

DEVELOPMENT OF PROCESS-BASED ENTROPY MEASUREMENT  
FRAMEWORK FOR ORGANIZATIONS

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*To my beloved mother who always supports me from heaven*

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## ABSTRACT

Managing organizations by routine functional controls makes it difficult to focus on the regions beyond and between functional areas. This leads to disorder in organizations and to control this disorder, it is proposed that measuring entropy as an important concept in systems can help significantly in controlling and decreasing disorder. Entropy is based on the degree of order and disorder and is a complicated indicator for measuring social system. Based on literature, only three studies have been conducted for entropy measurement in organizations and these are theoretical based. In this research, a model for entropy measurement based on organizational process for practical application was developed. It was designed and implemented using a to-be management system based on customized business process models. Effectiveness of this model was based on measurement of entropy. In the first stage, a qualitative survey was designed and implemented to define the gap between as-is state of management systems and identify the best process. In this survey, all organizational activities were analyzed based on established models such as Turtle Model and Process Hierarchy Diagram (PHD). From the findings, the formulas for measuring entropy were defined based on effectiveness and efficiency of designed processes. Then, the model was implemented in Bandar Imam Petrochemical Company (BIPC), Iran for six months and the entropy results were analyzed to measure the effectiveness of the designed model. Two sets of data were collected before and after the implementation of the model in a longitudinal manner. ANOVA and linear regression analyses on pre and post implementation data showed a significant decrease in entropy level. Additionally, results of an extra survey among 11 of the company's top managers showed that more than 70% of them agreed on the effectiveness of the proposed model and entropy measurement framework. Findings of the present study indicate that the proposed process based model and formulas for measuring entropy are likely to result in better performance of an organization. The proposed entropy model for managing disorder in organizations has been proven to be practical and effective in controlling entropy level.

## ABSTRAK

Mengurus organisasi dengan kawalan kefungsi rutin menyebabkan kesukaran untuk memberikan tumpuan terhadap kawasan luar dan dalam lingkungan bidang fungsian. Ini membawa kepada gangguan dalam organisasi dan untuk mengawal gangguan tersebut, adalah dicadangkan bahawa pengukuran entropi sebagai satu konsep utama dalam sistem dapat membantu secara signifikan dalam mengawal dan mengurangkan gangguan. Entropi adalah berdasarkan aras penyusunan dan gangguan dan ia merupakan petunjuk yang rumit bagi mengukur sistem sosial. Berdasarkan literatur, hanya tiga kajian yang telah dijalankan bagi pengukuran entropi dalam organisasi dan kajian ini adalah berasaskan teori. Dalam kajian ini, satu model pengukuran entropi berasaskan proses organisasi untuk aplikasi yang praktikal telah dibangunkan. Ia direka bentuk dan dilaksanakan menggunakan sistem pengurusan *to-be* berdasarkan model proses perniagaan yang disesuaikan. Keberkesanan model tersebut adalah berdasarkan pengukuran entropi. Pada peringkat pertama, kajian kualitatif direka bentuk dan dijalankan bagi menentukan jurang di antara sistem pengurusan *as-is state* dan mengenal pasti proses terbaik. Dalam kajian ini, semua aktiviti organisasi dianalisis berdasarkan model yang terkemuka seperti Model Turtle dan Diagram Proses Hierarki (PHD). Daripada dapatan kajian, formula bagi mengukur entropi ditentukan berdasarkan keberkesanan dan kecekapan proses yang direka bentuk. Setelah itu, model berkenaan digunakan di Syarikat Petrokimia Bandar Imam (BIPC), Iran selama enam bulan dan hasil entropi dianalisis bagi mengukur keberkesanan model yang direka bentuk tersebut. Dua set data telah dikumpulkan sebelum dan selepas model tersebut digunakan secara longitudinal. Analisis ANOVA dan regresi linear ke atas data sebelum dan selepas pelaksanaan menunjukkan penurunan yang signifikan dalam aras entropi. Di samping itu, hasil dapatan kaji selidik tambahan ke atas 11 orang pengurus atasan syarikat menunjukkan lebih daripada 70% daripada mereka bersetuju dengan keberkesanan model yang dicadangkan dan kerangka kerja pengukuran entropi. Hasil kajian ini menunjukkan bahawa model berdasarkan proses yang dicadangkan dan formula untuk mengukur entropi adalah cenderung menghasilkan prestasi yang lebih baik bagi sesebuah organisasi. Model entropi yang dicadangkan bagi mengurus gangguan dalam organisasi terbukti praktikal dan berkesan dalam mengawal aras entropi.

