IS Based Best Process Practices Propagation in Fractal Enterprises: a Viable Systems Perspective

Marite Kirikova[1], Paolo Piciocchi[2], Clara Bassano[3], Janis Makna[4], Julija Stecjuka[5]

[1,4,5] Institute of Applied Computer Systems, Riga Technical University,
1 Kalku, Riga, LV-1658 Latvia
[1]marite.kirikova@cs.rtu.lv, [4]promis@apollo.lv, [5]julija.stecjuka@cs.rtu.lv
[2]Department of Political, Social and Communication Science, University of Salerno,
Via Ponte don Melillo, Fisciano, Italy
p.piciocchi@unisa.it
[3] Business Studies Department, "Parthenope" University of Naples,
Via Medina, 40, Naples, Italy
clara.bassano@uniparthenope.it

Abstract. The aim of the paper is to merge the Viable Systems Approach (VSA) with one of the approaches to achieve the flexibility of the business process which is the bottom-up business process best practices propagation and leveraging these practices at higher organizational levels by appropriate information systems design. This is the first attempt to consider fractal business processes as viable and holistic service systems where similar branches of enterprise are free to develop their own processes and supporting systems.

Keywords: business process, best practices, fractal enterprise, holistic service systems, viable systems

1 Introduction

In his book "The Fractal Company: A Revolution in Corporate Culture" H.J. Warneke [1] envisioned a new flexible organizational structure for manufacturing - a fractal enterprise where each fractal is an independently acting corporate entity, whose goals and performance can be precisely described. Similar idea is also discussed in P. Hoverstad's "The Fractal Organization: Creating Sustainable Organizations with the Viable System Model" [2]. Moreover, in his book "Viable Systems Approach (VSA). Governing Business dynamics" G.M. Golinelli [3] introduces an innovative concept of flexibility as a systems capability which results from government action, promoting and guiding structural dynamics in harmony with the expectations and pressures coming from relevant supra systems, i.e., its ability to adjust to changing environmental needs.

There are different definitions of flexibility; however, most of them focus on the ability to respond to external changes in an appropriate period of time using a reasonable amount of resources [1], [2], [4], [5]. The flexibility, however, possesses some degree of stability because whenever a part of the system is made flexible, some other part is made inflexible [4]. From the point of view of fractal paradigm [1], [2]

the stable part is perceived as a pattern inside the system that is replicated at different scales. From the Viable Systems Approach (VSA) perspective, replication in different scales means “recursion process”: any kind of entities, as well as fractals, could be considered as a viable system if it is possible to look at it as a self-organization – able to survive by itself – and as a component of a suprasystem – able to be consonant with a system of an higher level – at the same time [6]. In other words, recursion means that each process activated by a system is incorporated into a wider process, originating in turn from the interaction of other systems.

With reference to the VSA, in general, the paper, aims to interpret fractal enterprises as viable and service systems useful to optimize information and resource flow and to share knowledge enhancing efficiency and effectiveness. In particular it aims towards methods and principles useful in information systems (IS) architecture management in viable enterprises.

Our main focus is on the changes in the system when the best practice is identified and chosen for propagation and leveraging (becoming a new stable pattern). Emergence of best practices is enabled by existence of fractal structures, which tolerate different processes used by different structural units to achieve one and the same organizational goal. Those processes may compete until superiority of one of them becomes visible. At that time-point a process common for all structural units may be designed and introduced for leveraging the best practices in the enterprise to support its viability by changing the internal service architecture. The paper focuses on such best practices that involve IS services and reflects on changes in IS architecture that may commonly occur during leveraging of best process practices in case of fractal business processes.

The paper is structured as follows. In Section 2 we introduce the notion of fractal process, viable systems, and holistic service systems. In Section 3 we demonstrate a change management method that helps to materialize the theoretical concepts. Section 4 consists of brief conclusions.

2 Fractal Processes, Viable Systems, and Holistic Service Systems

In a VSA view, fractal enterprises, as viable systems, satisfy five principles – postulates – whose validity is not inferred, but is posited a priori to explain phenomena or theories [7]: (1) *Survival*: a viable fractal has the aim to survive in a specific context; (2) *Eidos*: from ontological viewpoint, a viable fractal can be considered in a structural and systemic perspective; (3) *Isotropy*: in term of behaviour, a viable fractal distinguishes a decision making area and an operative area; (4) *Acting*: it’s aim it to reach a goal, an objective through the interaction of supra and/or subsystems from which receive, but also supply, indications and rules; and (5) *Exhaustiveness*: external entities are also viable fractals, components deriving from an higher level.

