Chapter 34
Learning, Knowledge and Impact Assessment from the Perspective of Complexity and Chaos

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Abstract The paper benefits from information on selected (public-transformation) project works, mostly carried out by Stratek R&D Ltd, a private company in Turkey, linking with existing body of academic and practical knowledge on public value and system evaluation. The construction of this link will then lead to new directions for academic and practical research, including the adaptation of a reflective (& refractive) function to satisfy the principles & dynamics of a self-organizing and self-referential complex and chaotic system. Possible practical implications for ongoing project work will also be discussed before the conclusion.

34.1 Introduction

From an academic and conceptual perspective, as McElroy [9] introduces, the New Knowledge Management (TNKM) benefits mostly from complexity theory, the complex adaptive systems theory, or CAS theory in terms of helping to explain the role and evolution of knowledge. Accordingly, it can be claimed that learning is a self-organizing process, and that the knowledge produced through such processes is then emergent, as well. These concepts of emergence, self-organization, together with self-referentiality in fact deserve more attention in terms of their applicability into public policy-making and management areas [14].

As a bridge between this academic and practical perspective, Güçlü [7] benefits from the conceptualization and application of public transformation in (electronic) public services to be based on the "value delivery" to the public. Competing for the

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limited public funds emphasize basic rules of Economy, Efficiency, Effectiveness, (and Environment) in complex and chaotic Public Management. A Strategic Management Model (SMM) is based on and an extensive expansion of Government Finance Statistics (GFS), which the public finance officers are familiar with, introducing simplification over complex and chaotic public financial management environment in Turkey. A specific Value Space is developed in order to provide a framework for multiple perspectives such as organizational, functional, and performance with the same set of values, by fixing related dimensions under analysis. In order to measure both direct and indirect benefits as Agency Value, User Value, Political Value, Strategic/Social Value, and Environment Value, a specific method is developed for evaluating effectiveness of information systems (IS) in the public sector. A calculation method for both different indices for these values and the combined index, called the Total Public Value (PV) is provided. Güçlü [7].

Another related important project is the Erzincan Pilot Project (EPP) for the development of the ontology model of the public services inventory. One of the answers provided by the project is the complexity of business of each service (bureaucracy level indicator) which is scored using number of documents, number of activities and the number of services given per year [7]. Furthermore, currently, for instance, a new work on impact assessment of information and communication technologies, based upon cost-benefit analysis in public administration has also been initiated [8].

Table 34.1 Overview of tools for prioritization of new investment projects and new policies/programmes

	Main application	Main indicators used	Monetization of information	Degree of quantitative skills required	Computer software requirements
Cost-benefit analysis	Investment projects	Rate of return of investment and capital net present value, social discount rate	Full	+++	Spreadsheet, some specialized software
Cost-effectiveness analysis	Broad (Investment projects + other projects)	Cost-effectiveness ratio, net benefit	Partial	++	Spreadsheet
Impact assessment	Investment projects, legislative (policy changes)	Social, environmental, quality of life impacts	Limited	++	Spreadsheet, econometric software (STATA, SPSS, EVIEWS)

(continued)

Table 34.1 (continued)

	Main application	Main indicators used	Monetization of information	Degree of quantitative skills required	Computer software requirements
Multi-criteria decision analysis	Broad scope, highly complex policy context (environment, transport)	Performance matrix, criteria weights	Full	++	Specialized software (HIVIEW, VISA, DECISION DESKTOP, MACBETH)
Mathematical programming	Broad scope, highly complex policy context (environment, transport)	Allocation variables	Full	+++	Specialized optimization software

The paper will first benefit from this information on selected project works, mostly carried out by a private company in Turkey, namely, Stratek R&D Ltd, linking it with existing body of academic and practical knowledge. The construction of this link will then lead to new directions for academic and practical research. For instance a reflective (&refractive) function will be suggested to satisfy the principles & dynamics of a self-organizing and self-referential complex and chaotic system, furthering the TNKM as a theoretical contribution. Possible practical implications for ongoing work will also be discussed before the conclusion.