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## LIST OF ABBREVIATIONS

AIAG	-	Automotive Industry Action Group
ANOVA	-	Analysis of Variances
APQC	-	American productivity and quality center
APQP	-	Advanced Product Quality Planning
AVI	-	Availability Value Index
BIPC	-	Bandar Imam Petrochemical Company
BPR	-	Business Process Reengineering
BSC	-	Balanced Scorecard
CEO	-	Chief Executive Officer
CMMI	-	Capability Maturity Model Integration
CMMS	-	Computerized Maintenance Management System
CPK	-	Capability of Process
CRM	-	Customer Relationship Management
DFD	-	Data Flow Diagrams
EC	-	Electronic Commerce
EFQM	-	European Foundation for Quality Management
Ek	-	Indicator of Effectiveness or Efficiency
EOAVI	-	Entropy Level of Availability Index
EOM	-	Entropy of Maintenance Process
EOMTB	-	Entropy Level of Mean Time Between Failure
EOP	-	Entropy of Production Process
EOQ	-	Entropy Level of Quality
EOSP	-	Entropy of Strategic Planning Process
EOTD	-	Entropy Level of On Time Delivery
ERP	-	Enterprise Resource Planning
ESP	-	Effectiveness of Strategic Planning
FHD	-	Function Hierarchy Diagrams
GST	-	General System Theory
H	-	Shannon's entropy

IATF	-	International Automotive Task Force
Ik	-	Indicator
IMS	-	Integrated Management System
IT	-	Information Technology
K	-	Boltzmann's constant
KPI	-	Key Performance Indicators
KPIDj	-	Deviation of key performance indicators from selected target
MTBF	-	Mean Time between Failures
OTD	-	On Time Delivery
P	-	Probability
PCF	-	Process Classification Framework
PHD	-	Process Hierarchical Diagram
PPE	-	Production Process Effectiveness
Q	-	Heat
QC	-	Quality Control
QCC	-	Quality Control Circles
QM	-	Quality Management
R	-	Relationship
RADAR	-	Results, Approach, Deployment, Assessment & Refine
S	-	Entropy
SAP	-	Systems, Applications and Products in Data Processing
SCM	-	Supply Chain Management
SET	-	Social Entropy Theory
SWOT	-	Strengths, Weaknesses, Opportunities, and Threats
T	-	Temperature
TE	-	Total Entropy
TEE	-	Total External Entropy
TEOP	-	Total Entropy of Process
TEOPM	-	Total Effectiveness of PM Process
TIE	-	Total Internal Entropy
TNOP	-	Total Negentropy of Process
TQM	-	Total Quality Management
TWP	-	Total Weight of Process
W	-	Microstates Consistent
WGj	-	Weight for objective number J
Wi	-	Weights of Indicator

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Preface**

Growing changes of today's business environment in connection with the globalization of economy obliges the organizations to be more flexible. Nowadays, business environment has become so competitive so organizations ought to be alert to respond to the new challenges and opportunities. The new emerged phenomena in trade markets such as linearization have brought new situations that are described mainly by unsteadiness and tough competitions in markets. In this new emerged and competitive environment, the concentration of businesses have been somehow transformed from conventional issues like quality to new priorities like flexibility so, the role of new management approaches is considered important. In other words, quality has been considered as the basis of businesses which has been already existed.

Undoubtedly one of the greatest achievements of managerial sciences in the recent decades, regarding to the above notes, comes from the systemic approach and assuming organizations as open systems. The mentioned approach for managing the organization tries to realize organization as a live system and not just as a simple gathers of human beings. This mentioned approach also applies the theories used for live systems to analyze the important factors that affect the organizational systems.