VSA is an approach to study the viability of systems in a complex environment. Viability is both objective survival and subjective ability to respond to environmental change, where environmental change is mostly generated by other viable systems (also those belonging to the same fractal). Viability depends first and foremost on a

government capability, for both internal self governance and external relationship governance that creates value for the stakeholders or suprasystems. In fact, each system has to attain consonance (a potential for value creation) and resonance (the realization of value creation) with its environment to be viable. The innovative concepts of consonance and resonance are fundamental to all VSA analysis of problem situations. Consonance means the structural compatibility or adequacy between different entities, while resonance is the outcome of the interaction between these consonant entities.

Above presented axiomatic interpretation can be enriched by the theoretical approach of IBM – Service Science Management Engineering and Design (SSME+D) – [8] if we consider fractals in terms of self-organizational services or as components of a whole service systems. In fact, SSME+D framework begins with an analysis of the service systems in a real-world problem situation. In broad outline, the SSME+D analysis approach is to (1) identify all the stakeholders service system entities – fractals as well – in a network under study (a network analysis is always done in the context of the whole service system ecology), (2) examine existing relationships and understand the problems and opportunities the stakeholders have identified, (3) next try to improve existing value cocreation mechanisms (this may involve freeing up resources from existing service system entities and redistributing them), (4) if problems and opportunities remain, create new service system fractals to address them.

SSME+D is a specialization of Systems Science, in which service fractal entities interact and create outcomes. VSA and SSME+D perspectives interpret fractals as Holistic Service Systems (HSS) and Whole Service (WS) to better illustrate one way that local optimization can lead to global optimization in complex human systems. Multilevel governance of HSS can be especially effective when entities use a Run-Tranform/Copy-Innovate investment mechanism. Over time as the entity architecture of holistic service systems are better understood, it should be easier to accelerate the sharing of innovation and best practices, do more to ensure that local optimizations in fact lead to global optimizations. “Run” here means small adaptation of behavior through practice effects but stable structure or variety; “Transform/Copy” means copying the structure and actions of another entity. Transform is costly and risky, but may have benefits once the change is complete (adopting a new best practice). Transform has to be considered as “the boundary” between adaptation and creativity; “Innovate” means creative change of structure and actions, and may be riskier and more costly. According to P. Hoverstad [2] viability is achieved via fractal architecture of the enterprise. The notion of fractal enterprise [1], [2], [9], [10], [11], [12], [13], [14] stems from Warneke’s “fractal company” [1], where basic patterns of fractal geometry are applied to the design of industrial corporation. Architecture of a fractal enterprise consists of self-similar, self optimizing, goal-oriented fractals (independently acting corporate entities), which perform services, are the object of constant change (dynamic restructuring), and are integrated into the goal-formation process. In certain settings it is possible to identify fractal processes [15]. These are processes that have the following features similar to the features of constituents of fractal enterprises [15]:

- Self-similarity: fractal processes have similar inputs and outputs, but each fractal may have its own unique inner structure [1]. Thus, in fractal processes system

self-similarity manifests when processes of different scales have common objective and similar inputs and outputs. The scale in the fractal process system is represented by process decomosition. Fractal process entities simultaneously have two essential relationships (1) part-of relationship and (2) is-a (class) relationship; i.e., each process which is a subprocess of a particular process is the process of the same type as the process whose part it is. For instance in an educational institution (University further in the text), research administration processes take place. There is research administration process at the University level, at the Faculty level (Faculty here means a large department which consists of institutes performing research and administrative duties), at the level of Institutes and at the level of particular Departments. Research administration process at the University level includes research administration at the faculty level, which in turn includes research administration at the Institute level, which, in turn, includes research administration at the departmental level. Several of these research activities, e.g., report preparation might be similar at all levels.

- Self-organization: ability to adopt process behaviour and interaction mechanisms with others fractals for achieving system's common objective [1]. Fractal processes have suitable methods for controlling workflows, and optimizing the composition of processes in the system. The self-organization method, referred to as the dynamic restructuring process, is a method of reorganizing fractals in the system by reconfiguring fractals' network connections [10].
- Goal-orientation: each fractal (process) has its own goal. Fractals perform a goal-formation process to generate their own goal by coordinating processes with participating fractals and by modifying the goal as necessary. Systems common objectives are achieved in iterative way, by developing each single fractal's individual objective taking into account feedbacks.
- Dynamics and vitality: coordination and cooperation between self-organization fractals is characterized by individual dynamic and ability adapt to dynamical environment. IS plays a vital role in achieving this property of fractal business processes.

