A Dynamic and Integrative Model for Detecting Strategic Changes in Efficiency and Effectiveness of an Industrial Company

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Abstract

The purpose of the paper is to present a model developed for detecting strategic changes in efficiency and effectiveness of an industrial company that is structured along with mechanistic concept , produces consumer products, and profit center.

Main aim of the research is to develop a model for detecting strategic changes that is a step of strategic issue diagnosis. Which strategic changes are monitored is on dependent on which analysis unit is. In this study It is organisations that are structured with mechanistic concept, vested in a multi product company and profit centre. It can be found in literature that for these companies changes in effectiveness and efficiency are likely strategic changes.

Our approach to constructing the model is based on problem detecting approach due to relevant literature'.The model consists of two sub model ;namely simulation sub model that is a system dynamic model and control chart sub model.The simulation model provides us with distribution of profit values that can be obtained under the normal changes in effectiveness and efficiency. The control chart model receives profit values produced by simulation model and calculates limits to show a manager whether there is strategic changes in efficiency and effectiveness or not.

The model was run by input values of a Turkish company that produces paints.In the test of the simulation model we did not found any statistical difference between profit values obtained from the simulation sub model and one obtained from profit formula,which may be a confidence indicator for validation.

As a conclusion it can be said that that detecting strategic changes offers a lot to system dynamic researcher and using management science tools with system dynamic will likely increase strength of it.

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Introduction

The purpose of the paper is to present a model developed for detecting strategic changes in efficiency and effectiveness of an industrial company that is structured along with mechanistic concept , produces consumer products, and profit center.

Although change is a mythic word and exists in all thing,it's entering into management literature goes back to introduction of strategic planning in 1960's. Strategic planning differs from long range planning in respect to taking discontinues or changes into consideration (Ansoff 1980,1985).

It is likely said that there are two schools of change in strategic management literature .First school may be called change management and mostly concerned with changes to implement a strategy . The second is called strategic issue management and mainly concerned with speed of changes and how to develop strategy in order to over come fast change.(Ansoff 1980,1985,King 1984,1982,1981). This school calls changes as strategic issue.The term of strategic issue is developments, trends, and events that have the potential to influence the current or future strategy, functions, and/or performance of a organization. Concept of issue firstly came to attention of corporate with demand for women's rights in the work place in the late 1960 and early 1970 (Wartick and Rude 1986).Since the big petrol crisis in 1973 ,corporations hava been facing bombard of issues.

Strategic issue management is hot and emerging matter of strategic formulation and implementation (Ansolf 1985,1980; King 1982;1984;Dutton and Duncan 1987).It covers following steps:issue diagnosis,development of issue related strategy,strategy implementation and measuring results(King 1984;Ansoff 1980,1985;Camillus and Datta 1991). Models especially quantitative models for detecting strategic issue that is a step of strategic issue diagnosis are scare, which triggered us to develop such a model.

Strategic Issue Diagnosis

Strategic issue management consists of three phase: idenfication of issues,interpration of issues and action planning.

The idenfication phase covers detecting, and interpreting of issues. Detecting issues (sometimes idenfication is used interchangeably with detecting) is triggered by stimulus that can be anything,and come from anywhere.Their source are important variable affecting process of interpretation (King 1984;Dutton and Duncan 1987;Nutt 1993;Dutton and Ashford 1993;Dutton et all). Dutton and Ottensmeyer (1987) divided issues according to place which they occur; internal issues,external issues. Internal issues come from internal environment of an organisation. External environment of an organisation creates external issues.Internal issues can be pick up from internal trends, performance trends and objectives. (Ansoff 1980;Dutton and Jackson 1987). On the other hand external issues are captured by enviromental analysis.Since strategic issue diagnosis takes place at the top level of the organisation(Dutton and Duncan 1987,King 1984,Ansoff 1980) ,top level managers are bombarded by all kind of issue. Under both time restriction and mental capacity restriction the managers have to spend their attention to some issues(Dutton and Duncan 1987;Dutton and Ashford 1993). This limitation firstly defines success of outcome of strategic issue diagnosis.

