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Design of a Compensation System for Management Executives Using Generalized Nets

SYNOPSIS

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Thesis: Design of a Compensation System for Management Executives Using Generalized Nets

Chapter 1

Introduction

This dissertation is concerned with one of the crucial problems faced by many companies operating in the difficult economic, social, technological, etc. conditions which are common in the present day world, namely how to determine the executive compensation which is meant as the financial and non-financial benefits paid or provided to an executive such as CEO (Chief Executive Officer), CFO (Chief Financial officer), COO (Chief Operating Officer) and other executives. It is well known that it is of utmost importance for a company, institution or organization to have the best possible executives who have to be properly compensated, both financially, exemplified by a proper salary and performance bonus (i.e. additional money depending on results obtained), and non-financially, exemplified by insurance, company car, laptop, options on the company's shares, etc.

The executive compensation is usually considered in the more general perspective of a reward system adopted in a particular company to identify key objectives placed on the executive compensation as well as key requirements for the compensation design process, with extremely important evaluation and updating procedures in the compensation design which include a continuous cycle of developing, implementing, using, evaluating and adjusting of the executive compensations. The executive compensation system is meant to support the attainment of business goals, and to attract, motivate and retain competent executives in view of the market competition, both in a short-term and long-term perspective. This process is characterized with being multifaceted, distributed over various time periods and horizons, being a combination of long-term strategic and short-term tactical aspects and day-to-day operations, various priorities assigned to various aspects, the use of various measures for the evaluation of alternatives, the use of various information sources, the use of various benchmarks, etc. These characteristics clearly indicate that the process of designing the executive compensation system, and of the determination of executive compensation, is a very complex one and calls for the use of novel techniques. In this work, we advocate Atanassov’s Generalized Nets (GNs) as a proper tool for an effective and efficient analysis and solution of this problem.

The purpose of this dissertation is, therefore, first of all, to propose a new model for the design of an executive compensation system in various types of companies, private and public, smaller and larger, with a concentrated or dispersed ownership, using the powerful tool of Atanassov’s Generalized Nets (GNs). Moreover, we also present some original solutions of how to formalize and implement elements of a specific reduced Generalized Net for the purpose of a practical application. In this context the aim is to attain the comprehensiveness of the model for domain experts who are experts in economics, management science or human resources (HR) with a limited command of mathematics.

Chapter 2

Management Compensation as a Crucial Problem in Highly Competitive Business Conditions

In this part of the dissertation, main issues related to the operation of companies and the importance of a proper executive compensation are discussed. To be more specific, the executives concerned are the two top executives, mainly the CEOs (Chief Executive Officers), CFOs (Chief Financial Officers), COOs (Chief Operating Officers) other board members, managing directors, etc. However, our analysis and model can also be employed for other top managers such as division directors, plant managers or sales managers. An executive should possess a wide array of capabilities and skills, both "hard" (related to his or her knowledge and expertise) and "soft" (related to his or her social interpersonal skills, etc.) and it is not easy to find many such people. This all means that there is a scarcity of (very) good managers on the labor market, and companies have to more and more proactively search for good managers, and if they find one, then such managers should be appreciated and appropriately compensated, both financially and non-financially. The compensation (both a salary and other benefits) to be paid to an executive may have a very strong influence on the finances of the company. The problem of how to determine a proper compensation is still a big challenge in the theory and practice of management and organizational science as well as corporate finance, and a multitude of books have been published on this topic over the years in which various approaches are proposed.

In the dissertation, the role of executive compensation is meant in a more general perspective of an executive reward system, that is a system supporting the setting and implementation of business goals of a company (or, more generally, an organization) in question, and attracting, motivating and retaining highly skilled employees. In addition, this all should be aligned with what is critical for the company to succeed in both a short-term and long-term perspective, and to accomplish its strategic goals. This is clearly a performance-oriented view but there are also some behavioral type approaches that state that the reward system should be concerned with the formulation and implementation of strategies and policies that aim at rewarding people fairly, equitably and consistently in accordance with their value to the company. In this dissertation, we follow a performance-oriented approach.

In general, the design of a rewards strategy (system) is a very complex problem which should take into account multiple aspects, notably those related to business strategy, which is obviously long-term, through medium-term and short-term tactics to day-to-day operational tasks and decisions. Many components should be accounted for, notably: how the rewards strategy will support the business strategy and needs of the company's stakeholders, the main criteria for the evaluation and their prioritization (assignment of importance), types of rewards with their description and relative relevance, a relative importance of various rewards in relation to other tools applied for motivating, attracting and influencing employees, which measures should be used for the evaluation, selection of proper competitive market reference points (benchmarks) of particular compensation components, a proper updating of rewards strategy in response to a change of performance or conditions, proper data management (choice of data sources, processing, analytics), communication with shareholders, owners and other stakeholders.

In general, the executive compensation packages for senior managers often consist of six components: (1) a base salary and a performance related annual incentive (bonus) which is of a short-term character, (2) a performance related long-term incentive, (3) benefits, (4) executive perquisites, and (5) contingent payments. It is easy to see that the executive compensation is devised to reward the company's performance and to relate the executive compensation to the value of the company to shareholders so that there is a risk, as opposed to normal salaries, that if the performance of the company is unsatisfactory, then the managers can even receive significantly lower compensation in comparison to a previous year. However, in case of a very good performance, they can usually expect a very high compensation.