One of the essential features of fractal processes is the possibility of executing different processes in parallel to achieve one and same goal. On the one hand, this feature might contradict with the notion of process optimization, however, on the other hand, this parallelism in certain situations allows higher flexibility. In University example it can be true in situations when differing in local external environments (e. g. Institute of Mechanics with emphasis on patents and Institute of Economics with emphasis on indexed journal papers) require slightly different data gathering approaches. Possibility to run similar parallel processes supports also the emergence of best process execution practices as will be shown in the next section.

While viability is a desirable feature of enterprises and IS, there is still lack of practical approaches of achieving this feature and applying theoretical principles in enterprises. In the reminder of the paper we propose some methods applicable from VSA perspective for managing changes in processes and IS architecture in case of existence of best practices in a fractal enterprise where fractal business process can be identified. University as a fractal enterprise is used to illustrate the proposed methods. The University is an appropriate example since it satisfies all five VSA principles listed in the beginning of this section.

3 Changing the Business Process and IS

Here we discuss how business processes might be flexibly changed in the setting of fractal business processes, i.e., when processes are self-similar, self-organized, goal-adaptive, and structurally dynamic. The change procedure is illustrated on the following example.

Each year University has to prepare a report about its scientific activities It is achieved by the delegation of goal "Prepare the report" from University level fractal via Institute fractals down to the Department level fractals. Departments are free to achieve this goal in the most suitable way for them. Departments send information to the higher level fractal process to prepare the institute level annual report about scientific activities, using the template that has been introduced at the institute level.

Suppose Department 1 has a larger staff than other departments and capability to develop a business process support system for the acquisition and maintenance of information about scientific activities. The use of the system allows the department to accomplish the process more efficiently in comparison to other departments. This attracts the interest of another department and they consider it possibility to acquire the practices of the Department 1. To achieve this Department 2 has to manage the change from the AS IS process to TO BE process which is equal to the process performed by Department 1. This involves the change of information and knowledge processing systems of Department 1 and Department 2. At this point of time it does not matter how the best practice was developed – was it the result of "Innovate" or the result of "Run" (See section 2). In any case Department 2 must learn from Department 1 and transform/copy its processes and supporting IS services. It is essential that at this point supra fractals are not involved in decision-making, it is Departnment 2 initiative and responsibility to acquire the best practice from the Department 1. Any transfer of best practices would require at least the following steps: (1) Best practices identification; (2) Best practices acquisition planning; (3) Best practices acquisition cost estimation; and (4) Best practices acquisition.

Best practice identification in fractal setting where several parallel similar ways of process organization are tolerated, can be informal, i.e., the situation can emerge where one way of performing of a particular task is acknowledged as worth to be imitated by several structural units. When best practices are identified it is necessary to plan for their acquisition. This involves analysis of AS IS and TO BE business processes (Step 2). The *best practices acquisition planning* involves the following sub-steps: (2.1) Changing granularity of process description; (2.2) Identification of activities to be changed; and (2.3) Change process risk analysis.

To identify actual changes in business processes we suggest specific tables [22] used for transition task analysis that consist of columns of performer activities, which are marked for both AS IS and TO BE cases. Change analysis table for Department 2 secretary is represented in Table1. The sign "+" denotes a fully performed task, the sign "–/+" denotes a partly performed task because another part of it is performed by IS or other business processes and empty TO BE cell means that the task is fully performed by another business process or computer system.

Table 1. Business process change analysis table: Department 2 secretary's tasks

AS IS	Department 2 secretary: tasks description	TO BE
+	Receive the template (7)	
+	Create the list of employees to whom to send the template (7)	+
+	Send the template (7)	
+	Determine who has not sent back the filled template (9)	
+	Send filled template to Institute 1 responsible executive (12)	
+	Make sure the template is sent (12)	
+	Find out who is not available (business trip, conference, vacations) (7)	+

Business process changes may considerably influence responsibilities, knowledge/information patterns and tasks of business process performers [15], [16], [17], [18], [19]. Therefore multiple aspects are to be analyzed to assess the risks of best practice acquisition. Taking into consideration that the changes in the processes depend on the changes in the IS, the risk analysis is based on IS change management [20]. The patterns are reflected in Table 2.

