Diagnosing, Simulating and Improving Business Process Using Cybernetic Laws and the Viable System Model: The Case of a Purchasing Process

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Abstract

This paper approaches business process diagnosis from a cybernetic viewpoint. Ashby's law of requisite variety is used to understand deficiencies of business processes. A case of a purchasing process which suffers from low effectiveness and long waiting times of purchase requests is considered to be improved using cybernetic concepts and models. It is discussed that the problems with the process result from a lack of requisite variety. Then, Stafford Beer's Viable System Model (VSM) is used to ease the problems by balancing the varieties. The static and dynamic aspects of the process are modeled using Data Flow Diagram (DFD) and integrated computer simulation model. It is demonstrated that after applying the VSM, the duration of the process will decrease largely. This is the first study that utilizes cybernetic law and VSM for improvement of a purchasing process through computer simulation and DFD.

Keywords: Organizational Cybernetics; Viable System Model (VSM); Law of Requisite Variety (LRV); Business Process Management (BPM); Computer Simulation

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1 Introduction

1.1 Cybernetics

Norbert wiener gave the name “cybernetics” to the science of communication and control in systems. Stafford Beer redefined cybernetics as “the science of effective organization”. Traditionally, we have thought of control as imposed on a function or a unit by a higher-level authority but in cybernetics viewpoint, a system should be structured in a way that it can control itself. In this way, management has less to do with imposing control, and more with structuring the system so that it can be self-controlling. Cybernetics offers three concepts, which can help enable self-control and self-organization: variety, requisite variety and black boxes. Variety and requisite variety among them are of especial relevance to our matter of concern.

1.2 Variety

Variety is the number of possible states of a system. A one-digit number has 10 different states: 0,1,2,…,9 . A two-digit number has 100 different states. A three-digit number shows 1000 different states. The more complex a system, the more variety it has. “Variety” is a measure of a system complexity as the temperature is a measure of heat. If a system is complex, it has a large variety. If it is simple, the variety is low (Christopher, 2007).

1.2.1 Requisite Variety

Ashby (1956) formulated the basic law of control, which is known as “requisite variety”: “Only variety can absorb variety”. It means the variety of a regulator must be at least as large as that of the system it regulates. In organizational terms, this (for example) concerns ensuring that the capabilities of the systems which perform the task

of regulating, are sufficient to deal with the complexity of the problems which they have to deal with. In even a small business the states of the system – the actions, behaviors, and results of all employees, machines, processes, equipments, all of the interactions among them become beyond human comprehension. The variety of operations is greater than that of the management. If management is to control the operations, the vast variety of operations should be attenuated and the variety of management should be amplified. The varieties should be balanced. This process of 'balancing varieties' is known as variety engineering.

1.2.2 Ways of Balancing Varieties

For balancing varieties, the variety of management should increase and the variety of operations should decrease. There are some well known and some less obvious ways to do so:

Table 1: Some ways of balancing varieties

Increasing management variety	Decreasing operations variety
More managers (and delegation)	More rules
Hire consultants	Obedience
Management training	Discourage innovation
More conferences	Fixed work patterns

However, there is a more effective way to enable units and individuals manage themselves (self-organization and self-control) and it requires proper training and right information flows in the organization.

1.3 The Viable System Model (VSM)

Stafford Beer (1979, 1981 and 1985) developed the "Viable System Model" using cybernetic laws and ideas from neurophysiology. He claimed that any viable system, whether an organism or an organization, has such a structure as showed by VSM. The VSM is a sophisticated model of the implications of Ashby's law of requisite variety for enterprises. VSM can be used for two purposes: 1-diagnosing existing systems; 2-

designing new systems. VSM consists of five elements (system1 to 5), information channels and the environment of the system. The elements are described below:

1- System1: Implementation:

Implementation consists of the various parts of the organization concerned with carrying out the tasks directly related to purposes. The System 1 parts need to be as free as possible to deal with their environments. They too, therefore, must be designed according to the VSM with their own five elements and information systems. Granting autonomy to system1 units is the basis of variety engineering, as in this way an extent of environment variety would be absorbed by system1 units and management will not be overwhelmed by inflow variety.

2- System2: Regulatory direction (coordination):

System 2 fulfils the co-ordination function. System 2 consists of the various rules and regulations that ensure the System 1 parts act cohesively and do not get in each other's way. It will also embed any legal requirements that must be obeyed (Jackson 2003).

3- System 3 (operational control including services management) and 3* (audit): Operational direction; responsible for "inside and now":

System3* is a servant of System3, fulfilling an auditing role to ensure that targets specified by System 3 and rules and regulations promulgated by System 2 are being adhered to. This channel gives System 3 direct access, on a periodic basis, to the state of affairs in the operational elements.

The role of System3 is operational control of System1 and services management (of functions such as human resources and finance). It has overall responsibility for the day-to-day running of the enterprise, trying its best to ensure that policy is implemented appropriately. It sits on the vertical command axis and must produce a coordinated plan and pass it down the line to System 1. It engages in a 'resource bargain' with the parts of System1 during which targets are agreed together with the resources to achieve them. System 3 also

has to report upward any information needed by the policy-determining System 5(Jackson, 2003).

4- Strategic direction (development or intelligence); responsible for "outside and future":

System 4 is the place in the organization where internal information received from System 3 is brought together with information about the organization's total environment and presented in a form that facilitates decision-making. System 4 will also help the organization represent itself to its environment. In general, it is home to activities such as strategic planning, corporate planning, marketing, research and development, and public relations (Jackson, 2003).

5- Executive direction (policy or leadership):

System 5 is responsible for the direction of the whole enterprise. It formulates policy on the basis of the information received from System 4 and communicates this downward, to System 3, for implementation by the divisions. An essential task is balancing the often conflicting internal and external demands placed on the organization. Here it needs to adjudicate between System 3, representing the commitment of autonomic management to ongoing operations, and System 4, which with its links to the environment tends to be outward and future-oriented. System 5 has to ensure that the organization adapts to the external environment as and when necessary, but still maintains the benefits to be gained from internal stability. System 5 must also articulate the identity and purposes of the whole system to the wider system of which it is part. In this role, it is acting as the localized management of a particular element of the System 1 of that wider system (Jackson, 2003). We call system 2-5 the "metasystem". The metasystem in VSM plays the role of brain for human body.

6- Information flows and information systems.

A very important part of VSM is information channels, which link different elements together and allow the information flow in the system.

The functions handled by these five elements must, cybernetics dictates, be adequately performed in all systems that wish to remain viable. The VSM is shown in Figure 1.

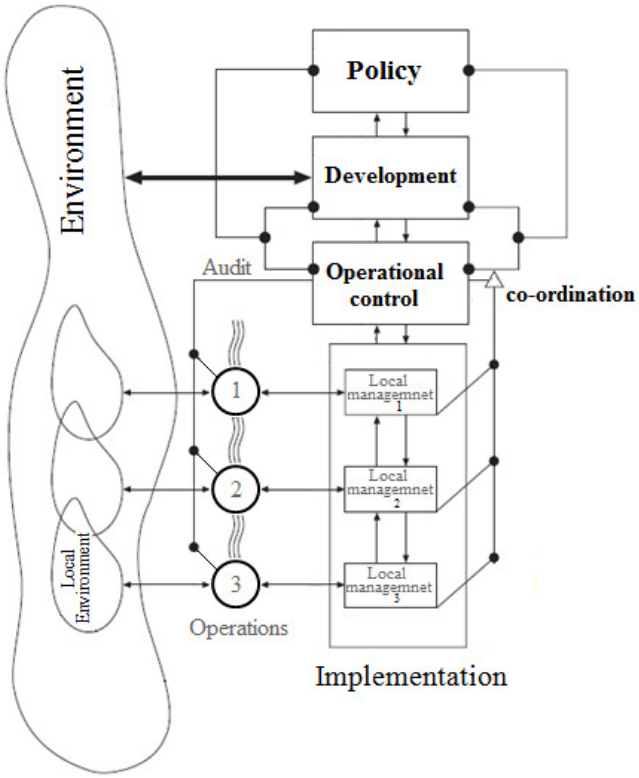

Figure 1: The Viable System Model

2 Literature Review

Since cybernetics supports interdisciplinary laws and models, we can find its applications in a variety of different fields. We'll mention some of them in the following section.