34.2 Public Transformation Projects in Turkey

Melford [13] identifies the following stages in eGovernment transformation in his 2005 presentation "Beyond eGovernment, Transforming Public Services":

- Promote access and connectivity;
- Provide services online;
- Transform the enterprise (first through automating the existing processes, then transforming business processes and organization);
- Next generation government, IT enabled radically different means of providing services.

With operational fragmentation, lack of proper control & audit, it is evident that information kingdoms arise in silo/stovepipe approach. New concepts, such as value chain and Public Value emerge within the context of strategic management, covering

risk management, performance management, process management and knowledge management. Based on these concepts, accountability and fiscal transparency emerge as the key approach in providing for economic, efficient and effective collection & utilization of public funds. Strategic planning is the central nervous system, transforming policy into goals, and goals into measurable objectives.

Güçlü's [7] work argues that assessment of IS effectiveness, particularly in government, still remains not well developed, mainly due to the realization of non-tangible benefits. All net benefits [3] can be merged into the concept of PV, which is a combination of Agency Value, User Value, Political Value, Strategic/Social Value, and Environmental Value, with hierarchical breakdown into key goal and performance indicators, merging the concepts from IS and public finance domains.

The developed model assumes that a strategic plan (SP) has already been developed and hence the objectives/goals, based on higher level policy papers, are identified together with Key Goal Indicators (KGI) and Key Performance Indicators (KPI). The model does not calculate the PV if the outcomes are not defined prior to the assessment, hence for instance if the environmental impact is neglected in the plan, no value will be calculated. More importantly, the model does not assess impact, but effectiveness. Although not specified in the SP, the values might be in conflict, an initiative yielding to a maximum value in one category may yield to a negative impact value on another category. Political, User and Environmental Values will often appear to be in conflict. This approach will eventually tell how much damage can be tolerated in one value (such as environment) while other values might have positive indicators (such as building a dam for energy and job creation).

Consequently, for instance, PV for Accounting Service is calculated to be as 1.0458. The model also relies on predetermined discretion and threshold by the management. Here, if the threshold set by the management is 0.80, then the TPV result is acceptable. Experience shows that the effectiveness can be calculated even at the micro level of one initiative rather that at a more global service level. Furthermore for a particular objective, how much money is spent for the related unit of performance or how much the agency had to spend in order to achieve one unit of performance can also be measured.

The developed model is also used for the project, Technical Assistance for Decision Making and Performance Management in Public Finance EuropeAid/129067/D/SER/TR. Prime Ministry, Ministry of Finance, Ministry of Development and Undersecretariat of Treasury of Turkey, as well as The Grand National Assembly of Turkey are the beneficiaries of the project. The project aims to establish a decision support system and a performance management model in order to be used firstly at the Beneficiaries and then to be disseminated to the other public administrations for the purposes of strengthening financial decision making and performance management capacity of the Beneficiaries. Stratek collaborates with Ecorys to accomplish the related activities and deliverables (Apr 2012 ongoing) (Stratek profile).

The framework that, within the given Environment, integrates the "Economy, Efficiency, Effectiveness", which can be referred to as "Value for Money" (VFM) is depicted below ("Decision Making and Performance Management in Public Finance" project deliverable report [2]):

Economy is careful use of resources to save expense, time or effort; in other words it is minimizing the cost of resources ('doing things at a low price').

Efficiency is performing tasks with reasonable effort ('doing things the right way'). Efficiency is delivering the same level of service for less cost, time or effort, i.e. attaining the most program outputs possible for each program input; and is usually expressed in monetary terms. Technical efficiency is associated with productivity, cost per unit of work done or service delivered, whereas economic efficiency is associated with benefits of a program compared to its economic costs, and is net social value of a project/program, estimated by subtracting the discounted social costs from the discounted social benefits.

Effectiveness is the extent to which objectives are met ('doing the right things'). It is focused on delivering a better service or getting a better return for the same amount of expense, time or effort. It is expected that the observed outcomes are consistent with the intended objectives.

