (β)	t-value	Sig
Constant	0.757	0.209		3.619	0.000**
HRS	0.199	0.046	0.231	4.369	0.000**
KMS	0.316	0.054	0.323	5.802	0.000**
ITS	0.258	0.045	0.313	5.750	0.000**

*** Denotes significance at 1% level*

The multiple regression equation is

Knowledge Acquisition Effectiveness = 0.757 + (0.199 X HR Strategy) + (0.316 X KM Strategy) + (0.258 X IT Strategy)

Relationship between HR Strategy, KM Strategy, IT Strategy on Knowledge Application Effectiveness

Dependent Variable: Knowledge Application Effectiveness
Independent Variables: HR, KM, and IT Strategy
Method: Enter
Multiple R value: 0.671 R-square value: 0.450
Adjusted R-square value: 0.443
F-value: 66.875 P-value: < 0.001**

Table 5: Regression table for HR, KM, IT Strategy on Knowledge Application Effectiveness

	Unstd. Coefft (β)	SE (β)	Std. Coefft (β)	t-value	Sig
Constant	0.659	0.245		2.691	0.008**
HRS	0.378	0.059	0.370	6.406	0.000**
KMS	0.148	0.065	0.132	2.273	0.024**
ITS	0.323	0.067	0.299	4.851	0.000**

*** Denotes significance at 1% level*

The multiple regression equation is

Knowledge Application Effectiveness = 0.659 + (0.378 X HR Strategy) + (0.148 X KM Strategy) + (0.322 X IT Strategy)

Relationship between Knowledge Creation, Acquisition and Application Effectiveness on Innovative ability of the Organization

Dependent Variable: Knowledge Creation, Acquisition, Application
Independent Variables: Innovative ability
Method: Enter
Multiple R value: 0.628 R-square values: 0.394
Adjusted R-square value: 0.387
F-value: 53.173 P-value: < 0.001**

Table 6: Regression table for Knowledge Creation, Acquisition, and Application Effectiveness on Innovative ability

	Unstd. Coefft (β)	SE (β)	Std. Coefft (β)	t-value	Sig
Constant	1.104	0.264		4.176	0.000**
K. Cre	-0.043	0.049	-0.048	-0.872	0.384
K. Acq	0.350	0.069	0.291	5.081	0.000**
K. App	0.447	0.053	0.470	8.444	0.000**

*** Denotes significance at 1% level*

The multiple regression equation is

Innovative ability = 1.104 - (0.043 X Knowledge creation effectiveness) + (0.350 X Knowledge acquisition effectiveness) + (0.322 X Knowledge application effectiveness)

C. MODEL STRUCTURE AND RESULTS

Innovative ability of an organization and KM effectiveness go hand in hand. It is seen often organizations with good KM practices excel at innovation and enjoy a good market standing. The market standing can be measured by the sales of the product or service. It is well-known that demand for the product or service determines the sales. In this research, the attributes that define product quality are described as product performance index. This has been defined between 0 and 1. The product performance index is calculated as the ratio between Actual Product Score (APS) and the Maximum Product Score (MPS). The APS is a function of the Technology Life Cycle, Initial Product Score (IPS), and the ability to improvise on the design/ features of the product. It can also be observed that, when the sales soar, so do the profits. A market leader always re-invests a part of its profits on R&D and works towards improvisation of the product. This is done in order to maintain its strategic lead in the market. To ensure this, every organization has to always keep in mind the customer and hence their feedback becomes vital. Feedback about the product/ service is a critical tool for the organization. The most successful organizations value their customer feedback as it gives essential inputs for them to improve. During this feedback session, new problems are identified, which fetch the attention of the design and operations and the cycle of solving the issue innovatively is triggered.