In the environment management field, Lewis (1997) used VSM to analyze environmental management in 7 factories from a systems science view point. He suggested major structural and managerial changes to the factories if they were to remain viable. Lewis and Stewart (2003) explained why business organizations are not effectively integrating the natural environment into business strategy, applying Ashby's law of requisite variety. Leonard (2008) noting the climate change, global warming and difficulties that has been risen as e result, used VSM as a framework for integrating sustainability practices in communities and cities.

Qiu-yan et al. (2007) analyzed manufacturing inter-organizational coordination and inter-organizational information system by the application of managerial cybernetics under environmental uncertainty by a typical case study in automobile company. The results showed that the fit between environmental uncertainty, inter-organizational coordination, and inter-

organizational system can determine the performance of coordination significantly and performance was better when coordination was active and Inter-organizational system was frequently used under the condition of high environmental uncertainty.

In the social, behavioral and organizational field, Schwaninger (2003,2004) dealt with the issue of organizational intelligence from a cybernetics approach. He also approached the evolution of society and organizations from an organizational cybernetics viewpoint. Fransoo and Wiers (2006) investigated the impacts of task complexity on the variety of actions deployed by the planners. Jones et al. (2007) proposed to use VSM and cybernetic thinking as a contextual model to approach multi-agent system simulation in Tijuana-San Diego.

Achterbergh et al. (2003) assessed whether the balanced scorecard supports the necessary functions for organizational viability. They used the VSM as a means to describe the functions required for organizational viability. Then they used the VSM as a template to assess whether and how the balanced scorecard supports these functions for organizational viability. In the financial and budgeting field: Morlidge (2009) used the law of requisite variety for designing an efficient budgeting system.

In the field of information and knowledge management: De Raadt (1990) examined the process of information transmission in adaptive, viable organizational systems. He used VSM to explain a system's information requirement at each time of the adaptation process. Gray (2000) proposed KM as a means of amplifying variety in teams that deal with complex issues. Achterbergh and Vriens (2002) applied VSM to KM and identified domains of knowledge that an organization should possess to maintain its viability. Kovacheva (2006) proposed to utilize VSM as a basis for information technology implementation and development to present organizational cybernetics as a needed methodology for managing modern enterprises. He proposed it is possible to use softwares and techniques to carry out the functions prescribed by VSM. For example it is possible to use goal management software and artificial intelligence (AI) in system5 –policy. It is also possible to use marketing information systems, data mining, neural networks and AI for system4 –development.

Takahashi (2006) proposed Agent-based Organizational Cybernetics which combines organizational cybernetic framework and computational organization theoretic approach, especially agent-based computational learning model. proposed model described the two loops of organizational learning by representing both processes of learning of internal models and resolving tasks by agents. Rosenkranz et al. (2008) developed a method for the analysis and design of information and communication structures. Building on the Design Science Research Framework and using an exemplary case, they showed how coordination complexity can be analyzed and measured. The results were combined with theoretical concepts from management cybernetics and created the foundation for the constructed method.

Ríos, J.P. (2006) attempted to show how the new communication and information technologies and the internet in particular can help in the design of viable organizations and presented a set of specific software tools based on internet, created for the purpose as gived above bundled in two packages. The VDMod package supports the application of Beer's VSM and the inclusion of system dynanics simulation models into the VSM model, as well as easy access to other tools such as team syntegrity. The SystemsNet package allows the members of the systems community to communicate with each other and gain swift access to these tools through the internet.

In the field of process management, Vidgen (1998) argues that the tenets of business process redesign (BPR) are largely consistent with cybernetic principles. He proposed VSM as a guide to the organization of business processes. Di Mascio (2002) comparing service processes with chemical processes discussed that it is possible to recast a service as a feedback control system and apply chemical process control principles to a service process. Snowdon et.al. (2007) used cybernetics and VSM to design a framework for designing and organizing business process support systems. The framework ensures the flexibility of the supporting systems, such as information systems, and consequently being open to change.

Schwaninger (2000) introduced a concept of “intelligent organizations”. He proposed a framework for the design of intelligent organizations that links three organizational cybernetic

models: the Model for Systemic Control, the Viable System Model, and the Team Syntegrity model. The proposition was that a combined use of these models, guided by the integrative conceptual framework, enable a more effective response to complex situations than merely pragmatic approaches to "integrative management". Assimakopoulos, N. and Dimitriou, N (2006) proposed framework was based on the VSM principles and its equivalent problem structuring methodology schema for the design of the information and communication systems together with the coordination structure necessary for a virtual enterprises to become more efficient and flexible. they had investigated the role of virtual enterprises as a new organizational structure viewed from the perspective of cybernetics. In particular, the systemic approach followed was used to formulate a generic four-step architecture for the effective diagnosis and design of virtual enterprises, based on the theoretical principles of Stafford Beer's viable systems model.

In other fields, Benton and Kijima (1998) proposed to define the revolution occurring in Japanese retail distribution from a systems-theoretic perspective. They explained the success of large general merchandising stores and national supermarkets by their ability to meet the increases variety of environment and the failure of traditional retail outlets by their lack of requisite variety. Tejeida-Padilla et.al.(2009) considered MRP, MRPII, ERP and SCM as different levels of recursion of the VSM and proposed Ashby's law of requisite variety as a means of managing complexity in this area. Foster (1997) reviewed the failure reasons of risk analysis and proposed a cybernetic model for risk control. Bassett-Jones, et al. (2007) used VSM for managing the diversity managers face in their organizations. Kinloch et al. (2009) integrated soft systems methodology and VSM to propose a framework for designing information systems. They applied the framework to a UK police authority.

Schwaninger (2004) made a proposal for leveraging the complementarities of system dynamics and organizational cybernetics. At a higher level of abstraction, the author postulated that, for the sake of relevance, this methodological synthesis is to build upon both the positivist and inter-positivist traditions. On this basis, a framework called integrative systems methodology was proposed to help actors at different levels to achieve the requisite

variety. Donaires et al. (2010) presented a proposal of a systemic model composed for the micro and small companies of the region of Ribeira˜o Preto and the agents which influenced their environment. They combined tow system models so that, when facing the results of a field research carried out in micro and small companies of Ribeira˜o Preto and Serta˜ozinho, they could identify and characterize the interaction bonds among these companies, public power and promotion agencies.

Schwaninger, M. and Koerner, M. (2004) had developed a set of conceptual tools that were helpful in coping with dynamic complexity in change and development projects. These tools had in common an inherent logic deriving to a great extent from Stafford Beer's VSM and the St Gall framework for systemic management. The application of the tools was illustrated by a state-of-the-art case study from the realm of Technical Co-operation - the revision of the Urban Master Plan for the City of Addis Ababa, the capital of Ethiopia. Schwaninger, M. (2006) attempted to underpin the theoretical claim of the VSM to specify the necessary and sufficient preconditions of organizations for viability. He explored a number of case studies. The evidence documented in the paper both corroborated the model's claim and provided evidence of its enormous diagnostic power.

Hoebeke, L. (2006) clarified the concept of organizational closure as developed by Stafford Beer in his VSM, defined as System 5. The author referred to his experiences of multi-stakeholder platforms and confronts them with the original texts of Stafford Beer. He took the stance of a reflective practitioner. The identity function, defined as organizational closure, only can be embodied at the boundary of a system, defined by an observer. The author gave an alternative way of thinking about identity different from the mainstream essentialist way of defining identity. He explored the consequences of this way of thinking for governance and governing bodies. He clarified in this way the fundamental tension between participative and representative democracy. This paper is the extension of a talk presented by Azadeh and Darivandi (2010).

3 Background

Functional organizational structures are still popular in Iran, especially in governmental organizations. These organizations suffer from bureaucracy and low speed in doing their tasks and missions. Information flows support hierarchical control and organizational units and processes lack the ability of self-control and self-organization. Here a purchasing process in a functional project-driven organization (called Alpha) is considered to be improved applying VSM and cybernetic laws. The process is one of the major processes of the organization, which is consisted of three businesses and five staff units supporting the three businesses. The organizational chart is shown in Figure 5.