Hence, **Value for Money** is about providing services that are of the right quality, level and cost that reflect the needs and priority of citizens, taxpayers and the wider community. VFM is a term used to assess whether or not an organization has obtained the maximum benefit from the goods and services it both acquires and provides, within the resources available to it. Some elements may be subjective, difficult to measure, intangible and misunderstood. Judgment is therefore required when considering whether VFM has been satisfactorily achieved or not. It not only measures the cost of goods and services, but also takes account of the mix of quality, cost, resource use, fitness for purpose, timeliness, and convenience to judge whether or not, together, they constitute good value. Performance management cycle evolves around these concepts; it is a normative model of organizational planning and actions that emphasizes the importance of stating clear goals and objectives, translating these into policies and programs, implementing and then assessing and reporting outcomes so that goals and objectives can be appropriately modified. ("Decision Making and Performance Management in Public Finance" project deliverable report [2]).

The project also conducts a comparative analysis or tools for assessment and prioritization of new policies and investment projects ("Decision Making and Performance Management in Public Finance" project deliverable report [2]) (Fig. 34.1).

Cost-Benefit Analysis (CBA) is especially preferable for investment projects, benefiting from main indicators such as Rate of Return of Investment and Capital, Net Present Value, and Social Discount Rate. These one-dimensional analysis and indicators, however become less useful for more complex systems evaluations such as the impact assessments of Information and Communication Technology projects or systems. Instead, for instance Multi-Criteria-Decision-Making (MCDA) that enables multi-dimensional indicators approaches can be more useful to address the complexity and chaos in the system. ("Decision Making and Performance Management in Public Finance" project deliverable report [2]).

There are certain initiatives and tools to address the arising need for such evaluations and assessments (Ex. Stratek internal report on Information System

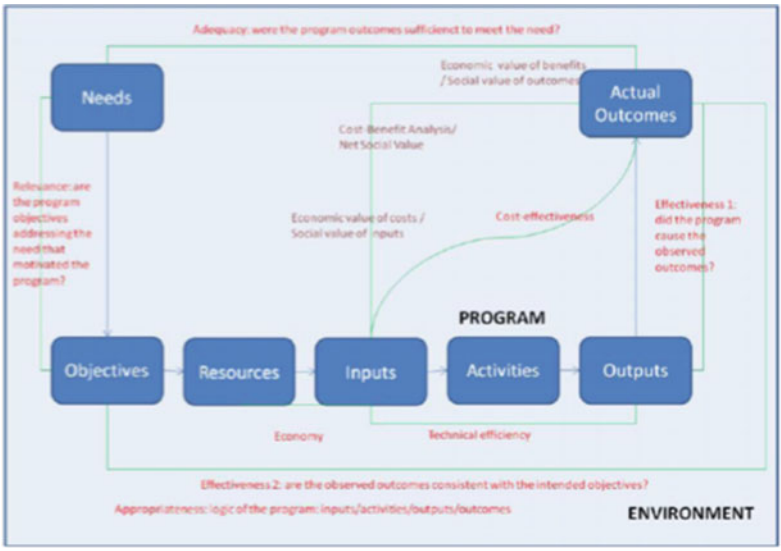

Fig. 34.1 Economy – efficiency – effectiveness (Adapted from Nagarajan, N. & Vanheukelen, M. (1997). Evaluating EU expenditure programmes: A guide, p. 25)

Evaluations [16]). While some of these methodologies and tools can be considered to be more sophisticated and useful than others, identifying and measuring more intangible benefits is still seen as a problematic issue. Furthermore, integrating the interactions among various stakeholders and other involved entities remains another important issue, among others. All these issues are significant in order to develop more useful conceptual models and practical applications to address chaotic and complex domains.

As a more real example, recently, the project of "Decision Making and Performance Management in Public Finance" provides specifically developed tools to government officers in order to help them deal with the complex and chaotic order in finance domain. The suggested programme budget modeling revitalizes the bottom-up and top-down interlinks among various planning, programming and budgeting entities. Furthermore, specific methodologies such as Data Envelope Analysis or sophisticated technologies such as Oracle Business Intelligence systems are adapted as user interfaces for agile decision support (Closure Meeting of The project of "Decision Making and Performance Management in Public Finance", [18]).

On the theoretical side, furthering conceptualization of Cost Benefit Analysis with respect to certain complex and chaotic systems features could also provide interesting implications. The next section is dedicated for such model development, benefiting from concepts of TNKM, reflection and refraction, mostly adapted from Medeni and Medeni's recent work [11].