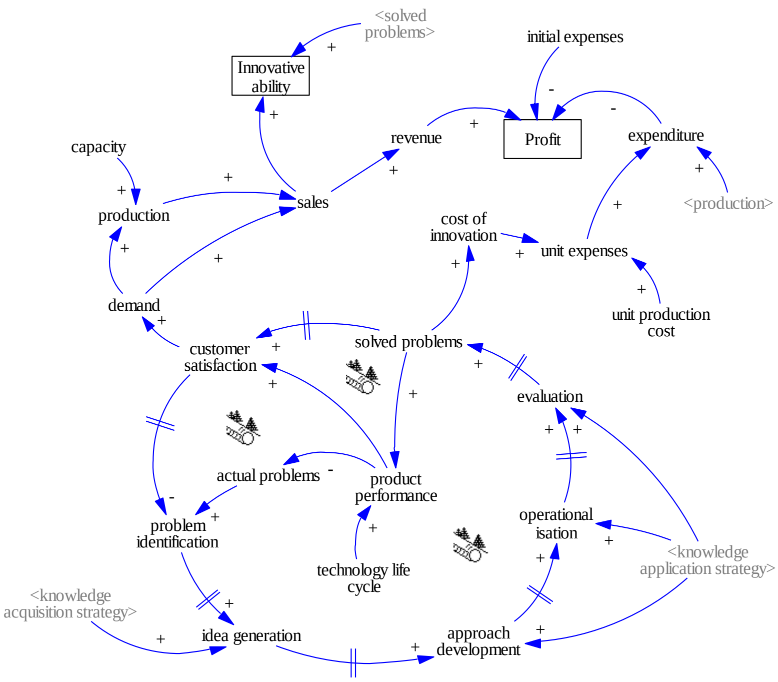

Fig 1: Causal loop diagram

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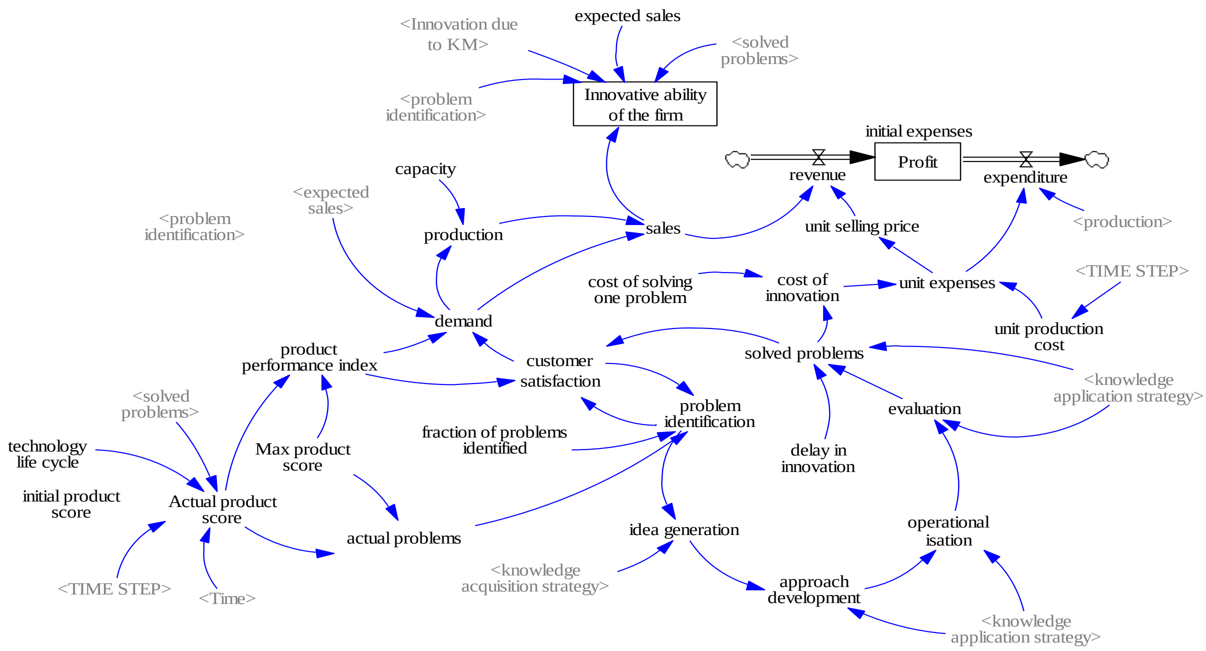