Table 2. Change patterns (adapted from [20])

IS and business process element	Pattern 1 Internal improvement	Pattern 2 Improvements based on handed over activities	Pattern 3 Improvements based of received activities
BP activities	Improved	Handed over	Received
Data	New or Improved	Received	Handed over
Knowledge	New	Handed over	Received
IS users	No change	New	Moved
IS activities	Extended	Suspended or Handed over	Received
Control	Improved	Improved	Improved
Territory	No change	Handed over	Received
Resources	Cheaper or Different	Cheaper	More expensive
Products	Improved	Improved	Improved

The risk analysis concerns each activity which is to be changed due to the best practice acquisition. The patterns given in Table 2 are used as guiding risk analysis points. The pattern for changed activities is chosen depending on whether the activities are handed over (Pattern 3), acquired (Pattern 2), or changed internally (Pattern 1). Table 3 shows how Pattern 2 is used for the assessment of risks related to activities handed over by Department 2 secretary.

After risk assessment, business process change *cost estimation* is to be performed, taking into consideration tasks with "+" in Business process change analysis table and all issues discovered in risk analysis. After this sub-step the final decision about best practice acquisition may be made. So far the best business processes practices acquisition at one fractal level was discussed. However, it is possible to leverage the practice and apply it on a higher fractal level. This operation is illustrated in Fig. 1.

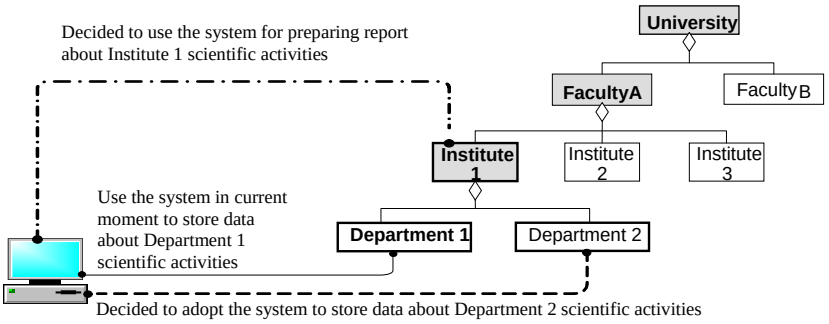

Fig. 1. Leveraging the best practices

Leveraging of the best practice requires business process design on a higher level of fractal hierarchy. It concerns mainly IS services, because the difference between two similar information systems services on the lower level of hierarchy and one service on a higher level of hierarchy does not considerably change the manual processes at the lower level of hierarchy. Thus SMEE+D approach can be used to decide whether to leverage the best practice of Department 1 at the institute level or not.

Table 3. Risk analysis issues for tasks handed over by Department 2 secretary (excerpt)

Change element	Mandatory considerations	Sources of risks
BP activities	Handed over	It is essential to analyze all activities the secretary is going to hand over at a proper level of granularity. The frequency of tasks can be different therefore it might be cumbersome to consider all tasks in one go. On the other hand, it is essential to make sure that all activities handed over are received by all people and systems to which they are handed over. And it is necessary to ensure that they are capable to perform these activities.
Data	Received	The secretary is supposed to receive data about scientific activities of employees,- therefore IS activities that can represent these data are to be implemented.
Knowledge	Handed over	All employees need knowledge for performing activities handed over to them by the secretary. If all activities are not handed over in one go – the knowledge should be transferred several times. The knowledge transfer should be properly organized, because it might happen that the secretary is not able to transfer all required knowledge to large number of employees simultaneously. It is necessary to take into consideration that additional individual smaller scale knowledge transfers will be needed over the period of time during which the new way of working is gradually adopted.
…	…	…

In this case best business practices leveraging involves the change of ownership of IS services. Instead of having three separate IS services it is possible to operate with

only one Institute 1 level service. IS service has to be changed for the leveraged process in order to accommodate two or more departments instead of one department. In case of fractal business processes this is mainly a matter of scale rather than complex IS change endeavor due to the similarity of activities at different levels of scale of administrative hierarchy.

4 Conclusions

In this paper we illustrate that in enterprises with fractal processes the fractal approach to business process and IS development is applicable [18] and enables incremental bottom-up changes in enterprise processes and supporting IS services. This approach reflects the systems development process that is in line with living systems theory, where common processes are gradually delegated to higher fractal levels of the system for the sake of higher functional efficiency of the system [21]. Gradual bottom-up delegating promotes emergence of best practices, willful propagation of these practices at a particular level of scale that naturally may lead to design of new processes and services at a higher level of hierarchy. This is decided at higher levels of fractal hierarchy. Fractals as holistic service systems integrated within a whole service perspective can be represented in terms of multilevel governance and component interaction.

With reference to the VSA, this paper has been our first attempt to interpret fractal enterprises as *viable* and *holistic service systems* useful to optimize information and resource flow and to share knowledge enhancing efficiency and effectiveness, and suggest and propose particular business process analysis and risk assessment methods useful in VSA setting.