Despite the progresses made within managerial techniques, one of the most important principles of the live and open systems, the state of balance and equilibrium in open systems still remains vastly neglected and just a few researches have been done in this regard (Flood, 2010). Failing to take equilibrium into account and not considering its remarkable effects result in applying different models for controlling all kinds of activities of an organization including day to day activities and strategic activities simultaneously.

In the present research, it is attempted to develop a new model for managing organizations based on one of the most important concepts of open systems known as entropy. In fact, entropy shows the state of equilibrium in live systems and can be defined as the level of order or disorder in an organizational system and its business processes. In this research, it is aimed to design the entropy measurement model based on organization`s processes. The main difference of this research with the previous ones is measuring and monitoring entropy based on organization`s processes. In order to achieve this objective, at first total organizational system and the processes had to be designed and implemented according to BPR models. In order to do so, the generic business process model is customized for a selected company in Iran (BIPC) as the research`s field of study. Therefore the researcher had to concentrate on this area and tried to design and implement the proper business process model for BIPC as the biggest petrochemical company in Iran.

Previous experiences in implementing generic business models in Iran implied that these generic process models (such as APQC`s process classification framework, Porter`s process model, and SAP business process maps) and BPR methodologies cannot be used for Iranian organizations without customization. Because the situation of Iran is so different from developed countries for which well-known business process models have been applied. As a result, the researcher had to work on a new methodology which would be suitable for the Iranian organizations. In other words, he was supposed to design and develop a new process model which would be considered as another output of this research.

After applying the new developed process model, it was attempted to design a new model for measuring the entropy of the designed processes and organizational system in order to control and manage order and disorder. As it will be explained in following chapters, there was a need for well-defined indicators for quantitative measurement of effectiveness and efficiency of processes. As a matter of fact, the formulas whose development will be presented in chapter 3 for entropy measurement have been originated from these two concepts (effectiveness and efficiency) so that the output of the formulas for entropy measurement can be compared with predefined acceptance criteria. Finally, the concept of order and disorder (entropy) can be measured quantitatively. This framework enables the researcher to investigate the effect of implementing process management system on controlling entropy and see whether the process framework result in entropy decrease. Meanwhile, measuring entropy can be used in a model to control day to day and development activities simultaneously.

This research's outputs offer managers the ability to control the equilibrium of the system and its variations quantitatively. Outputs of this research can be used as a new approach for advanced management information systems such as ERP.

## **1.2 Background and Statement of the Problem**

Improved understanding of the social systems' dynamics makes it possible to have reliable predictions and modeling of system's future state (Davis, 1984). Nowadays one important issue for top and middle managers in this dynamic environment is the process of decision making based on reliable information. Efficiency and effectiveness of the management system and their processes are usually measured by calculating the quantity and quality of their outputs (Adesola & Baines, 2005). However analyzing only the outputs does not provide a holistic view of the system's performance.

It seems that the main cause of this problem is the existent quantitative models. In one hand, these type of quantitative models do not offer a whole view of the situation of management system and also its business processes. On the other hand, these models are not able to offer an integrated view of the current and daily activities in an organization as well as the activities that have been defined for achieving strategic goals simultaneously (Lederer Antonucci & Goeke, 2011). For example, strategic planning and control models such as SWOT, HoshinConry and BSC have been used for organizational development as well as many other techniques for current and day to day tasks such as accounting, production planning, sales control and procurement. In addition, many models have been developed for designing, implementing and leading management systems. This leads to a functional relationship between different units of organization which itself results in resource waste because it needs different information systems for a single organization. This research aimed at proving this fact that process approach which brings an integrated attitude to organization, can decrease disorder and help organization achieve its goals while spending less energy and resource as Hammer (2010) argued that process management is aimed to decrease energy and resource waste in organizations.

In order to control disorder, firstly we need to measure it. Entropy is a system variable that indicates level of disorder in systems. Therefore if a framework for measuring entropy based on processes' performance be prepared, it can help in decreasing disorder in two different paths. Firstly, as it is hypothesized in this research, process management models can decrease level of disorder in organization by integrating day to day and development activities and enabling managers to control them simultaneously. Secondly, as entropy is considered a global variable for a system, its measurement can lead to an integrated information system based on which managers can refine and adjust organizational processes and control their performance.