34.3 Model Development Based upon Reflective and Refractive Interactions on Complex and Chaotic Systems

Reflection is an important concept for management of knowledge. For instance, Nonaka and Toyama [15] incorporates reflection into their conceptual framework for the conversions between tacit and explicit knowledge among different societal entities (as individual, group and organization and with environment) as part of the Socialization-Externalization-Combination-Internalization (SECI, Takeuchi & Nonaka [17]) processes of knowledge creation. However the underlying dynamics and interactions enabling such flow of knowledge among entities that can be very different deserve further analysis and articulation in order to apply these concepts into practice. Medeni [10] respectfully attempts to complement concept of reflection with a new conceptualization of refraction. Suggested as an important phenomenon in cross-border interactions among different societal entities, refraction is identified as a more cross-cultural, creative and critical types of reflection that are mostly missed in cross-cultural management and transfer of knowledge. Accordingly, reflection and refraction exists together and complement each other. Meanwhile, they function together as important dynamics for knowledge conversions between tacit and explicit knowledge.

Using the mathematical/geometric features of the ellipse, and conceptualizing the practice/management and knowing/learning both as a product and process, reflective model of experiential learning and practice can also be developed. This is somewhat related to discussions of soft and hard systems methodology [1, 12], in which, simplistically, the former stresses the process and the latter signifies the product. Initially desired, the ideal is to be able to obtain both the process and product. Second, if we place learning or knowing and management or practice as the two loci in an ellipse, the resulting figure provides a useful expression for the attainment of process and product. This elliptical diagram is also a recognition of the equal importance of both mental learning/knowing and physical managerial practice, moving beyond the perception of previous circular models like learning cycles, or singular spiral models as suggested in knowledge creation. Moving along the ellipse, one can obtain the process, then process and product together, and finally the product by itself, which is transferred to the other side with a reflective object passing through the middle of the whole figure. In this way both the spatial and temporal meanings of the possible transfer of the rich experience and knowledge gained from learning and practice can be visualized. What determines to be transferred or not is the power associated with experience and knowledge (Fig. 34.2).

Here, underlying that there are two knowledge-creating spirals instead of one spiral or two constant centers is important. These two spirals are spatial and temporal (one moves clock-wise, the other moves anti-clock wise) reflections of each other, resembling the image of a moving object in a mirror. The integration of these two reflective spirals also corresponds with lemniscates or chaordic (Chaotic & Ordered) systems, as often recalled together with Lorenz Attractor (Fig. 34.3)

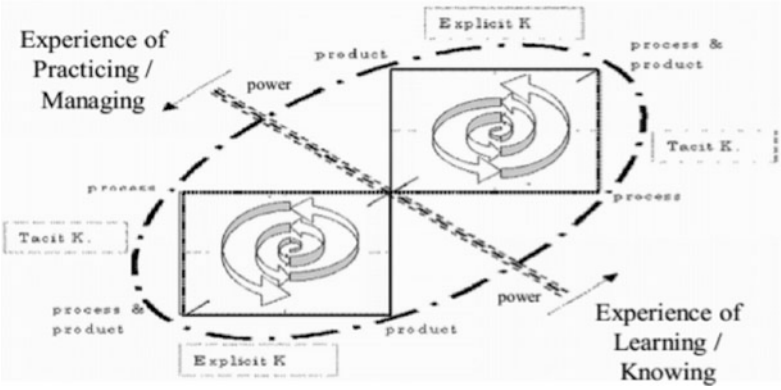

Fig. 34.2 Reflective and elliptic model of experiential learning and practice [11]