In detecting of issues,top managers determine which issue will be examined and will interest their organisations.This is very socio-political process(Mintzberg et all 1976).Some of sources of issue identify them naturally as being examined (King1984).For example, "if the boss or board of directors identifies an issue it will undoubtedly at least begin its trek through the SIM".

Dutton and Ottensmeyer (1987) suggested two different approaches to identifying issues. The first one for internal issue is performance gap analysis that is a way to detect problems . The second one is environmental scanning system for external issues.

In the interpretation phase ,issues confronted by top managers are assessed according to some criteria.In this step, issue either will be turn into strategic one or ordinary one. Ansoff(1980) proposed impact and urgency as criteria to assess them. In addition strategy relevance, actionability, criticality and urgency are criteria suggested by King(1984). It can be said that King's criteria cover Ansoff's ones. Interpretation phase plays a role as filter (King 1984).If the filter is very tight organisation for which the filter work will likely miss important issues for it. If otherwise, organisation will have big load, which results in low efficiency in use of its resource.

In the action planning, issues are assigned priorities, in other words they are ranked according to their relative importance. These assignment is based on mainly interpretation of issues.

Since our model is concerned with internal issue,our attention turns to these ones. Internal issues is detected by performance gap analysis that is a way to detect problems(Dutton and Ottensmeyer 1987;Smith 1989). Although why the researchers proposed performance gap analysis for internal analysis is not clear it can be explained in terms of concept of delay of system dynamics as follows:There is a delay between performance and causal variables. We assume that D1 and D2 are delays between performance and internal causal variables ,and performance and external causal variables, respectively. Since D1 is smaller than D2, a change in internal condition affect performance fast than one in external condition.

Cowan(1986) developed a model for recognition of problems based on gap analysis. To Cowan, problems can be detected in two ways. First one is based on magnitude of the discrepancy between existing state and desired.When the magnitude is as big as sufficiently it is accepted that there is a problem. If the magnitude is not so much , persistence of discrepancy will be monitored, which is the second way. When this persistency goes on , it likely points a problem.

A Review of Problem Detection Models

Firstly it can be said that problem detection models are scarce in number(Polat 1992). These models can be divided into two groups:qualitative models and quantitative models. Qualatative ones are out of concern of this study. The quantitative models can be classified as descriptive and prescriptive. Altman Z score(Altman 1968),and D'aveni D score (D'aveni 1989) are examples for descriptive ones and mainly concerned with bankruptcy of an organisation. These models are based on statistical analysis on cross-sectional and historical data and define a band or threshold for banckrupty.If a organisation's score fall in the band it is likely to be said organisation has no problem.The magnitude of band varies with the model. For example 3-1.8 is a band for Altman Z score. In D score, if you have small D score you have likely a problem/or problems.

STEMCOM (Sharma and Achabal 1982) is a prescriptive model and based on theory of control chart and applicable to divisions in a multiproduct company. It shows whether division under question has a problem or not.

We can assess them in respect to some dimensions. The first dimension is performance criteria used in these model. Performance criteria should be consistent with the responsibility of the organisational level under question(Polat 1992). Descriptive model 's performance criteria are related with top level management responsibility but responsibility of divisions in a multiproduct company that is our concern in this study. The second dimension is performance standards used in these models. Bourgeois(1980) divided performance standards into two parts: organisation-out-standards and organization-in-standards. Organization-out-standards are produced from performance values of other organisations which live in same environment with the organisation under concern. Organization-in -standards are generated from organization own performance values. These models use organisation- out- standards having some shortcomings(Smith 1990,Wijts 1990). These shortcomings is a result of differences among such as, strategies structures, financial structures of organisations of which performance values are used for producing performance standards.

Model Conceptualizing

The model developed in this research is based on performance gap analysis that is a way to detect problem. According to performance gap approach, problems is detected by examining magnitude of the gap and also by monotoring the continuity of the gap(Cowan 1986). Main process of problem detecting is to define desired states,to measure reality(existing state) and compare them.If there is a meaningful gap or continuity, it can be said that there is likely a problem .