However, hardly there is a research using the basic concepts of system such as entropy as an important factor in monitoring and accelerating operations throughout the organizations. If it is assumed that organizations are open systems,

then managers can use those concepts to conduct their organization in this complex world (Becker, Pfeiffer, Falk, & Räckers, 2010). It seems that entropy is an important concept that all other system concepts can be analyzed simply by measuring and monitoring it as it enables us to control all open systems by keeping them at their equilibrium (Durst & Binder, 2006).

If we measure and monitor entropy, we can control deviation based on the predefined equilibrium and make the best decisions such as corrective or preventive actions in addition to have a holistic view of a management system. As a matter of fact, there are just a few scientific researches which have measured the entropy and equilibrium of an organization (see section 2.2.4.7). Monitoring the balance of a natural system like human body is easy because showing the temperature of 37°C assures us regarding to this balance. But the point to make here is that diagnosis of social system's balance is not as easy as natural system's and it is in need of taking a number of criteria into consideration.

Generally speaking, two diverse powers affect systems. The first one is the power of progression toward excellency and the second one is the tendency of systems toward extinction (Kogetsidis, 2011). Unlike the natural systems such as human body, which cannot live more than a specified time, administrative or managerial systems can survive successfully for several years if they keep their balance and discipline by measuring and controlling the entropy. When we talk about balance in an organizational system, it means complete coordination between environmental changes and the organization's reaction to new conditions (Mettler, 2011).

Entropy is an important factor for supporting the survival of systems because it offers a valuable way to define and measure sustainable systems (Mingers & White, 2010). In a sustainable system the entropy level does not rise to its maximum that is why maximum entropy is tantamount to system's death (Smith, Scott, & Korn, 2011). In order to be sustainable, the system must have subsystems which support the survival of the system as well as supply of material, free energy and sufficient

information for maintaining the entropy level below the maximum (Smith et al., 2011).

In addition to the thermodynamic entropy, statistical equations for entropy measurement have been derived by Boltzmann (1866) in physics and Shannon (1953) in the field of information Theory. Entropy has been also applied in social science in form of social entropy theory (SET). Since entropy is a complex concept and is widely applied in a variety of disciplines, it will be presented in more details in the next chapter.

This research considers entropy as an important appraising and monitoring tool for managerial systems. It provides an integrated measurement that depicts the system's entropy and offers a full insight to the system's behavior and reaction. It can be considered as a basis for information system to provide the best information for managers to lead their organization in a right way.

Entropy will be discussed in detail in the 2<sup>nd</sup> and 3<sup>rd</sup> chapters, looking at organizations through the processes window makes a better framework for both analyzing the reality and controlling it. This is mostly because processes are highly linked to both strategic planning and operations in an organization. It is worth saying that when talking about the processes, it is assumed that those processes are designed thoroughly based on standards. To date, there are limited researches for measuring entropy in organizations; when it comes to entropy measurement based on processes there is actually a full gap in literature (see 2.2.4.7). It has been attempted to fill in this gap by designing a research.

### **1.3 Rationality and Current Interest to the Subject**

System approach analyzes the whole system of an organization according to its stakeholder's requirements in order to find the appropriate ways of managing it (EFQM Excellence Model, 2013). New technologies affect social factors in a way that the social problems cannot be solved by traditional methods (Jeston, 2008). Companies in a modern and competitive environment should solve various kinds of problems. Nowadays, problems of organizations should be solved fundamentally and with considering all aspects of a system. The system approach with its high creative and innovative abilities makes the managers able to find the best solutions in the dynamic environment (Senge, 1990).

When new approaches and methodologies about management and leadership are taken into consideration, the lack of a model specially designed to control all aspects of an organization simultaneously is found (Kohlbacher & Gruenwald, 2011). In other words, there is no model to provide enough information for managing the current activities and strategic activities together. As a result, managers have to apply many models and techniques to lead their organizations. In addition, if a manager is interested to apply a total solution for one company, at first he should combine all separated information about those two mentioned sides of an organization. The majority of mistakes in decision making usually starts from this point, which is incorrect data analysis.