Fig 2: Stock and flow diagram

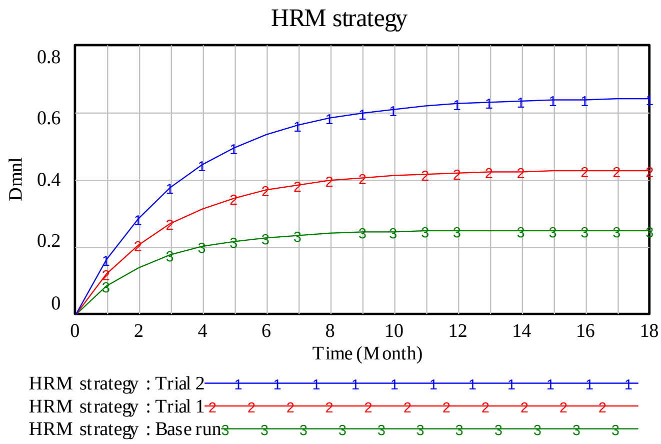

Fig 3: Variation in HR Strategy with time

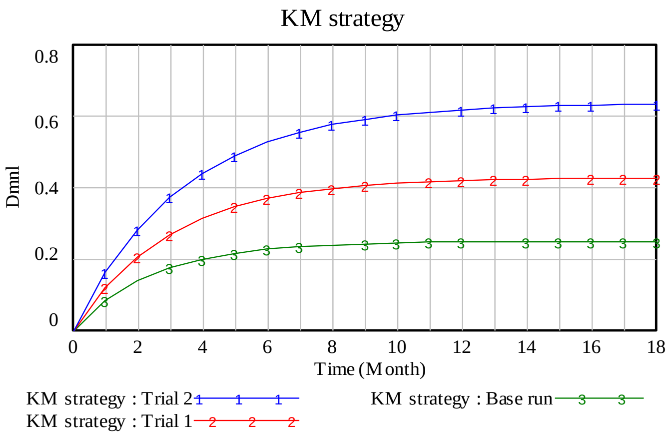

Fig 4: Variation in KM Strategy with time

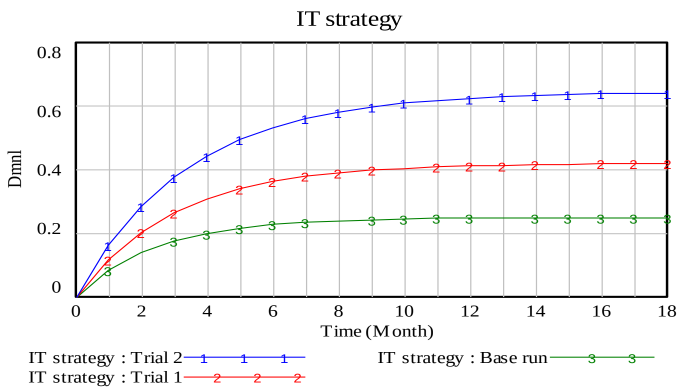

Fig 5: Variation in IT Strategy with time

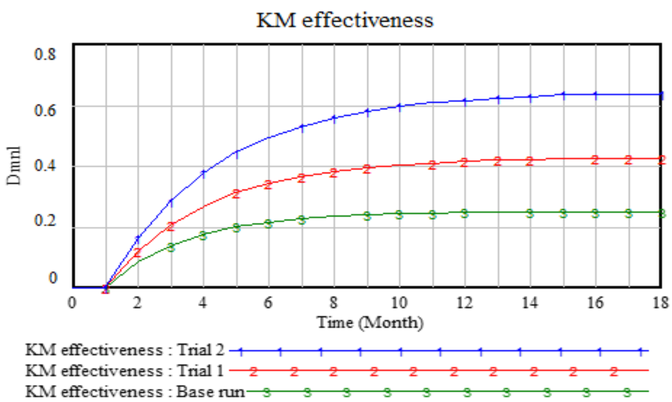

Fig 6: Variation in KM effectiveness with time

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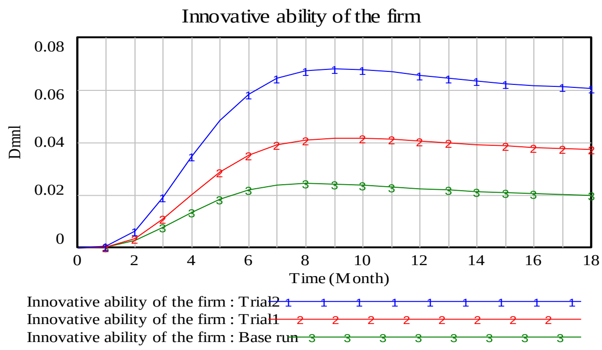