In real life , there is always a gap between reality and desired states. How can anyone know that the gap comes from chance or systematic changes? These assessments can be made subjective and objective depending on tool available. If so assessments at strategic level are made subjective it is likely to arrive at wrong results,due to a lot of disturbance factors at work. In that matter control chart theory can help anyone (Sharma and Achabal 1982).

Performance gap analysis to detect problem, requires four parameters:performance criteria, performance standard, limits to show existence of problem, and measured reality. Performance criteria and performance standard are related to each other. Performance criteria are a construct such as a profit, profitability etc. Performance standard is a numerical value of the criteria such as 50 % profitability etc. The limits are based on distribution of performance standard in objective assessment as in control charts. To construct limits, we need a distribution of performance standards.Here we face a situation to make a decision on which standards are used. As aforementioned due to shortcoming of organisation-out standards, we should use organisation-in standards. There are only one method available to give distributions of performance standards(Polat 1992). This method is to use past performance values of the organisation under question. Using past performance values for constructing performance standard carries some shortcomings like organisation-out-standards(Polat 1992), which led us to try to a new model to generate distributions of performance standards.

Model Construction

The first step of the model construction is to define analysis unit . It defines design parameters of a model. In this resarch, analysis unit shows type of organization for which a model is developed. Type of a organization is characterized mainly with its organizational structure and its products. The structure mostly determined by the products. Firms that produce consumer products are more likely structured with mechanistic concept and work a machine(Mintzberg 1979).

Type of organisational structure is relevant to our study for three reasons. The first reason is that strategic issues that are defined as efficiency and effectiveness in this research are dependent on the structure(King 1982,1984;Dutton and Ottensmeyer 1987;Dutton and Jackson 1987). The second

reason is that system dynamics models are constructed according to organisational structure that defines how it works and process(Wolstenholme 1991,1983;Morecroft 1982). The third reason is related to selecting performance criteria to be used.We are interested in firms which produces consumer products, is structured along with mechanistic concept and nested in a multi product company which is called divisionalized structure in terms of Mintzberg terminology. Type of analysis unit defines performance criteria to be used for performance control(Polat1992). Performance control mechanism used by head of company is related to degree of autonomy of a division. In a divisionalized company, control over the divisions are exercised by the head of the company using performance criteria(Mintzberg 1979;Polat1992).

Which performance criteria is used for control is dependent on relationship between the head of company and divisions. Mostly, there are two type of relationship in a divisonalized company;namely profit centre and investment centre. A profit centre is responsible for operating functions and responsibility of strategy formulation rest with the head of the company. An investment centre called strategic business unit is responsible both operating functions and strategy formulations.In profit centres profit is a widely used performance criteria. Profitability goes for investment centre. Since our analysis unit is a profit centre profit was chosen as performance criteria.

Definition of Strategic Changes in Effectiveness and Efficiency

Definition of strategic changes in efficiency and effectiveness is crucial to construction of the model. Everything changes and also efficiency and effectiveness change. Is it economic to take into consideration every changes? For example, at a shoes factory, let us assume that a worker produced 50 pair of shoes on Monday and on Tuesday he/she produced 49. In that case there is a change in productivity. What do management of the shoes factory on realising the change? The control chart theory helps managers in such situations. According to the control chart theory, there are two types of changes.(Grant and Leavenworth 1980;Juran and Gryna 1979;Duncan 1974). One of them stems from common cause in the system Other one is a result of assignable cause. Their characteristics are shown in table 1. The control chart theory tells us that if your changes results from common causes you should not intervene the system. If otherwise, you should intervene the system and produce new strategy against assignable cause.