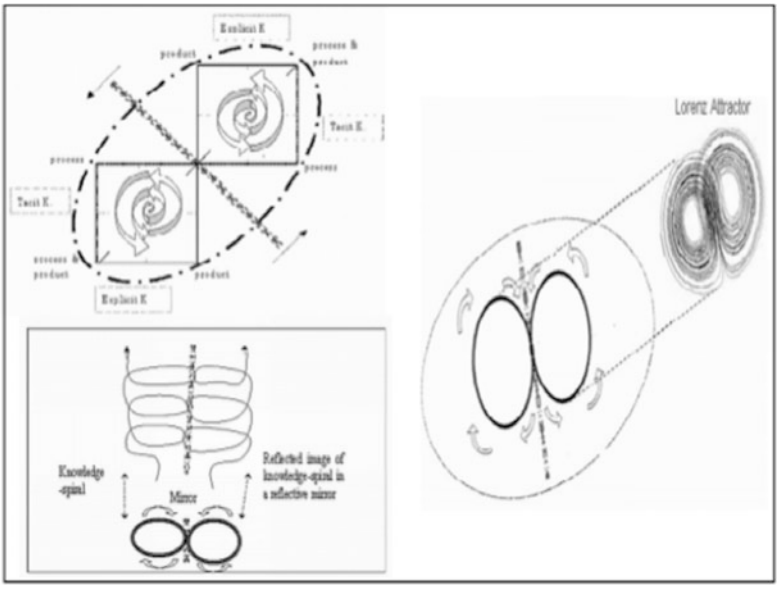

Fig. 34.3 Experienced reflections as a chaordic (Chaotic & Ordered) knowledge-creating system [11]

In this illustration, the upper part is a 3 Dimensional (3D) visualization, while the bottom part is a 2 Dimensional (2D) projection on a plain surface. The upward spiral in 3D looks like an endless cyclic movement in 2D. Finally, the cyclic movement in the left spiral/circle is clockwise, whereas in the right spiral/circle, it is anti-clockwise, which together creates a continuous horizontal-8 figure, resembling the infinity symbol, in 2D. What is also worth-noting is that the conceptualization of

reflection here is not only the reflection of a physical object, but the metaphorical reflection of a knowledge-creating process that proceeds in time and produces an outcome, as well, as we have discussed above. Accordingly; if the clockwise move symbolizes the natural proceeding of time from past to present and future, then its reflected image, the anticlockwise move, symbolizes the reversed flow of time from future to past, while reflection plays the role of establishing the link between these two flows, i.e. making use of the reversed flow in order to make sense of the real flow, which could be one interpretation of reflection.

This interpretation is also in accordance with the self-referentiality aspect of complex systems. A simple reflective function can be defined, for instance, as $f(x) = -f(x)$, which also corresponds for (one type of) the self-referentiality, leading towards self- organization, as well.

What the above figure also implies is that the two knowledge-creating spirals of practice and learning are simply conceptualized as one knowledge-creating spiral and its reflected image, while their interdependence is the mere result of an exact, one-to-one reflection. However, such reflection would exhibit a simplified or ideal case, as it is more realistic to think that the reflection would be mostly refracted, and these refracted reflections would replace any exact linear correspondence with more dynamic, non-linear approximations.

In such modeling, reflection and refraction construct the practice-learning link and interaction, which includes concerns like what we learn from practice, how we apply our learning into action, or how we construct our knowledge, and accumulate our experience. These concerns highlight that how we reflect and refract is not simple, but a lot more dynamic, and chaotic; and a modeling about reflection and refraction should address this chaos. In fact, the inclusion of refraction within the conceptualization of reflection is an initial premise for such a non-linear, more dynamic modeling.

Such modeling of reflection and refraction fits also more with complex systems. For instance, as discussed above, it meets the self-referentiality principle. In fact Plato argued that all physical reality experienced by human beings in the material world are actually only imperfect and refracted reflections of a perfect world (that exists elsewhere in the universe). [19]. Benefiting from Plato and Hegel, and Heidegger' ideas, Eldred [4] discusses how (it can be seen that) the singular self is refracted on the other and thus 'broken in' on the world through the dialectic between singularity and universality. Authors like Geyer [6]) also brings the related discussions on self-reference into systems science. The model also satisfies not only self-organization but also emergence principles of complex systems, in accordance with learning and knowledge processes of TNKM, as introduced above [5]. As a result the developed model can also be used to explain the knowledge interactions in complex (and chaotic) domains.

One further step for this model development and use, which is previously suggested for knowledge creation and management learning, can also be a reinterpretation for cost and benefit analysis. Accordingly, cost and benefit could be considered as the two attractors of the system. Initially resembling for instance causal loop diagrams that illustrate the relationships between variables in system.

Such model reinterpretation could in fact be useful to formulate more measurable parameters and meaningful relations among cost and benefit variables for complex domains such as the impact assessment and public value measurement of a technological solution in a public agency.