The projects are broken down in businesses. Purchases are categorized in three kinds of purchases: 1- small-sized purchases (under 3500'000 Unit currency) 2- medium-sized purchases (between 3500'000 and 35'000'000 Unit currency) 3- large purchases (larger than 35 million Unit currency). However, only small and medium purchases are considered here.

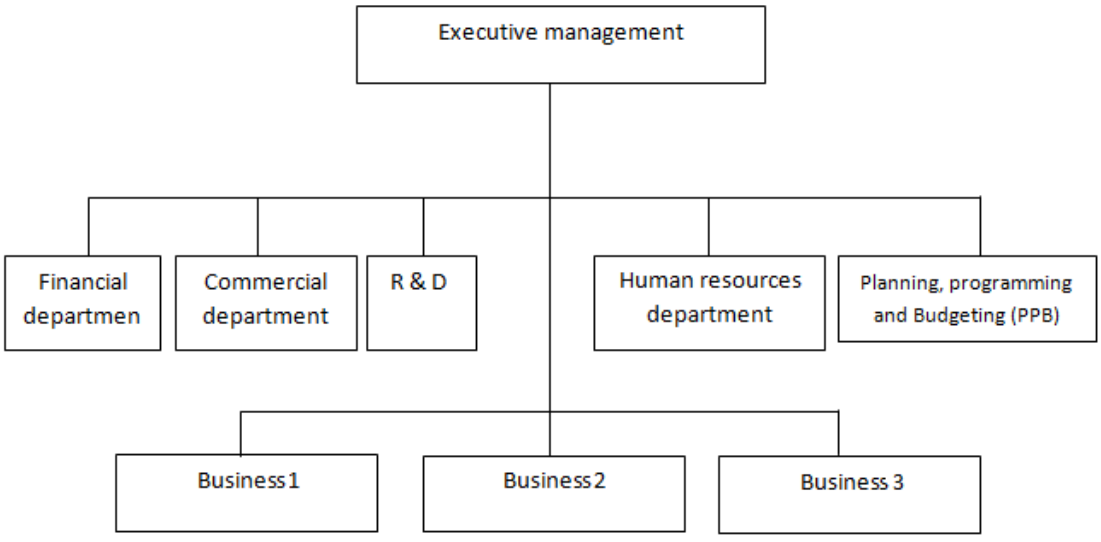

Figure 2: : The organizational chart of the considered organization

All purchases of the three businesses and staff units are all done centrally and concentrated in the commercial department. The businesses suffer from long waiting times of their purchase requests. They also suffer from insufficient expertise of commercial

department employees finding qualified suppliers and the right products since the most of requested goods are high-tech items in need of technical knowledge for making decision. From the other hand the nature of the works of businesses is different and commercial employees deal with three different and high-level technical engineering fields while they mostly have commercial management education and they are not as familiar with those engineering fields. Therefore, they face a great variety since they confront three technical and different fields and a large number of purchase requests each week and month. The formal process procedure is as follows:

Table 2: Current steps of the purchasing process

	Actor	Actor's organizational unit	Activity	Comments
	Request owner	Business	Filling purchase request form	
	Project manager	Business	Confirm purchase request (sign the form)	
	Business manager	Business	Confirm purchase request (sign the form)	
	Warehouse holder	Business	Confirm purchase request (sign the form)	
	Executive man.	Executive man.	Confirm purchase request (sign the form)	
	Request owner	Business	Sending the form to the commercial dep.	
	Purchase manager	Commercial dep.	Assigning a purchase agent to the purchase activity	
	Purchase agent	Commercial dep.	Inquiring into suppliers offered specifications and price.	At least 3 suppliers for medium purchases
	Purchase agent	Commercial dep.	Sending single-source confirmation form to executive	Just for medium purchases for which only 1 supplier is available
0	Executive man.	Executive man.	Confirm single-source form (sign the form)	
1	Purchase agent	Commercial dep.	Sending available suppliers offered specifications to the business	
2	Purchase manager	Commercial dep.	setting technical-commercial committee meeting	
3	technical-commercial committee	Business	Selecting one of the suppliers according to their offered technical specifications	
4	Business manager	Business	Confirm selection form (sign the form)	
5	Purchase manager	Commercial dep.	Confirm selection form (sign the form)	
6	Commercial dep. Manager	Commercial dep.	Confirm selection form (sign the form)	
7	Purchase agent	Commercial dep.	Setting purchase order form and credit request form	
8	Commercial dep. Manager	Commercial dep.	Confirm order form and credit request form	
9	Executive man.	Executive man.	Confirm order form and credit request form	
0	Purchase agent	Commercial dep.	Sending order form, credit request form and all documents to	

	Actor	Actor's organizational unit	Activity	Comments
1	auditor	Financial dep.	Auditing the purchase documents	
2		Financial dep.	Provide Credit	
3	Financial dep. Manager	Financial dep.	Confirm credit request form (sign the form)	
4	Executive man.	Executive man.	Confirm credit request form (sign the form)	
5		Financial dep.	Provide cheque/ cash	
6	Financial dep. Manager	Financial dep.	Sign the cheque	
7	Executive man.	Executive man.	Sign the cheque	
8		Financial dep.	Delivering the cheque to the purchase agent	
9	Purchase agent	Commercial dep.	Doing the purchase	
0	Purchase agent	Commercial dep.	Delivering the orders to request owner	

The process level 1 DFD is shown in Figure 3 in an abstract way. As it is shown in the figure, two units are very busy in the process, confronting a high degree of variety (because there is a great deal of information flowing to them): Executive management[†] and commercial department. All purchase requests come directly to the commercial department and all units receive their task confirmation directly from the executive management because of the hierarchical structure. Consequently, businesses receive unsatisfactory services. The varieties should be balanced. VSM can help us balance varieties.

[†] Executive management is also engaged in many other processes, even more important than purchasing process, because of hierarchical structure of the concerned organization. As a result, he faces a great deal of variety.

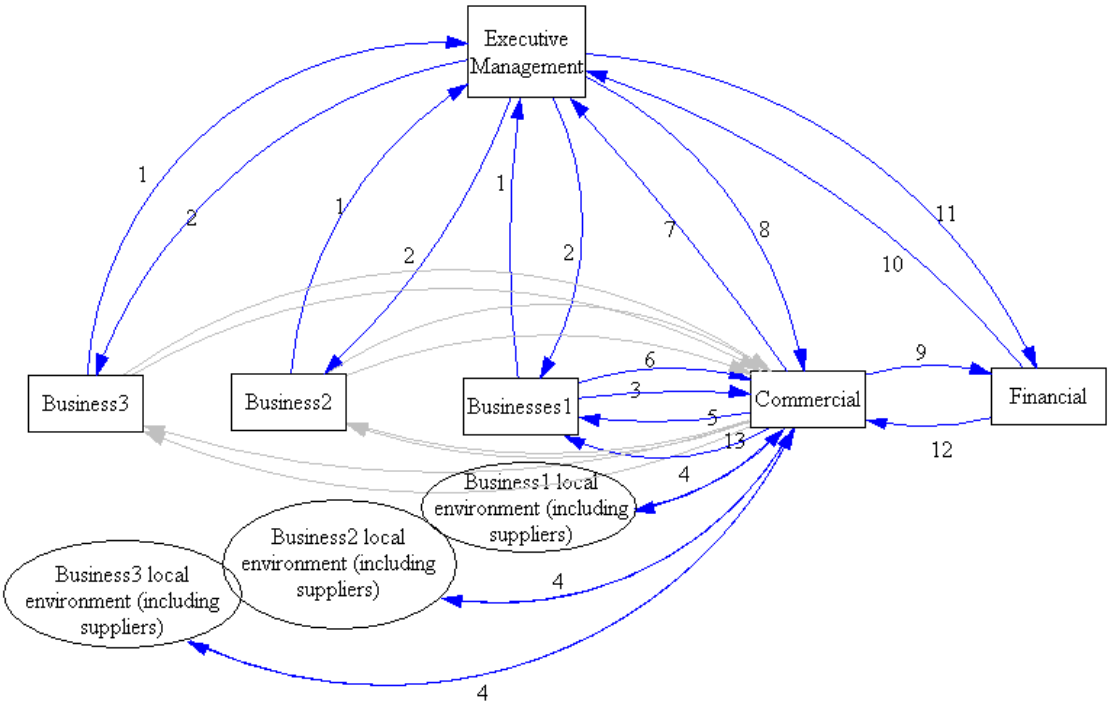

Figure 3: The DFD of current process

1: Purchase confirm request; 2: confirm;

3: Purchase order; 4: searching for suppliers and negotiation with them;

5: list of available suppliers and their product specifications;

6: list of selected suppliers; 7: purchase confirm request;

8: confirm; 9: cash or cheque request;

10: confirm request; 11: confirm;

12: cash/ cheque; 13: purchased orders.