Table 1. Characteristics of Causes

Common causes	Assignable causes
*a lot in the system	*few in the system
*causes little change in system	*cause big change in system
*not economic to eliminate them	*economic to eliminate them
*process under control only if they are present	*process out of control if they are present

Two criteria was used for defining strategic issue in this research; importance and criticality of issues. The importance is judged on basis of followings:

*its influence on the organisational performance
*its influence on the strategy which an organisation follows
*its influence on how organisation works

Based on the above we choose efficiency and effectiveness. Why we choose them can be explained as follows:Before doing this we should define efficiency and effectiveness.Some authors give different definitions for effectiveness and efficiency. Mostly they are used interchangeablely.In this paper they are defined based on Eilon(1984) as follows:

Efficiency = Actual Output / Planned Output

Effectiveness = Actual Output/Potential Output

The reason for choosing efficiency and effectiveness are the followings:
*Planning is very crucial to mechanistic organizations which is our analysis unit(Miller1983;Mintzberg 1979). Goals of these organisations is to achieve planned output(Quinn andCameron 1983). They are characterised by concepts of efficiency and effectiveness(Quinn and Cameron 1983;Miller 1983;Mintzberg 1979).
*Efficiency and effectiveness are ones of factors to affect organisational performance(Connat et all 1990;Schoeffler 1975).
*In mature industries efficiency and effectiveness have a positive effect on organisational performance(Macmillan et all 1982).

Criticality of an issue is concerned with time at which change of an issue has an importance.If a change in an issue is a result of common causes it has no criticality.If otherwise it reachs a critical situation that means that changes go out of control.

In this research, strategic changes was defined as an issue shows a change steming from assignable causes. We uses concept of normal changes of effectiveness and efficiency for modelling. It means that changes in efficiency and effectiveness are results of common causes in the company under question.

The Developed Model

The purpose of the model is to show which profit values point that there is a likely strategic changes in efficiency and effectiveness of the company. Our model was constructed according to problem detection concept to detect the strategic changes . As explained above problem detection requires a distribution of performance standard and a band(limits) to show existence of problems.To do so the model consists of two sub model ; namely simulation sub model and control chart sub model .

The simulation sub model produces profit values under the normal changes of effectiveness , efficiency and demand. It works like a distribution generator for performance standard .Control chart model gets the profit values produced by the simulation model and defines the limits to point strategic changes in them.Each model is explained below.

The Simulation Sub Model

The simulation sub model is a system dynamics model and was constructed mainly based on the followings: how the company works and concept of effectiveness and efficiency How an organisation works defines the structure of system dynamics models(Wolstenholme 1991;Morecroft 1982). We define how organisations that are our analysis unit works as follows: The company produces ,distributes and sells consumer products.It has a factory to produce its products and stock them at the factory storage. Products in the storage are delivered to market by its distribution force. In market it has sales points which consist of sale force and facilities to sell its products. Consumers come to sale point and buy the products he/she wants. As mentioned before our analysis unit is a mechanistic

company.In this type organisations planning is very crucial to how it will work. Every activity is conducted according to plans. How much will be produced, how much will be distributed are planned in advance and everything goes on as planned. Planning fixes activities such as production rate, delivery rate for a defined period of time. For such a production-distribution -selling companies main causal diagram can be depicted in figure 1.

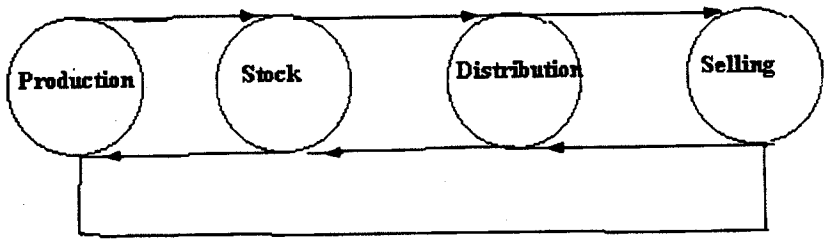

Figure 1.General Structure of Production-Distribution-Selling System

Based on planning for a defined period of time since there is no some information into back (such as from selling to production)during this period we can eliminate these information flows. Resulting causal diagram will be as below.