Fig 7: Variation in Innovative ability with time

Three runs are simulated with the values mentioned in Table 1. One can observe (Fig. 3-6) that even though the HR, KM, and IT strategy parameters are varied between 0.5 and 0.7, the collective effect of the variables are between 0.25 and 0.65. One can further observe that the trend gains stability at 12th month and later, there is not a significant variation in the same, i.e. stability is achieved. On the other hand, the KM effectiveness which is due to the collective efforts of the strategic enablers gains momentum after the first month. This is in accordance with a major rule of SD i.e. 'Cause and effect are not closely related in time and space' [15]. Similarly, the innovative ability (Fig. 7) of the firm varies drastically in the three scenarios. In trial 2, the innovative ability of the firm is maximum at 0.07 units. It reaches a maximum at the 8th month, regains stability and starts to decline after 12th month. This trend follows the Gartner's hype cycle and demonstrates a realistic behavior.

V. CONCLUSION

System dynamics was used to analyze the dynamic behaviour of the system. A causal loop diagram was developed to demonstrate the cause and effect relationship between the various parameters and subsequently followed by the stock and flow diagram which was used to analyze the future trends. The trends were analyzed for 18 months. The governing relations which defined the overall effects of the strategic enablers of KM on KM effectiveness, and their subsequent effect on the innovative ability of the firm were developed using regression analysis. This enabled the development of realistic weightages to the equations rather than the assumption of the uniform weightages among the independent variables. The results were in line with the findings and the trends were realistic. The innovative ability curve followed the trend of a typical technology life cycle clearly indicating the phases of growth, maturity and decline. Hence, one can conclude that innovation can be driven when KM is fortified in any organization, and to have a good KM practice, it is very essential that the three cores i.e. people, process, and technology are looked as a strategic enablers and efforts are made to optimize their capabilities.

REFERENCES

[1] Wiig, K.M, "People-Focused Knowledge Management: How Effective Decision Making Leads to Corporate Success", Butterworth-Heinemann. 2004.

[2] Wickramasinghe, N., & Mills, G., "MARS: The electronic medical record system. The core of the Kaiser galaxy", International Journal of Healthcare Technology Management, vol. 3, no. 5/6, pp. 406-423, 2001.

[3] Sushil, "How to Develop a System Dynamic Model: System Dynamics, A Practical approach for Managerial Problems", Wiley Eastern Publication, 1993.

[4] Deloitte Research, "Mastering Innovation: Exploiting Ideas for a Profitable Growth", Deloitte Research Global Manufacturing Study, 2007.

[5] Nahapiet, J. & Ghoshal, S., "Social capital, intellectual capital, and the organizational advantage", Academy of Management Review, vol. 23 no. 2, pp. 242-66, 1998.

[6] Hargadon, A., & Sutton, R. I., "Building an innovation factory", Harvard Business Review, vol. 78, no. 3, pp. 157-166, 2001.

[7] Justesen, S., "Innoversity— the dynamic relationship between innovation and diversity", Copenhagen Business School, Department of Management, Politics and Philosophy, 2001.

[8] Schumpeter, J. A., "The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle", Cambridge, MA: Harvard University Press, 1934.

[9] Alavi, M. & Leidner, D., "Knowledge management systems: Issues, challenges, and benefits" Communication of the AIS, 1999 [Online] Available at: http://cais.isworld.org/articles/1-7/article.htm,.

[10] Paukert, M., Niedree, C., Muscogiuri, C., Bouquet, P., & Hemmje, M., "Knowledge in the innovation process: An empirical study for validating the innovation knowledge life cycle", Proceedings of the 4th European Conference on Knowledge Management, pp 725- 737, 2003.

[11] Calabrese, F., "Key elements for a KM initiative", Doctoral thesis, School of Engineering and Applied science of George Washington University, 2000.

[12] Sterman J. D., "Business Dynamics Systems Thinking and Modeling for a Complex World", Irwin Mc Graw Hill, NY, 2000.

[13] Mendelsohn, H., & Pillai, R.R., "Industry clock speed: Measurement and operational implications", Manufacturing and service operations management, vol. 1, no.1 pp. 1 – 20, 1999.

[14] Marczyk, G., De Matteo, D., and Festinger, D., "Essentials of research design and methodology", John Wiley & Sons, Inc, 2005.

[15] Senge, P.M., "The Fifth Discipline", Currency Doubleday, New York, NY. 73, 1990.

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