4 Proposed process flow applying VSM

We will design a new process using ideas from cybernetics and especially the viable system model. First of all, we need to model the whole organization using VSM. The organizational cybernetics methodology steps are described below.

4.1 Step 1: unfolding complexity

In this step the major operational elements which are directly creating value should be identified. These elements will be granted autonomy. The aim of granting autonomy to some elements of a system is enabling the system to cope with the complexities it faces in doing its task, thus attenuating the organization variety for management. Therefore identifying complexity drivers of the organization will help identify the elements (Hoverstadt, 2008). Complexity drivers are the factors which make the organization task complex. There are two complexity drivers in the concerned organization:

1- Necessary knowledge and technology for doing processes;

2- Projects in hand.

The following figure shows a more detailed chart of the organization. The chart implies that the first driver has been given the first priority over the other one, despite the two drivers are as important as each other. It is noteworthy that each business is concentrated on an especial engineering field.

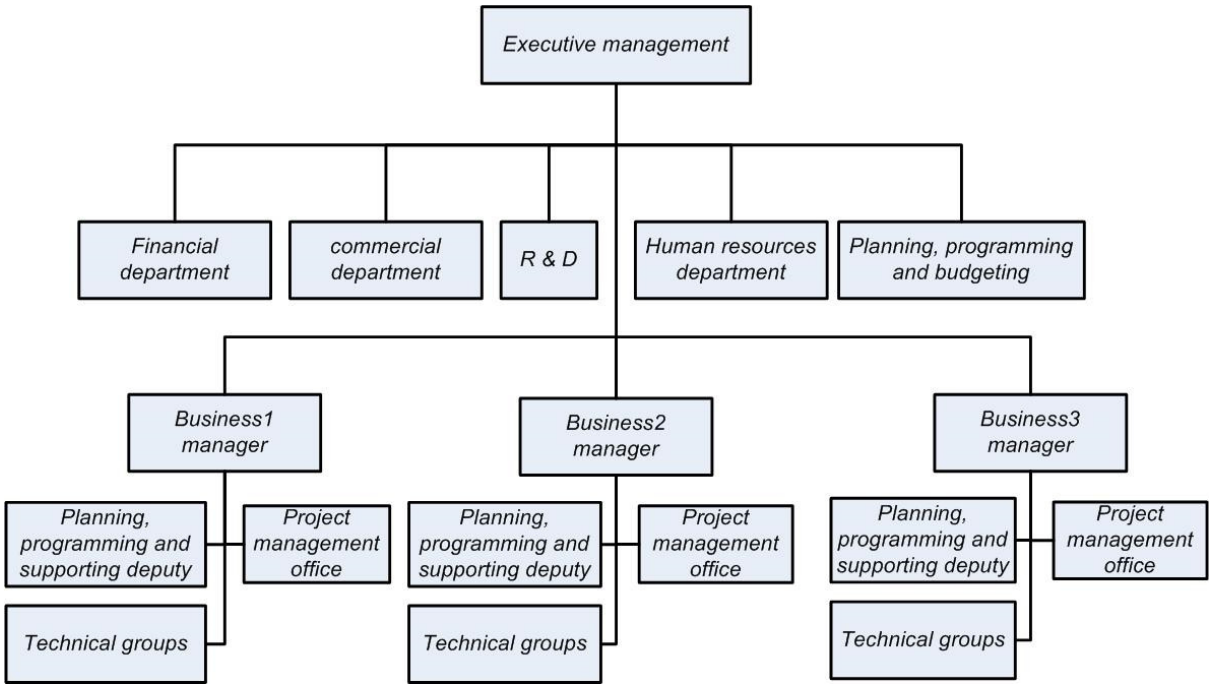

Figure 4: detailed organizational chart

The chart implies such a cybernetic model for the organization as Figure 5.

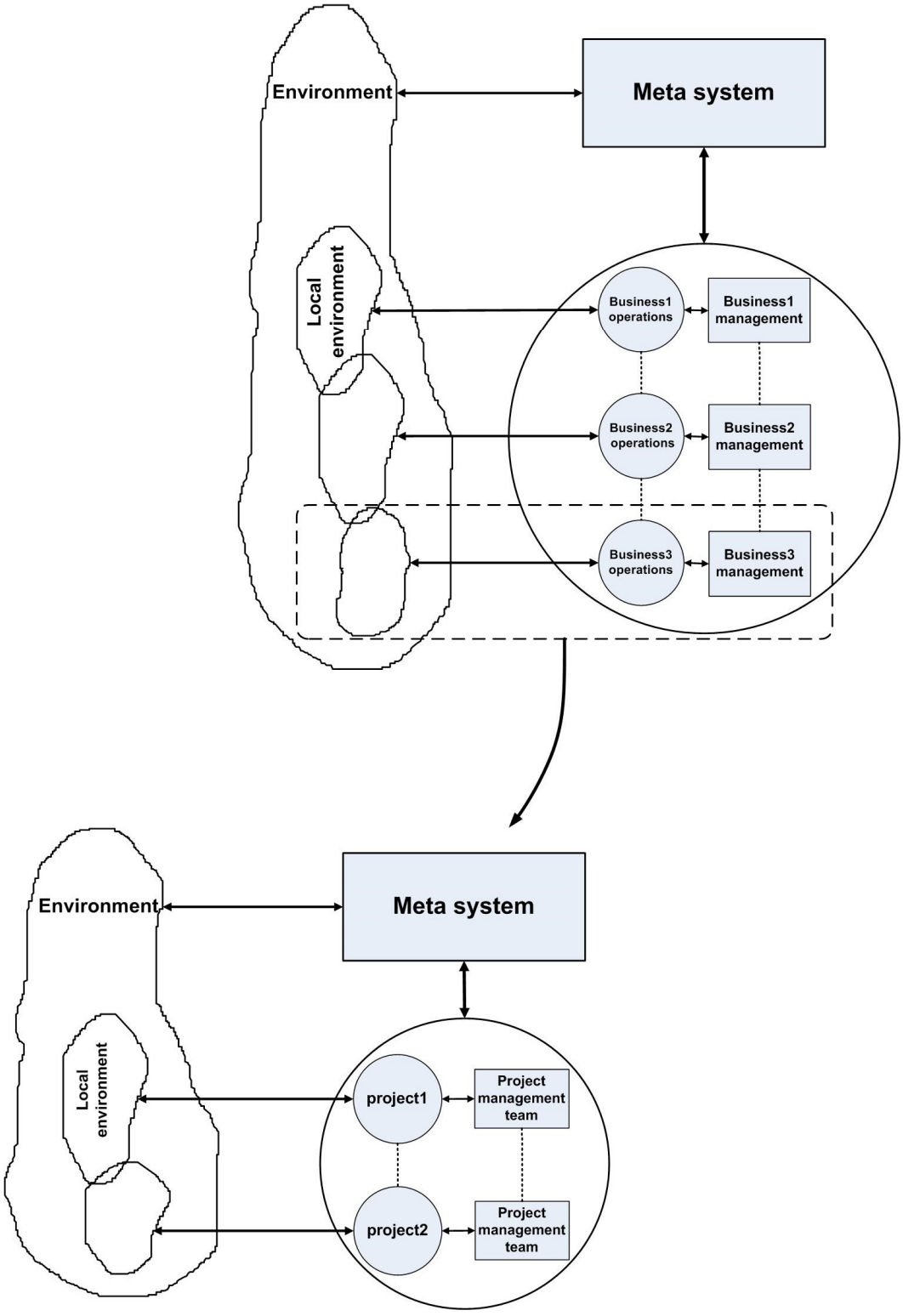

Figure 5: : Two recursions Model

4.2 Step 2: identifying recursion levels

In this step, the supra system of organization should be identified, too. The supra system (recursion level 0) is the industry of which the organization is a part of. Figure 6 shows recursion levels.