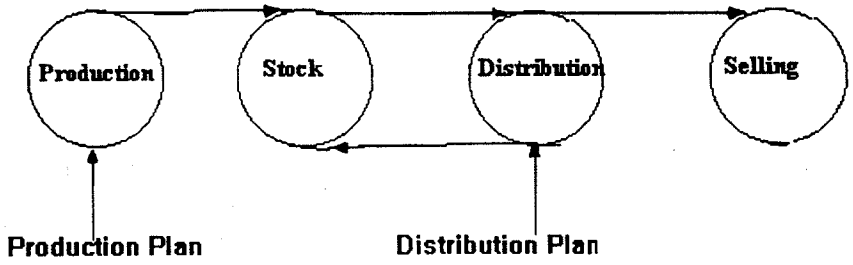

Figure 2.

Efficiency and effectiveness have been defined above. We divided efficiency and effectiveness into three parts according to King(1981,1982,1984). This division was made along with functions of the company: production, distrubution and selling. For production and distrubution, efficiency was chosen strategic issue, because efficiency is related to planning that is very important to companies that are our analysis unit. In addition, in mechanistic organisations rational planning can be done,which means that planning outcome is equal to potential outcome(Miller 1983;Mintberg 1979). For selling function, since potantial outcome is more suitable than planned outcome,effectiveness was chosen. They were introduced into model by means of random number. When we merge functions of the company,its structure and concept of efficiency and effectiveness,general structure of the system dynamics model will become in figure 3.

Figure 3 tell us followings: Production section produces products according to production plans. Depending on efficiency of production, production rate is determined. Products flow into storage at factory. Distrubution section delivers goods from storage at factory to market according to distribution plans. Depending on efficiency of distribution, planned distribution rate, and level of

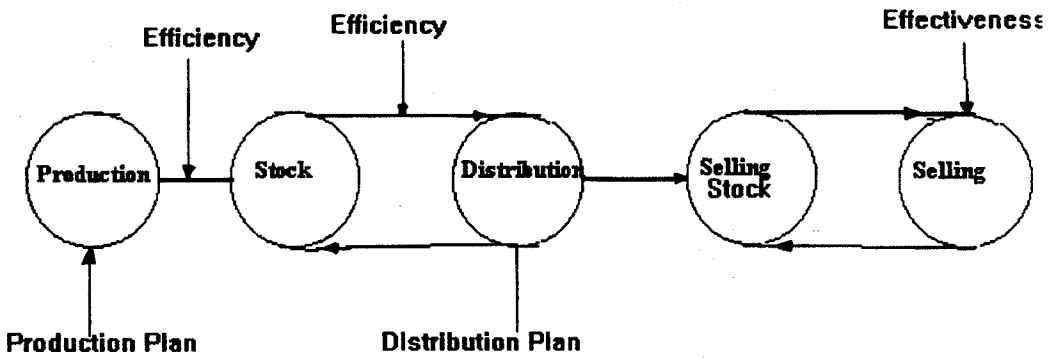

Figure 3.General Structure of the System Dynamics Model

stock at the factory distribution rate is determined. Distributed goods flow into stock at the sale points. Sales function convert demand for the products into sale. Selling rate is dependent on demand,sales effectiveness and stock at the sale point.

The system dynamics model consists of five sub systems: production,distribution,selling,cash flow and performance. In production subsystem, production rate, stock, distrubution rate from stock to market and relationship among them are modelled. Production rate is a function of planned production and production efficiency. Stock is a function of previous stock,production rate and distribution rate. Distribution rate is a function of planned distribution and distribution efficiency.In distribution subsystem, distributed goods from stock to market, delivered goods to market are modelled. Delivered goods are a function of distributed goods and delay in the delivery.In selling subsystem,delivered goods to market, stock at sales points, selling rate and demand are modelled. Stock at sale points is a function of delivered goods and selling rate.Selling rate is a function of stock at sale points,demand, and selling effectiveness. Demand is a function of average market share of firm, and standard deviation of the market share.In cash subsystem, cost incurred by firm and income resulting from selling are modelled.In performance subsystem, profit is modelled.