Current Information Technology (IT) systems have been designed based on separated techniques and current management methodologies. So, they will not be able to create an integrated and holistic view of organization's status (Simonsson, Johnson, & Wijkström, 2007; Siriram, 2011). For instance, in one hand, SWOT, HoshinCanery method or BSC are used for defining strategies, goals, and controlling the plan that guides organizational systems toward those pre-defined strategies. On the other hand, there are many methods for controlling current and daily works in organizations such as budgeting, quality control, production planning and control etc.

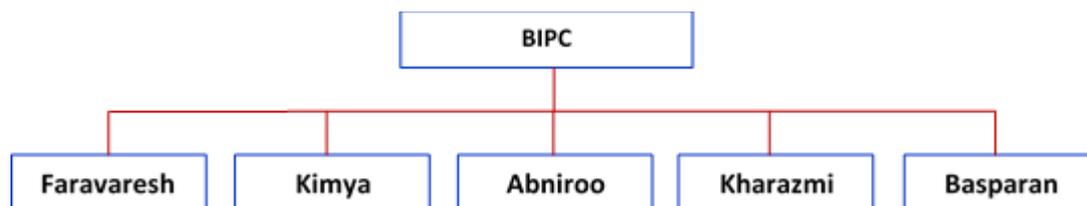
If managers desire to have a comprehensive insight into their organization's status, they need a new approach. These methods should provide them with a panel gauge which in turn should show them order and disorder in current works and strategic progress plans simultaneously. These kinds of management systems can guide them toward a considerable improvement in existing management methods. The most important and remarkable point about this research is developing a model for measuring entropy based on organization's processes which has not been done before.

#### **1.4 Purpose of the Study**

As stated in earlier sections, the general problem is lack of an integrated management system that can help in reducing disorder in organizations. System approach along with a framework to measure entropy as its indicator of disorder in open systems might be the solution. Since the process models represent system approach, designing a proper process model, KPI of which be entropy can provide managers with an integrated management system which they can deploy to control wastivity and disorder in their organization. However, designing a process model and implementing process approach in developing countries including Iran has its own difficulties and contingencies. Therefore the first step to design such system is to explore these contingencies to provide additional inputs to our design. Regarding the stated problem, purpose of the study is to qualitatively explore all the existing inputs and contingencies regarding designing a model for managing disorder in an Iranian case and also quantitatively explain relationship of the proposed model and trend of change in disorder of the selected organization.

## 1.5 Field of Study

Bandar Imam Petrochemical Company is a holding company which includes one parent company and five subsidiaries (figure 1.1) more details about Bandar Imam Petrochemical Company will be presented in Appendix A.



**Figure 1.1** Structure of Bandar Imam Petrochemical Company

## 1.6 Research Questions

### General questions

- R1. What is the suitable process model for BIPC according to all the existing limitations and contingencies?
- R2. How will implementation of the proposed model affect disorder in BIPC?

### Detailed questions

- R1.a what are the limitations and contingencies that affect the design? Or in other words what are all the inputs of the design process? And
- R1.b what are the current state of the organization and its ideal state in terms of process structure? Or in other words what is the gap between the As-Is state of the organization and To-Be state in terms of the process structure?

## 1.7 Research methodology

The objective of the present study was to design a contingent model for managing organizations through the processes and by entropy as the performance indicator of processes and since the question of effectiveness of the proposed model couldn't be neglected, the study was aimed also at implementing the model to evaluate its effectiveness. Therefore, the objectives of the research can be stated as below:

1. Designing a management model which has the following specifications:
  - a. A process map designed based on all the existing contingencies and limitations and
  - b. A framework for evaluating how the processes are working, and
2. Indicating how effective the proposed model is or in other words providing knowledge, based on observations, of whether the proposed model is performing in the manner which it is designed for.

Answering the research questions (R1 and R2) helps to achieve research objectives respectively. For each question to be addressed properly, a strategy and systematic design of research procedures was required. This methodology must include a proper strategy which clears the Meta plan behind all the research procedures and a suitable approach to collect, analyze and interpret data.

Big picture of the methodology includes three main stages: (1) designing the model, (2) implementing it, and (3) evaluating its effectiveness. In the sections 1.7.1 and 1.7.2, the mentioned issues are attempted to be addressed shortly while the complete explanation with details are presented in the third chapter of the thesis.