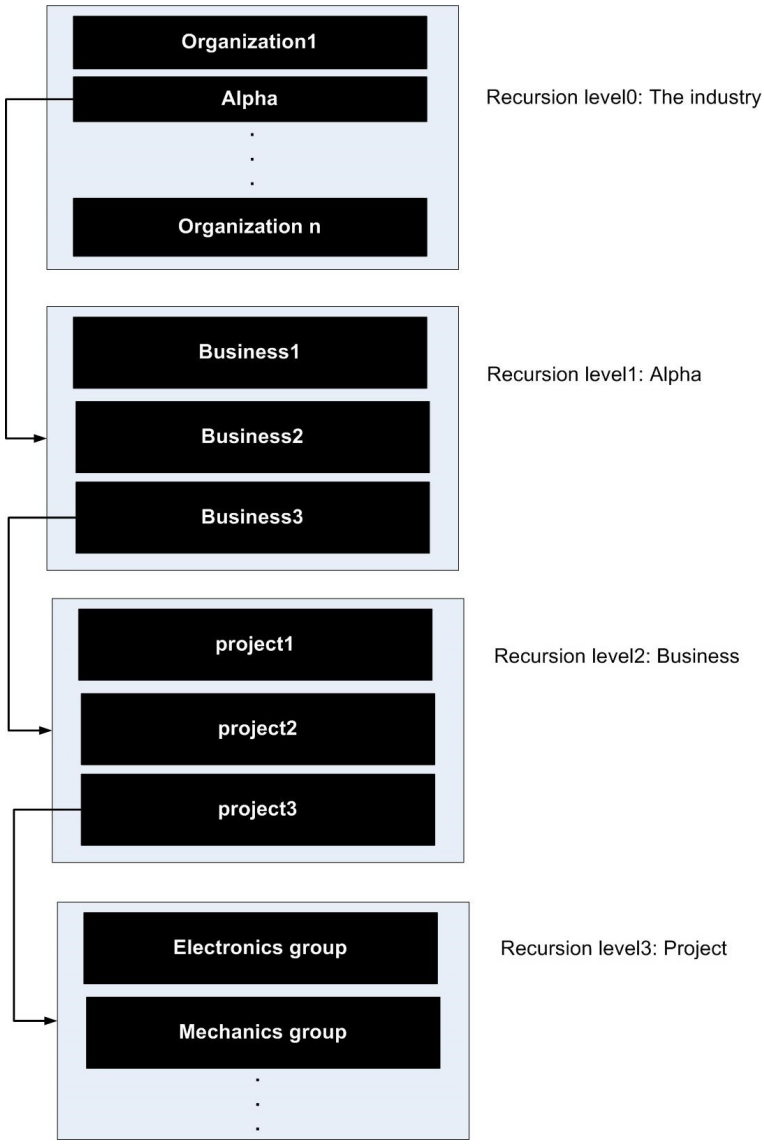

Figure 6: Recursion levels

4.3 Step 3: modeling using VSM

System1 is the organization itself. The following tables show major metasystemic processes of recursion levels 1 and 2.

Table 3: metasystemic processes at recursion level1

Organization unit	process	Matching with VSM function	Department-task ID
Planning, programming and budgeting (1)	Annual planning	System 3, system 2	1-1
	Projects control (progress control)	System 3 , system 3*	1-2
	Annual budgeting	System 3	1-3
	IT support services	system2, System 3	1-4
	Structures and processes analysis	System2, system4	1-5
Financial department (2)	Accounting	System3	2-1
	Salaries payment	System3	2-2
	Finance	System 4	2-3
Commercial department (3)	purchasing	System3	3-1
	Contracting and legal affairs	System3	3-2
	Marketing and exhibitions affairs	System3	3-3
Human resources department (4)	Hiring	System3	4-1
	Training and education	System 3, system4	4-2
	utility services	System 3	4-3
R & D (5)	Research	System 4	5-1
	Quality auditing	System 3*	5-2
	Standards management	System 2, system 4	5-3
Projects steering committee (6)	Periodical meetings to resolve issues and have a review on the projects situation	System 2, System 3, system 5	6-1

Table 4: metasystemic processes at recursion level2

Organization unit	process	Matching with VSM function	Department-task ID
Project management office	Project scheduling	System 3, system 2	b1-1
	Project control	System3 , system 3*	b1-2
Planning , programming and	Projects resources assignment	System3	b2-1

Organization unit	process	Matching with VSM function	Department-task ID
supporting deputy	Reporting to higher level system3 departments	System 5	b2-2
	Resources bargaining with higher level system3	System 5	b2-3
	Personnel performance assessment	System 3, system 3*	B2-4
	accounting	System 3	B2-5
	Documentation and knowledge management	System 3 , system 4	B2-6

Most of supporting processes such as purchasing, hiring, IT services,… are centrally done at the corporate level. If variety imbalance symptoms exist in a process, then it is in need of variety engineering. Purchasing process is one of the processes which has the symptoms. The Alpha VSM functions are shown in Figure 7. One option for balancing variety is to decentralize the process across recursion levels. Simulation is used to see if the process would improve.

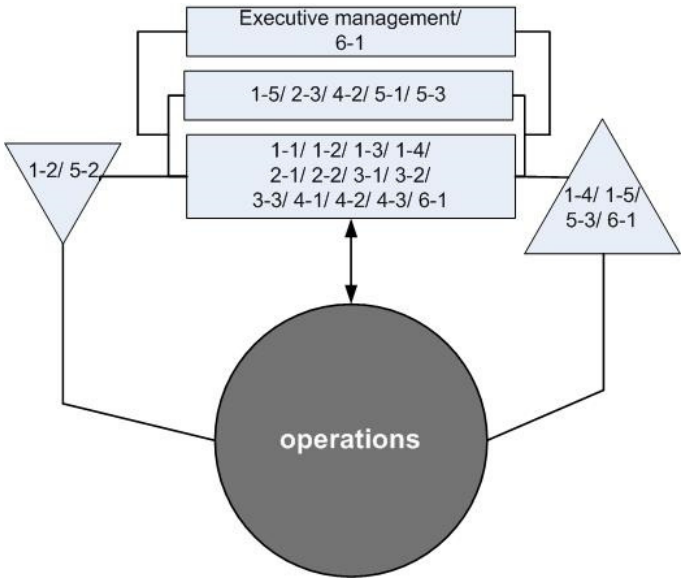

Figure 7: recursion level1 VSM

Inspired from VSM, we propose to grant some autonomy in the purchase process to businesses. Thus, some of the variety flowing towards the commercial department and

executive management would be absorbed by businesses. For this purpose, it is necessary to enable the businesses to do their own purchases. Each of them needs a commercial department in a smaller scale for its own and the older commercial department would control corporate process parameters. It implies a change in the structure of the organization. The proposed structure (omitting units other than those engaged in purchase process) is as follows:

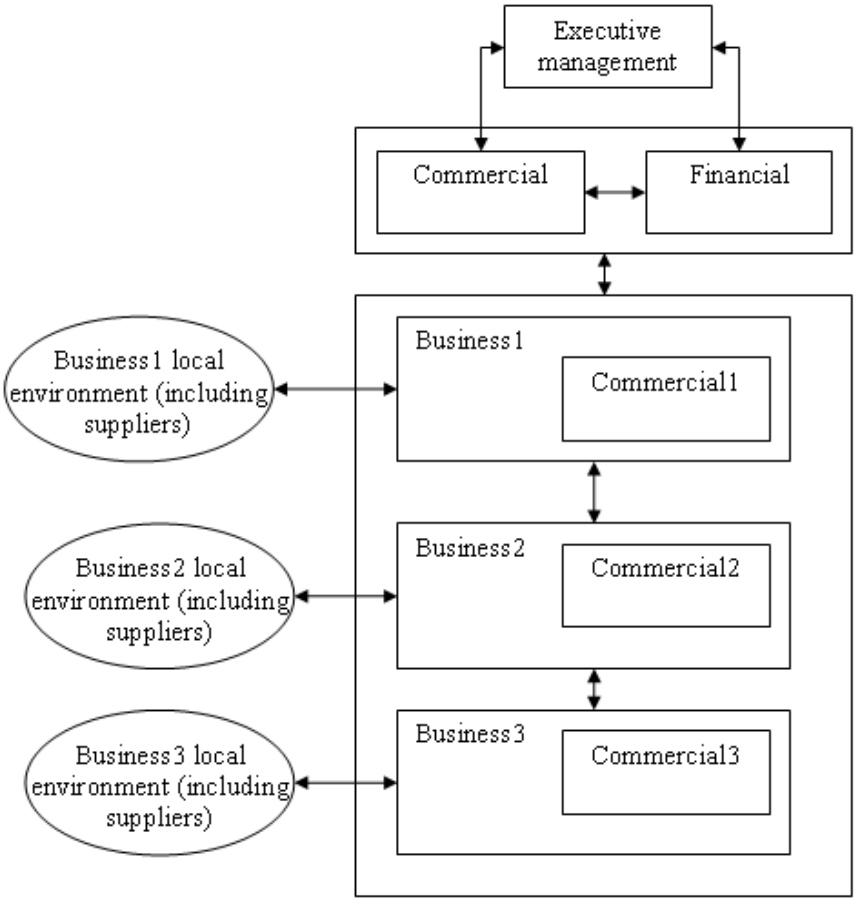

Figure 8: The proposed structure applying VSM

In the new structure, each business would communicate with its local environment itself and would do its purchases itself, thus absorbing some extent of variety. The corporate commercial department has two roles: 1- Doing the purchases of other units in the metasystem and 2- coordinating and operational control (controlling and auditing) of three businesses commercial departments. It also is noteworthy that financial department is a part of operational control.

For designing new process flow, control parameters and required information flows should be identified first. The following are parameters which need controlling for a purchase process:

1- Inventory at hand;

2- Cost of purchase and available credit;

3- The supplier past records and quality of service;

4- Competence with legal methods and instructions;

5- The duration of the process;

6- Competence of purchased products specifications with what is needed;

We will design the new process in the new structure in a way that the mentioned parameters would be controlled by metasystem or by self-controlling of three businesses commercial departments.The proposed process procedure is as shown in Table 5.

Table 5: : Proposed steps of purchasing process

	Actor	Actor's organizational unit	Activity	Comments
	Request owner	Business	Filling purchase request form	
	Project manager	Business	Confirm purchase request (sign the form)	
	Business manager	Business	Confirm purchase request (sign the form)	
	Warehouse holder	Business	Confirm purchase request (sign the form)	
	Request owner	Business	Sending the form to the Business commercial dep.	
	Business Purchase manager	Business	Assigning a purchase agent to the purchase activity	
	Business Purchase agent	Business	Inquiring into suppliers offered specifications and price.	At least 3 suppliers for medium purchases
	Purchase agent	Business	Sending single-source confirmation form to executive	Just for medium purchases for which only 1 supplier is available
	Executive man.	Executive man.	Confirm single-source (sign the form)	
0	Business Purchase manager	Business commercial dep.	setting technical-commercial committee meeting	
1	technical-commercial committee	Business	Selecting one of the suppliers according to their offered technical specifications	
2	Business manager	Business	Confirm selection form (sign the form)	
3	Business Purchase manager	Business	Confirm selection form (sign the form)	
4	Business Purchase agent	Business Commercial dep.	Setting purchase order fom and credit request form	
	Commercial	Commercial	Confirm order form and	

	Actor	Actor's organizational unit	Activity	Comments
5	dep. Manager	dep.	credit request form	
6	Executive man.	Executive man.	Confirm order form and credit request form	
7	Business Purchase agent	Business Commercial dep.	Sending order form, credit request form and all documents to financial dep.	
8	auditor	Financial dep.	Auditing the purchase documents	
9		Financial dep.	Provide Credit	
10	Financial dep. Manager	Financial dep.	Confirm credit request form (sign the form)	
11	Executive man.	Executive man.	Confirm credit request form (sign the form)	
12		Financial dep.	Provide cheque/ cash	
13	Financial dep. Manager	Financial dep.	Sign the cheque	
14	Executive man.	Executive man.	Sign the cheque	
15		Financial dep.	Delivering the cheque to the purchase agent	
16	Business Purchase agent	Business Commercial dep.	Doing the purchase	
17	Business Purchase agent	Business Commercial dep.	Delivering the orders to request owner	

The process level 1 DFD is shown in Figure 9 in an abstract way:

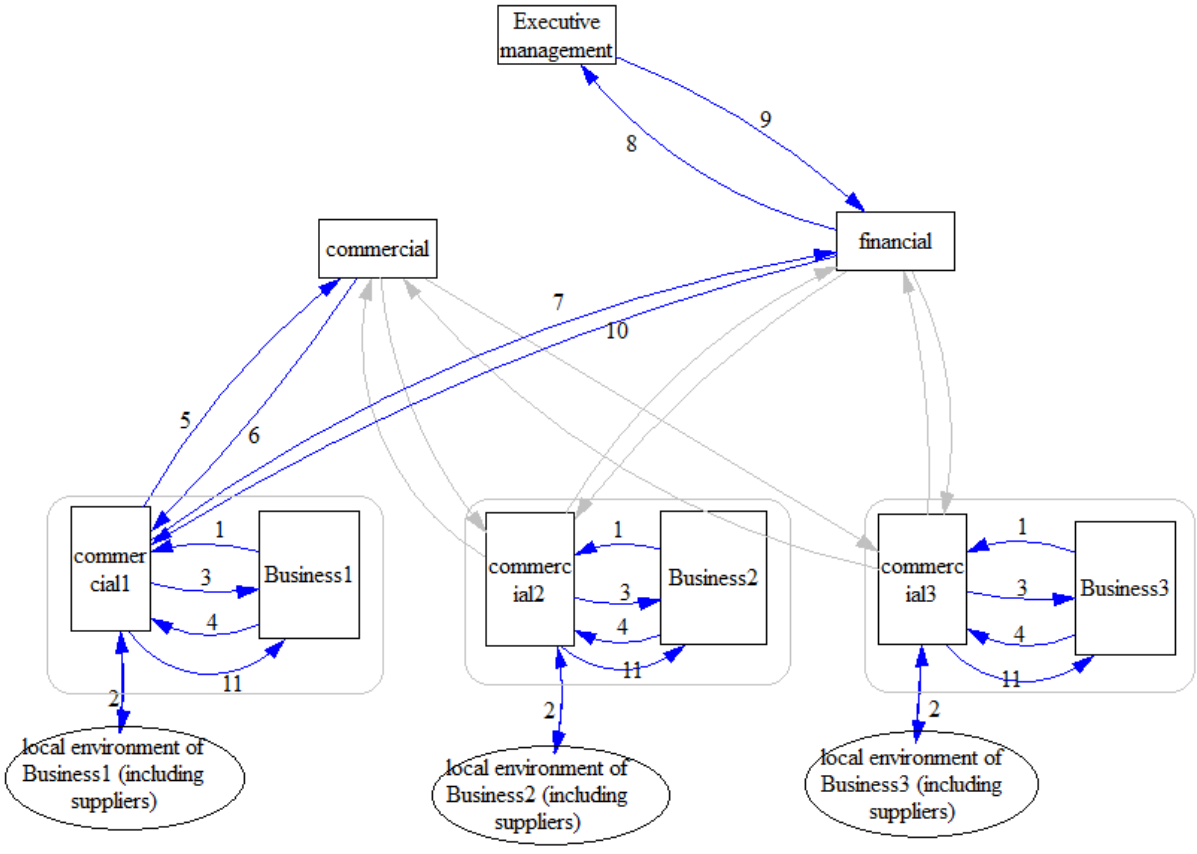

Figure 9: The DFD of proposed process

1. Purchase request; 2. Searching for suppliers and negotiation with them;

3. Available suppliers list and their product specifications;

4. Selected suppliers list; 5. purchase confirm request;

6. Confirm; 7. cash or cheque request;

8. Confirm request; 9.confirm;

10. Cash/ cheque; 11. Purchased orders

Control parameters will be controlled in this way:

- The first parameter, inventory at hand, is controlled by warehouse holder s of businesses. Any purchase request should be confirmed by warehouse holder of that business. In this way if there are any items of requested product in the warehouse, the purchasing process would stop. This stage is not shown in DFD to keep the DFD abstraction.
- The second parameter, cost of purchase and available credit, is controlled by financial department.
- The third parameter, the supplier past records and quality of service, is controlled two times. The first time in each business, as the suppliers database is available to each business commercial department. The second time, it is controlled in the corporate (central) commercial department when businesses receive their purchase confirmation from the corporate commercial department. Here the corporate commercial department has a coordinating role, too. For example when it observes that more than one business are going to have a purchase from a common supplier and thus the whole organization is going to have a large deal with that supplier in total, it will intervene in the process to receive a discount from the supplier. Controlling of this parameter can benefit from feedback mechanism and learning techniques, like AI, too but they are not considered in this paper.
- The fourth parameter, competence with legal methods and instructions, is controlled by periodic auditing activities carried out by central commercial department and other units of metasystem which are concerned with this issue and have supervisory role in this respect, like “quality and standards” unit or “systems and procedures” unit.