The systems will be attracted to reach a leveling situation at the sides of both costs and benefits. These costs and benefits could be identified and measured with respect to self-referentiality, self-organization and emergence principles.

34.4 Future Work and Conclusion

The paper has presented a background on public transformation projects in Turkey, benefiting from available relevant academic and practical knowledge. Based on this, then;

1. a leading-edge public-value and cost-benefit analysis framework that is applied to real life examples is provided, benefiting mostly from Stratek projects.
2. a model development based upon reflective and refractive interactions on complex and chaotic systems is suggested.

Various implications can be drawn from these suggestions. For instance, the measurement of user efforts could be incorporated into the design of the impact analysis for specific information and/or communication technologies as real-life projects. Or assessment of individual initiatives at micro level could be conducted to complement aggregate assessments at macro level. Accordingly, inferences on the interrelation between micro and macro with respect to self-organization, emergence and co-existence aspects of complex systems [14] could be made. or, suggestions for more flexible, evolvable and maintainable organizational ontologies could be provided for Future of Internet.

It should be underlined, however, that this is mostly a conceptual work that needs to be complemented with empirical data collection in the future. Accordingly, some of the coauthors currently work on developing a cost-benefit analysis model as a part o integrated assessment for a selected information and communication technology to be applied in a government agency in Turkey, benefiting from existing literature and practical examples [8].

Impact assessment of institutional and technological systems is among the highly-appraised topics in current Turkish practice and academia, following the general trend in the world. We hope our work also contributes to these related ongoing and future works.

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References

1. Checkland P (1999) Systems thinking, systems practice. Wiley, Chichester
2. Decision Making and Performance Management in Public Finance (2013) EU IPA (Instrument for Pre-accession Assistance)-funded Project deliverable.
3. DeLone WH, Mclean ER (2003) The DeLone and McLean model of information systems success: a ten-year update. J Manag Inf Syst 19(4):9–30
4. Eldred M (2007) Dialectic of self and other: wrestling with Plato, Hegel, Heidegger. http://www.arte-fact.org/untpltcl/dlctcslf.html. Accessed 7 Dec.2011
5. Firestone JM (2004) The new knowledge management: a paradigm and its problems. http://www.kmci.org/media/Firestone-tnkmparadigm.pdf. Accessed 30 Jan 2014
6. Geyer F (2002) The march of self-reference. Kybernetes 31(7/8):1021–1042. Emerald
7. Güçlü N (2011) Modeling and assessment of the effectiveness of government information systems. Unpublished PhD thesis submitted to METU, Turkey
8. Güçlü N, Alır G, Öztopçu L, Medeni T (2013, 2014) Weekly group meetings. Ankara
9. McElroy MW (2003) Understanding 'The new knowledge management', 2. www.macroinnovation.com. Accessed 30 Jan 2014
10. Medeni (2008) Educating managers for the global knowledge economy: an action research into international masters program in practicing management. Unpublished PhD thesis submitted to JAIST, Japan
11. Medeni T, Medeni İT (2012) Reflection and refraction for knowledge management systems. Int J Ebus Egov Stud 4(1):55–64
12. Medeni T (2004) Reflective management learning practice model. International workshop on Business and Information (BAI), Taiwan. http://www.jaist.ac.jp/~medeni/researches/taiwanconference_reflective%20management%20learning%20model.pdf. Accessed 30 Jan 2014
13. Melford M (2005) Beyond eGovernment, transforming public services., 2005. Ministerial eGovernment conference
14. Morgül (2013) Kamu politikaları için karmaşıklık kuramı. V. Kamu Politikaları Çalıştayı, Turkey
15. Nonaka I, Toyama R (2003) The knowledge-creating theory revisited: knowledge creation as a synthesizing process. Palgrave Macmillan J 1(1):2–10
16. Stratek (2014) Stratek internal report on information system evaluation. Stratek, Turkey
17. Takeuchi H, Nonaka I (1995) Hitotsubashi on knowledge management. Wiley, Singapore
18. The project of Decision making and performance management in public finance (2014) Closure meeting, 28 January, Ankara, Turkey
19. Willner M, Hero G, Weiner J (2006) Global history volume I: the ancient world to the age of revolution Barron's. Barron's Educational Series, Inc., New York