### 1.7.1 Research Strategy

There are multiple paths of doing research, but selecting the proper path is very important because resources for a research is limited and there has to be decided what not to do to reach research objectives. Strategies for performing a research, according to (Yin, 2013) are in categories of experiments, case studies, surveys, archival analysis, and history. Each of the mentioned categories has its own limitations and functions.

For example to answer the research question of “how”, it is not suitable to choose the survey strategy or when total control over the subject is required the experiment seems the best method. Table 1.1 briefly explains functions and limitations of each strategy.

**Table 1.1** Different types of research strategy

Strategy	Form of research question	Requires control over behavioral event?	Focuses on contemporary events?
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many, how much	No	Yes
Archival analysis	Who, what, where, how many, how much	No	Yes/no
History	How, why	No	No
Case study	How, why	No	Yes

As the strategy is extremely subjected to the research question, a strategy to answer each research question had to be selected. For the first question, a survey was decided to be executed because firstly the question was “what” and secondly the

question had a focus on the contemporary situation (see the detailed questions) of organization which eliminates the choice of case study.

The second question obviously had to be done in an experimental design because a “relationship” is under question and it had to be investigated under control so that the right effect be investigated.

### **1.7.2 Research Design**

#### **First Question**

After selecting the best strategy, selection of best methods and techniques to collect and analyze data is part of the design. In other words it is necessary to go through details of operating the strategy. For the first stage, three outputs were predicted so that by using them the researcher would be able to provide answer to the first question. Those three outputs were (1) inputs of the design process, (2) As-Is state of the organization and (3) To-Be state of the organization. As it was mentioned before, a survey was assumed to help achieve the results. All the parts of the survey are summarized in table 1.2.

**Table 1.2** Details of survey

Analysis	Method	Source
Stakeholders analysis	Archive analysis	Documents
Process identification	Archive analysis	Documents
Strategic planning analysis	Archive analysis	Document
Laws	Archive analysis	Documents
Process maturity level	Interview/focused group	Reference models/ managers
Benchmarking	Benchmarking	Best practices
Policies	Interviews / Archive analysis	Managers / Documents
Complex contingencies	Interview/ Focused group	Managers

### **Second question**

Second question was attempted to be answered in an experimental design. Parameters of the design are as follows:

**Design Type:** time-series design

**Field of Study:** BIPC and its three selected process (production, maintenance and strategic planning)

**Time Scope:** 24 weeks from November 2010 to April 2011

**Experiment (dummy) Variable:** implementation of the proposed model

**Analysis Variables:** entropy of selected processes, experiment variable, total internal entropy, and total external entropy

### **Hypotheses**

H1. Implementation of the proposed management model causes entropy level of production process to decrease.

H2. Implementation of the proposed management model causes entropy level of maintenance process to decrease.

H3. Implementation of the proposed management model causes entropy level of strategic planning process to decrease.

H4. Implementation of the proposed management model causes total (external) entropy level of the organization to decrease.

H5. Implementation of the proposed management model causes total (internal) entropy level of the organization to decrease.

**Sampling Time:** a week for production and maintenance / a month for strategic planning

**Analysis Methods:** comparison of groups by ANOVA & Causality analysis by Regression

**Analysis software:** IBM SPSS v22

## 1.8 Research Objectives

At design stage of this research two main objectives were predicted:

1. Defining a new approach for managing an organization in a more simple and reliable way with measuring and monitoring the entropy, based on the designed processes.

2. Designing a specific method mostly useful for the Iranian organizations so that they can localize international BPR models.

## 1.9 Significance and Contribution of the Study

As it was mentioned in the introduction part of this chapter, entropy is the tendency of a system toward disorder. So, if we can measure entropy in a managerial system, we will be able to monitor the tendency of a system to disorder status and plan for its decrease. Moreover, if we get to know the concept of entropy and its reasons in an organization, we will be able to design the systems of an organization in a way which tendency to disorder eliminate as much as possible. In other words, in the designing phase of an organization, there will be the possibility to decrease potential entropy with efficient design.