- The fifth parameter, the duration of the process, can be controlled by the commercial department of businesses themselves (self-controlling). It requires feedback mechanism. A target duration should be identified first. According to the target duration, it will be possible to schedule different steps of the process. Any deviations of determined durations in each step should be detected and adjusted then. The problem is that when we find that a step duration has exceeded its intended target, it will not be adjustable. This is the difficulty of most of service processes. Therefore, we should try to do the next steps in a shorter time. This mechanism is not designed in this paper. In future researches we will deal with it.
- The last parameter, competence of purchased products specifications with what is needed, is controlled before doing the purchase when the purchase agent sends the available suppliers product specifications to the request owner to select the best of them. In addition, the closer interaction of the purchase agent with Request owner in new structure can ensure finding the right products.

In the following Figure, you will find proposed DFD versus current process DFD. It is shown that in the proposed process, corporate commercial department and executive management face a much less variety.

Variety is produced by 1- the extent of information flowing to a unit and 2- the content of information flowing to it (the more technical, the more complex and variant). It is noteworthy that the variety faced by financial department has not increased because the extent of information flowing to it, is as great as the current situation but it receives them from different sources. As the information from these different sources does not differ in content and all of them are just financial documents, the variety flowing to the financial department has not changed.

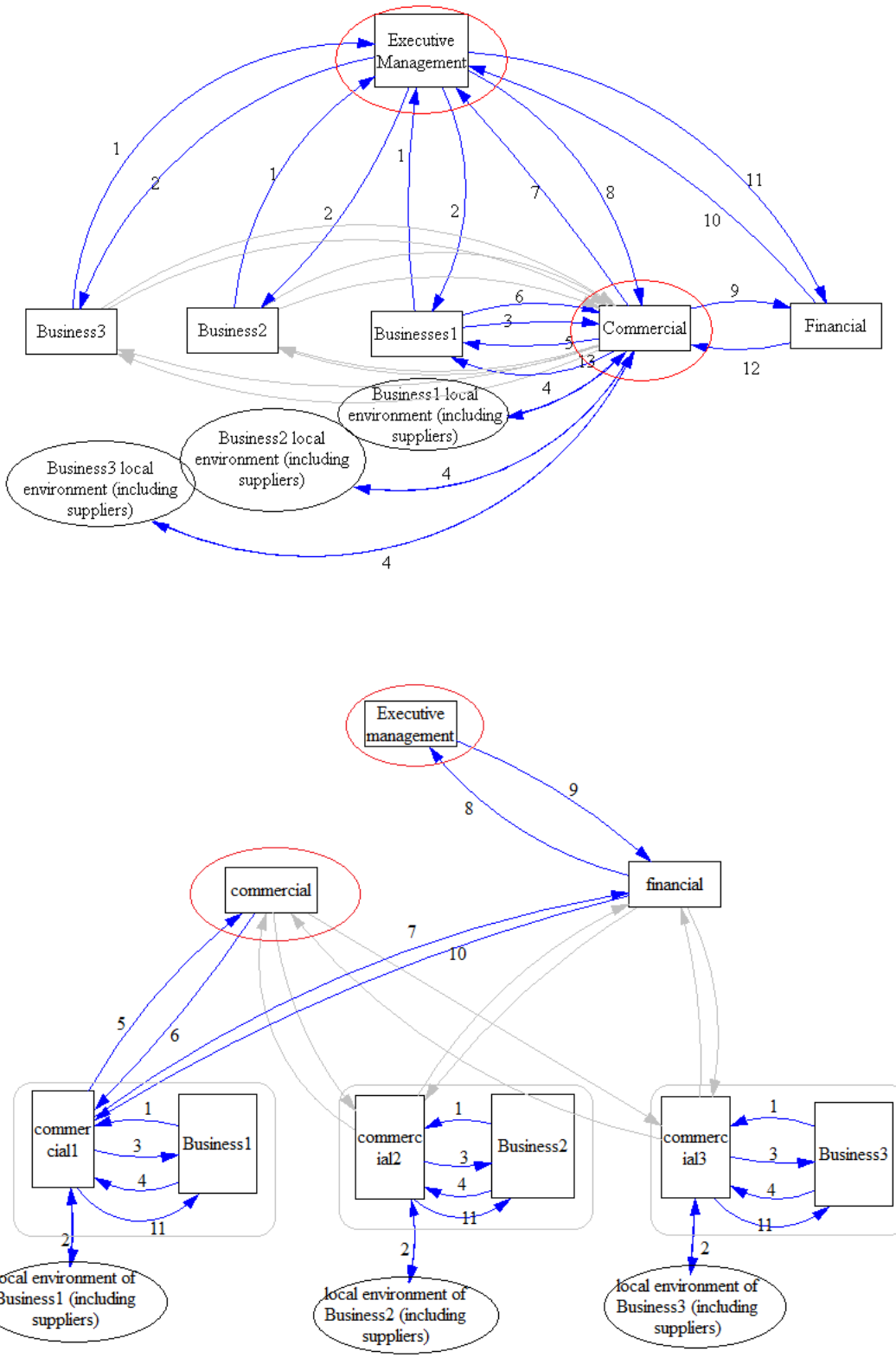

Figure 10: The DFD of current versus proposed process

5 Comparison of current and proposed process

We mentioned two major problems of the current purchase process in Section 3. They were 1- insufficient expertise of commercial department employees in finding the right products. Since purchase orders of the three businesses are various and mostly high-tech engineering parts and devices, they deal with three high-tech and different engineering fields; 2- long waiting times to receive purchase orders. We approached the problems using cybernetic law of requisite variety, and according to VSM, we decentralized the process. As a result, any purchase agent placed in a business, faces only around one fourth of the variety he faced in previous situation. He will be closer to the business engineers so after a short time he will adapt with the specific market and will be enabled to provide the engineers with the right requested products. Furthermore he can interact with the request owner more easily. In previous section, using DFD, we showed how the variety flowing to executive management and commercial department would be attenuated in proposed structure and process. Running a simulation model using Visual SLAM-Awesim, we will show the second problem will be relieved, too and the process duration will decrease. Note that because of limitations imposed by the organization in gathering data, we used judgmental (expert) data in simulating the process (Table 6). The simulation networks are shown in Figures 7 and 8 for current and proposed (improved) systems. The statistical results of computer simulation models for both systems are compared and shown in Table 7.