The Control Diagram Sub Model

The second sub model, namely control diagram model is aimed at determining which profit values show that there are strategic changes in effectiveness and efficiency of the company.The control diagram model takes profit values from the simulation model and converts them into a control diagram. To construct a control diagram,we follow the following procedure:

•determining type of control diagram which fits our purpose
•determining process characteristics (in other words performance criteria) which will be monitored
•defining control limits and central line

Control charts can be divided into two parts, according to process characteristics under concern:attributes and measures(Grant and Leavenworth 1980).Profits,length of a bar etc. are examples for measures. Charts of Measures can be also divided into two parts: averages and individual. Individual measures_ charts are established when only one value can be taken from process or it is difficult to establish average charts(Grant and Leavenworth 1980;Duncan 1974). In the light of control chart theory we chose:

* profit as process characteristic because it is a performance criteria for profit centers.
* individual control charts ,because profit is a measure and an individual data.
* Followings for Control limits and central line (Grant and Leavenworth 1980).

$UCL = X + A*\sigma x$
$CL = X$
$UCL = X - A*\sigma x$
where
UCL : Upper Control Limit
CL : Central Line
LCL : Lower Control Limit
X : Mean
σx : Standard Deviation
A : Constant

X and σx are process characteristics and independent of management. On contrary, A is a parameter and dependent on management. As usually , 3 is chosen for A. If A is high,when process contains assignable cause it is more likely chart says that there is no any assignable cause. If other wise, when process doesn't contain assignable cause, it is more likely that chart says that there is assignable cause in the process.

Illustrative Example

We applied the integrative model to a Turkish company which produces paint. Data of the company was taken from accounting and planning department of the company(see table 2). Values of efficiency and effectiveness were estimated by its planners and assumed fitted to normal distribution.

Table 2. Simulation Variables And Their Values

Variable	Value	Dimension
Distribution Cost Per Product	25000	TL/Ton
Production Energy Cost Per Product	20000	TL/Ton
Material Cost Per Product	523000	TL/Ton
Selling Cost Per Product	75000	TL/Ton
Selling Price Per Product	1670000	TL/Ton
Stock Cost Per Product	642000	TL/ton
Cost of Stock in Process Per Product	481000	TL/Ton
Total Distribution Quantity	15050	Ton
Total Average Demand	15550	Ton
Total Labour Cost	2.6E+08	TL
Total Fixed Cost	1.8E+09	TL
Standart Deviation of Demand	520	Ton
Total Production	15550	Ton
Planned Production Per Week	1170	Ton/Week
Average Distribution Efficiency	0.93	Dimensionless
Average Selling Effectiveness	0.9	Dimensionless
Average Production Efficiency	0.9	Dimensionless
Standart Deviation of Distribution Efficiec	0.01	Dimensionless
Standart Deviation of Selling Effectivene	0.01	Dimensionless
Standart Deviation of Production Efficien	0.02	Dimensionless

We can not say that this Turkish company is just one to which our model ican be applied. We made some assumption when obtaining the company data. Dimensions of time, money and unit were measured in week, Turkish Liras, and ton respectively.

To calculate the average and standart deviation of the profit that can be attainable under the normal changes of efficiency and effectiveness we need a sample for profit. Sample size was calculated 135 when 0.99 for reliability and 0.0025 for relative variation was chosen.The simulation model run 135 times with same data, under the different random number seed.

Validation of the Simulation Model

There is no consessus on which validation method is the best for system dynamics models(Sterman 1984). It is dependent on modelling purpose and background of the researcher.However ,a confidence interval should be built(Sterman 1984). To build a confidence in our model we should test its outputs with the profit formula .