From the basic management theories it is known that management is engaged with planning, execution and control. In terms of resources, the following simple formulation can be applied in most organizations:

$$\textit{Input resources} = \textit{Resources for day to day activities} + \textit{Resources for developing activities} + \textit{Resources for entropy elimination}$$

It means all input resources for an organization (human resource, money, infrastructure and etc.) are allocated in three parts:

1. Day to day activities like production, accounting, purchase, customer relationship and etc. which are categorized as “execution”.
2. Strategic activities and development programs, which are categorized as “planning”.

3. Elimination of disorder or entropy like controlling informal organizations, existent conflict between departments, lack of doing effective activities, customer`s dissatisfaction, lack of clarification in everyone`s responsibilities, labor`s dissatisfaction and etc. which are in sense “control” mechanisms and functions.

So, if we can decrease entropy in an organization, simply the resources which waste in order to control entropy will be available for development activities because day to day activities should be done in every situation.

As a whole, it can be said that taking the concept of entropy into consideration and apply this concept in real situation of organization management can have an enormous effect in resource management.

As it was mentioned before, entropy control can occur in two ways:

- A. In designing phase of an organization, entropy can be decreased by clear and precise definition of activities and processes which cause future conflict in an organization.
- B. By making entropy level quantitative so that it can be measured and refined in different departments of an organization by managers.

There is no significant research about controlling entropy in designing phase (first part), so far. Also, in entropy measurement, there is just a limited effort about the concept not in practice.

In this research, it is aimed at working practical and making the condition better for managers to manage their organizations more effectively. In other words, in this research the focus has been on the below issues:

- Designing and defining the mechanism and model for entropy measurement in an organization based on its processes which has not been done before. Entropy measurement and refinement can help managers as a powerful information tool for integrated improvement in different departments.
- Attempting to calculate the entropy of processes and total system in order to help managers to lead their organization easily based on information that will be driven from this important concept.
- Proving the fact that proper process design instead of functional design results in decrease in potential entropy in an organization. So it is possible to develop an improved methodology for moving from functional system towards process system based on controlling the entropy.

Additionally, in this research, it has been attempted to design a total process map for BIPC which can be used by other petrochemical companies everywhere.

### **1.10 Research Limitations**

The researcher in this study encounters some limitations. There are various kinds of research limitations such as limited access to information, data and also methodology limitations. As a whole, the researcher`s limitations are as follows:

- The majority of researches about the role and importance of entropy in organizations are qualitative and there are rarely models which measure entropy. The majority of performed researches in recent years, did not use and test the results in a real situation. In addition, if there is any, those results are not available free of charge.
- Because of the existent limitations in time, resources and also extension of the model, there was no possibility in order to design and deploy the model in total managerial system of the

selected organization. So, the researcher had to pilot the model in this research.

- Deploying the introduced framework in an international organization can't guarantee the accuracy and requirements which is needed for measuring the entropy as well as monitoring and managing all kinds of organizations in all industries.
- Achieving the goals of this research was strictly related to the team working in the selected company as well as its top and middle managers cooperation.
- The studied company is located in the south-west of Iran, 1000 km away from its capital, with an inappropriate weather condition. This fact caused many difficulties for accommodation and travels.
- During the project's implementation, the Iran's government decided to transform BIPC to a private entity and for this reason wide changes were imposed to organization's management structure. During this period, BIPC's CEO and his deputies were replaced and this matter brought a series of challenges for researcher in order to align new managers with the project. Fortunately, the experiences of the researcher in consulting profession and his effective discussions with new CEO and other managerial positions provided the possibility to continue the research. However, these organizational changes have interrupted the research progress for about seven months and therefore the researcher had to hold the training workshops for new managers.

### **1.11 Structure of Thesis**

The present thesis is structured in seven chapters. In chapter two, all the relevant studies and theories are explained in detail. In the third chapter the methodology of research is presented. This chapter includes both design and implementation of the research. Through the fourth and fifth chapters, the researcher tried to answer the first question. In chapter four, results from analysis of the As-Is state of the organization is presented and in chapter five, the ideal and practical model design is explained. Moreover in chapter 5 the framework of quantifying entropy is explained. Through chapter six, quantitative analysis results for answering the second research question is provided and hypotheses testing processes are explained in detail. In the last chapter, a summary of findings of research and implications of findings as well as limitation of the research and guidelines for future research is presented.

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