References

1. Warneke H.J.: The Fractal Company: A Revolution in Corporate Culture. Springer, Verlag (1993)
2. Hoverstadt P.: The Fractal Organization: Creating Sustainable Organizations with the Viable System Model, Wiley. (2008)
3. Golinelli G.M.: Viable Systems Approach (VSA). Governing Business dynamics. Kluwer, Cedam, Padova (2010)
4. Regev G., Wegmann A.: Business Process Flexibility: Weick's Organizational Theory to the Rescue. Available at http://lamswww.epfl.ch/conference/bpmds06/program/ (2006)
5. Daoudi F., Nurcan S.: A Benchmarking Framework for Methods to Design Flexible Business Processes. In: Software Process Improvement and Practice. Wiley & Sons (2006)
6. Spohrer J., Golinelli G. M., Picocchi, P., Bassano, C: An integrated SS-VSA analysis of changing jobs. In Service Science, Vol. 2, No. (1/2), ISSN 978-1-4276-2090-3, pp. 1-20 (2010)
7. Barile S., Calabrese M.: A new frontier in consulting: the VSA consulcube, contributions to theoretical and practical advances in management. A Viable Systems Approach, pp. 245-262 (2011)

8. Spohrer J. and Maglio P.: The emergence of Service Science: Toward systematic service innovations to accelerate Co-Creation of Value," *Production and Operations Management*, Vol. 17, No. 3, pp. 238-46 (2008)
9. Canavesio M.M, Martinez, E.: Enterprise modeling of a project-oriented fractal company for SMEs networking, Computers in Industry, doi: 10.1016/j.compind.2007.02.-05. (2007), http:// www.sciencedirect.com
10. Fryer, P., Ruis, J.: What are fractal systems: A brief description of complex adaptive and emerging systems (2006), http://www.fractal.org
11. Hongzhao, D., Dongxu, L., Yanwei, Z., Chen, Y.: A novel approach of networked manufacturing collaboration: fractal web based enterprise. Int. J. on Advanced Manufacturing Technology. 26, 1436--1442 (2005)
12. Ramanathan, Y.: Fractal architecture for the adaptive complex enterprise. Communications of ACM. 48, 5, 51--67 (2005)
13. Ryu K., Jung M.: Fractal approach to managing intelligent enterprises. Creating Knowledge Based Organisations, J.N.D. Gupta and S.K. Sharma (Eds.), pp. 312-348. Idea Group Publishers (2003)
14. Sihn W.: Re-engineeringthrough fractal structures. In: IFIPWG5.7 working conference Reengineering the Enterprise, pp. 21-30. (1995)
15. Stecjuka J., Kirikova M.: The process-oriented fractal information system development method. In: 14th International Conference on Information and Software Technologies (IT 2008). Kaunas University of Technology, pp.171 –181 (2008)
16. Schaad A., Moffett J.: Separation, Review and Supervision Controls in the Context of a Credit Application Process: case study of organisational control principles. In: 2004 ACM symposium on Applied computing, pp. 1380 --1384. ACM, New York (2004).
17. Tripathi U. K., Hinkelmann K.: Change Management in Semantic Business Processes Modeling. In: 8th International Symposium on Autonomous Decentralized Systems, pp. 155-162. IEEE Computer Society, Washington (2007)
18. Rinderle S., Kreher U., Lauer, M., Dadam, P., Reichert, M.: On Representing Instance Changes in Adaptive Process Management Systems. In: 15th IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises, pp. 297--304. IEEE Computer Society, Washington (2006)
19. Kim D., Kim M., Kim, H.: Dynamic Business Process Management based on Process Change Patterns. In: 2007 International Conference on Convergence Information Technology, pp. 1154 –1161 (2007)
20. Makna J., Kirikova M.: Pattern-based IS Change Management in SMEs. Information Systems Development. Part 1, Springer, pp. 55-56 (2011)
21. Cottam R., Ranson W., Vounckx, R.: Life and simple systems. In: Systems Research and Behavioral Science, Volume 22, Issue 5 , John Wiley & Sons, Ltd, pp. 413 – 430 (2005)
22. Stecjuka J., Makna J., Kirikova M.: Best practices oriented business process operation and design. In Proceedings of the 9th Workshop on Business Process Modeling, Development and Support Business Process Life-Cycle: Design, Deployment, Operation & Evaluation Proceedings of the BPMDS'08 Workshop held in conjunction with the CAiSE'08 conference Montpellier, France, June 16-17, 2008, CEUR Press, pp. 121-129 (2008)