We hypothesised that there is no difference between average profit value calculated by profit formula and average of the profit values produced by the simulation model. Average profit was formulated as below:

AVERAGE PROFIT = AVERAGE SALES * SALES PRICE – [AVERAGE PRODUCTION* (MATERIAL COST+ENERGY COST) + AVERAGE DISTRIBUTED GOODS*DISTRIBUTION COST + AVERAGE SALES*SALES COST + LABOUR COST + CONSTANT COST]

When we place the relevant numerical values in the formula above

AVERAGE PROFIT = 15.550*0.90*1.670.000 – [15.550*0.90(523.000+20.000)+15.550*0.90* 75.000+15.050*0.93*25.000+1.797.000.000+ 260.000.000

= 1.23158*E10

Average profit is equal to 1.23158*E10

Using the hypothesis formula below and putting the value of the variables in their place

$Z = (X-X')/\sigma x/\sqrt{n}$ here X = 12303543489 X' = 1.23158*E10 σx = 183638078

Z is obtained -0.77 .For reliability level of 0.01, Z(0.01) is found 3.3. Compared Z with Z(0.01) it can be said that there is no likely significant difference average profit value calculated by formula and average profit value from the simulation model.

Results

The simulation model was run 135 times with data of the Turkish company. The results of the simulation runs are shown in table 3. In order to calculate limits and central line of the control chart, avarage and standard deviation of 135 profit data was calculated and found 12303543489.9 and 183638078.2 respectively. UCL,CL,LCL of the chart was calculated as follows:12854457724,12303543489 and 11752629255.

To detect whether strategic changes in effectiveness and efficiency are present or not,real profit value taken from accounting figures should be set on the chart.If the profit fall between the 12854457724

and 1752629255 chart says that there is no likely working changes in effectiveness and efficiency of the company.

Table 3. Results of Simulation Runs

N.R	Profit	N.R	Profit	N.R	Profit	N.R	Profit
1	12354405688	55	12188870924	82	12138031545	109	12026681171
2	12241202031	56	12215285089	83	12474061719	110	12284566233
3	12535038220	57	12495151535	84	12008349152	111	12159350119
4	11897826559	58	12223438113	85	12092463603	112	12454133334
5	12476389936	59	12274749787	86	12369729356	113	12517667387
6	12249073885	60	12322169987	87	12110542185	114	12429235937
7	12332138983	61	12175720649	88	12014030586	115	12629066927
8	12499310422	62	12297332654	89	12514163850	116	12202823346
9	12152324746	63	12391690391	90	12071196519	117	12415523508
10	12460410826	64	12314315811	91	12487280972	118	12413432725
11	12387401861	65	12357531226	92	12223182349	119	12313974072
12	12105072288	66	12152261263	93	12275732810	120	12238896280
13	12425915116	67	12001361127	94	12894542151	121	12434797478
14	12005598467	68	12216432146	95	12266064040	122	12239862876
15	12162928525	69	12064370187	96	12749597397	123	12278803638
16	12508039029	70	12155704598	97	12350268037	124	11918397904
17	12250131058	71	12161303237	98	12285560474	125	12272662297
18	12303093493	72	12192117339	99	12387734462	126	12400387634
19	12200390912	73	12115435109	100	12329217329	127	12021311020
20	12156779336	74	12234609001	101	12473518652	128	12194333277
21	12148182870	75	12185347936	102	12459336600	129	12214632583
22	12126205053	76	12306213540	103	12056487405	130	12378678199
23	11841071720	77	12166091815	104	12302347191	131	12250191828
24	12366699696	78	12636315985	105	12037637675	132	11972794535
25	12476552502	79	11998280139	106	12585923681	133	12340276856
26	12324129944	80	12384614621	107	12426575436	134	12509714305
27	12269445690	81	12391426799	108	12696971579	135	12496439304

N.R:Number of Run

Conclusion

We arrived at some conclusion as follows:In this research an integrative model was developed to detect strategic changes in effectiveness and efficiency of a company. Its use is restricted to organisations that are structured along with mechanistic fashion and produce consumer products. Different concepts and techniques such as control chart and system dynamics was incorporated into a new model. We used synergy of gathering different concepts and techniques under a common one. we can say that detecting strategic changes offers a lot to system dynamics practioners and using management management science with system dynamics will likely increase strength of them.

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