Table 6: Simulation raw data

		Current process	proposed process
1	Business 1 purchase request rate	Poisson (1/2)	Poisson (1/2)
2	Business 2 purchase request rate	Poisson (3/10)	Poisson (3/10)
3	Business 3 purchase request rate	Poisson (1/5)	Poisson (1/5)
4	Meta system purchase request rate	Poisson (1/5)	Poisson (1/5)
5	Cost of businesses purchases	TRIAN(1,20000,35000)	TRIAN(1,20000,35000)
6	Cost of metasystem purchases	TRIAN(1,1000,35000)	TRIAN(1,1000,35000)
7	Executive signature duration	TRIAN(1,2,7)	
8	Total Available purchase agents	16	16
9	Purchase agents assigned to Business1	-	4
10	Purchase agents assigned to Business2	-	4
11	Purchase agents assigned to Business3	-	4
12	Purchase agents assigned to metasystem	-	4
13	inquiry duration	Uniform (4,5)	Uniform (4,5)
14	technical-commercial committee meeting	TRIAN(2,3,5)	TRIAN(2,3,5)

		Current process	proposed process
15	Business manager signature duration	Uniform (.5,1)	Uniform (.5,1)
16	Commercial dep. manager signature duration	Uniform (1,2)	Uniform (1,2)
17	Setting purchase order fom and credit request form	Uniform (.2,.5)	Uniform (.2,.5)
18	Auditing purchase documents	Uniform (.2,.5)	Uniform (.2,.5)
19	Doing the purchase	Uniform (1,2)	Uniform (1,2)

As it is observed, mean value of process duration has decreased from around 132 days to 20 days. It means we can decrease the duration of process to its 15% of current value by changing the process and structure according to VSM and cybernetic laws.

Table 7: The result of simulation

	Mean value	Standard deviation	Minimum value	Maximum value
Time in system (= process duration) For current process	**131.768**	64.286	18.187	242.963
Time in system (= process duration) For proposed process	**19.546**	14.565	7.551	68.147

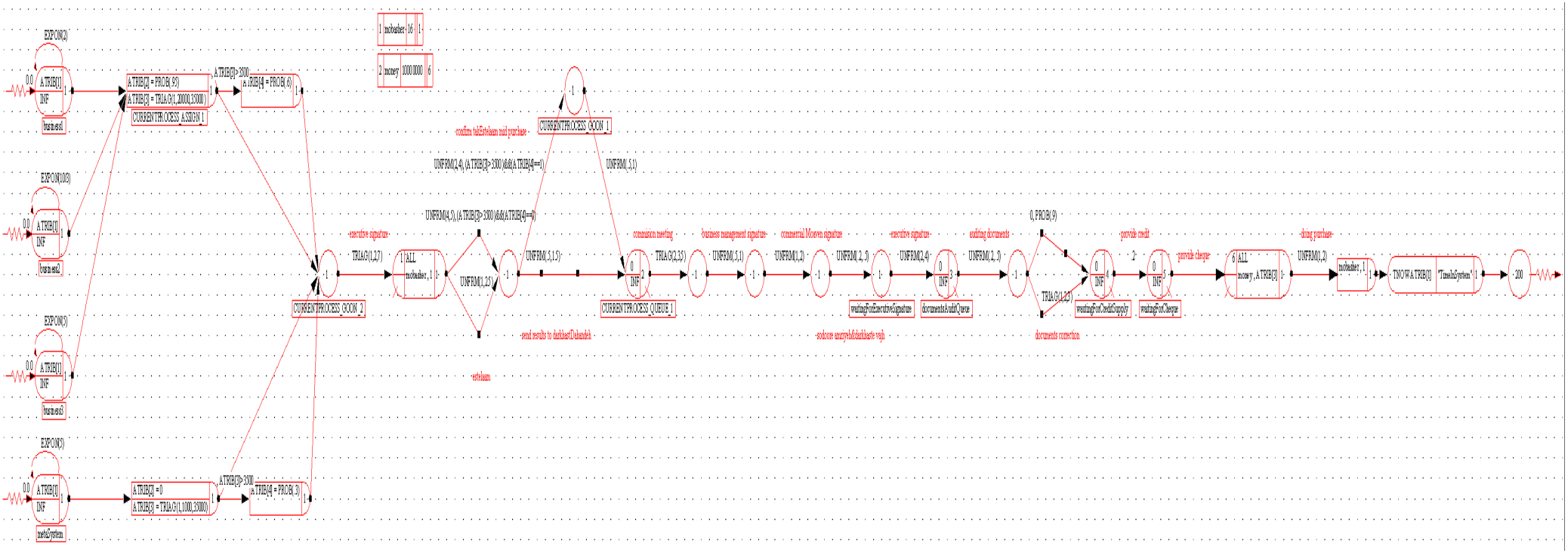

Figure 11: Current process network

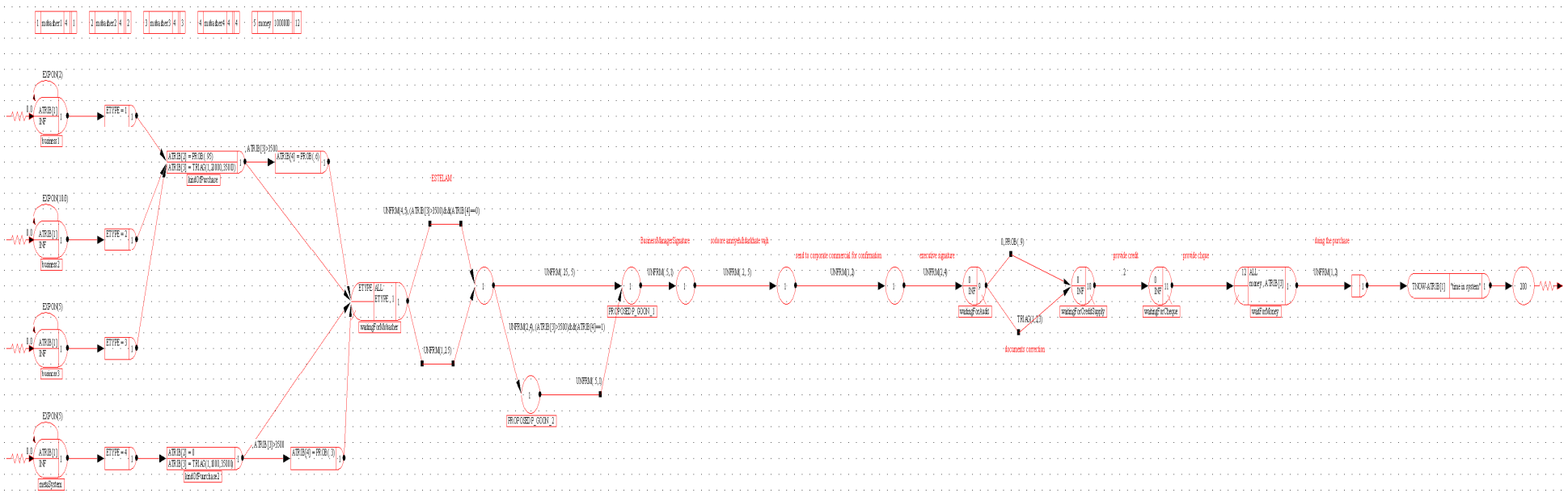

Figure 12: Proposed process network

1 Conclusion

In this paper, VSM and cybernetic law of requisite variety are used to improve a service process in terms of its quality and duration. The application of the mentioned law and VSM implied decentralization of the concerned organization structure and process, thus decentralization of information processing and decision making. In this way the variety faced by executive management and corporate commercial department decreased largely. Running a simulation model, we demonstrated that the duration of the process, decreases by 85%. Organizational cybernetics and systems science have much to say for managing enterprises in the modern era.

The proposed cybernetic approach and VSM is also compared with some of the current studies. Its features are compared with previous methods to show its advantages over previous ones (Table 6). The proposed cybernetic approach is capable of simulating and modeling the behavior of a purchasing system to show and maximize their effectiveness. Also, it has the ability of evaluating the influences of effective factors on the objective of VSM model, i.e. waiting times of purchase requests.

Table 8: The features of the integrated cybernetic and VSM approach versus other methods

Feature / Method	Business Process Simulation Analysis	Behavioral and Sensitivity Analysis	Evaluation of Effective Factors	VSM for qualitative factors	VSM for quantitative factors	Cybernetic and Requisite Variety
The Proposed VSM-Simulation Approach	✓	✓	✓	✓	✓	✓
Assimakopoulos and Dimitriou (2006)			✓	✓		
Fransoo and Wiers (2006)			✓			✓
Kovacheva (2006)(simulation and artificial Intelligence: Neural nets)	✓	✓		✓		✓
Lewis and Stewart (2003)			✓			✓
Morlidge (2009)		✓	✓	✓		✓
Qiu-Yan (2007)(anova)		✓		✓		✓
Jones et al. (2007)		✓		✓		✓

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