In our proposed approach, we assume initially that the structuring of the process of executive compensation design will be focused on internal company goals and we initially put aside external aspects and conditions. We assume the following three commonly assumed goals for our system for the determination of executive compensation: (1) to optimize executive compensation to maximize the value to a company and the value to a manager to first attract and then to retain the best possible managers, (2) to dynamically calculate the cost of executive compensation to the company and benefits to a manager to respond to a fast changing and highly competitive job market, (3) to provide a tool for an owner, a compensation committee, a human resource department, etc. to evaluate possible (feasible) options and conditions of the executive compensation package and their impact on the company, both positive and negative, in static and highly dynamic scenarios.

The above goals suggest that the approach for the determination of a proper (best) executive compensation package should include diverse sets of source data but also that it should explicitly take into account dynamic analyses of the incorporation of those sets of sources, evaluations and readjustments that can be performed throughout the compensation design process.

The proposed executive design process is composed of five main action steps: (1) description of the current compensation model, (2) benchmarks and constraints, (3) design phase, (4) finalization and implementation, and (5) assessment and evaluation.

From a more theoretical point of view, the problem of executive compensation is usually considered by using concepts and tools of the *agency theory*, also called the *principal – agent problem*, concerned with resolving problems that arise in a situation in which one party (the principal, which stands here for the owner, shareholders, etc.) delegates work to another party (the agent, here an executive). Two problems occur. The first is the agency problem that arises when the goals of the principal and those of the agent are different, and the principal cannot verify the actions and behavior of the agent. The second is the problem of risk sharing which occurs when the principal and the agent have different attitudes towards risk. The agency theory looks at a company as at a bundle of contracts, and focuses on potential conflicts of interest arising from an asymmetry of information between two contractual parties, i.e. the principal and the agent. The executives (agents) are meant to have a legal and fiduciary obligation to protect the rights and economic interests of the owners (principals). To implement this the principals (owners) must establish a system of robust corporate governance and maintain continuous monitoring (policing) of managerial decisions and performance. This may be difficult in the case when the ownership is separated from direct control (management) in a company which is often the case with large companies with multiple and dispersed shareholders, and when the executives are highly professional and self-interested.

The problem of executive compensation considered in this dissertation does involve a principal – agent situation and therefore the agency theory can be very useful. We use some conceptual elements of this theory since our emphasis is on more technical aspects related to the algorithmization of the design of the executive compensation packages.

However, we refer to some claims of the agency theory exemplified by that it is more important what the structure of the reward package is, and how its particular elements are prioritized than what are the levels (values) of these elements. That is, the way how a compensation package is formulated is more important than its value, i.e., ‘what’ is more important than ‘how much’.

What concerns the process of design of the executive compensation, the consecutive steps of the process are usually presented as diagrams that include specified sequences of tasks to be solved by particular agents (individuals, groups, committees, etc.), and a logical flow of information that is needed to model and implement those steps which clearly suggests that a proper formal tool should be used. This tool should make it possible to effectively and efficiently deal with the problem which is multifaceted and multiaspect, distributed over various time periods and horizons, combining long-term strategic through short-term tactical to day-to-day operational aspects, various priorities assigned to various aspects, use of various measures for the evaluation of options, use of various information sources, use of various benchmarks, and other characteristics of the process.

Chapter 3

Introduction to the Theory of Generalized Nets

As it can be seen from the formulation of the problem of management compensation, the process of determining the compensation (financial and non-financial) is a clear example of discrete event system as it is a sequences of consecutive tasks to be solved by particular agents (individuals, groups, committees, etc.), triggered by external events, internal events and which then trigger other series of subsequent tasks, that are run in parallel and possibly autonomously. These are clearly discrete event systems, an extremely challenging and important type of systems, both from a theoretical and practical points if view. In our work we will follow the exposition adopted in the very well-known book on the discrete event systems by Casandras and Lafortune. Then, we will present a new, powerful extension of the Petri nets, Atanassov's Generalized Nets, which provide new possibilities to model complicated event-driven changes, determine sophisticated time-related properties that will be relevant for the new models of determining the executive compensation, proposed in this dissertation.

3.1 Discrete Event Systems

First, the concept of a system can be viewed from different angles but it is convenient to assume here that it is a primitive concept which is intuitively well understood but difficult to precisely define. A system is usually some aggregate of elements (things) that are interdependent and interacting, which form a homogeneous whole and act together to perform functions in a way that it would not be possible for the individual components acting alone. A system can consist of animate (people, animals, social groups, ...) and inanimate (machines, computers, ...) components. The systems can be modeled and analyzed in various ways, both qualitative and quantitative; the quantitative way is clearly more relevant to us. From the theoretical and practical points of view, a very convenient representation of systems is an input-output relationship which assumes that we have input variables and output variables, maybe ones varying over time, and there is a mathematical relationship between them which represents a system. The system can be static or dynamic, time-varying or time-invariant, deterministic, stochastic, fuzzy, etc.

A very important concept is that of a *state* which is meant as a set of variables the values of which fully summarize the history of the system in order to predict the future values of the outputs under some specified values of the input. Relationships between the input, output and state variables are called *state equations*, and the determination of these state equations, which represent dynamics of the system, are what is sought in systems modeling. This is clearly a “black box” approach.

In many situations the state variables of a system take on discrete values, for instance from the set {1, 2, 3, …} and the state transitions are specified for discrete time moments only. These transitions are called *events* and such systems are the so-called *discrete event systems* (cf. the book of Cassandras and Lafortune), as well as many other books published by virtually all major publishers.

The point of departure here is the concept of an event which is intuitively clear but difficult to define so that it is good to assume it to be a primitive concept. An event occurs instantaneously and causes some occurrence, for instance a transition from one value of a state variable to another, or the triggering of a new course of action. An event can also be a specified deliberate action, for instance starting a car engine, a result of some number of specific conditions fulfilled simultaneously, but can also be a non-planned occurrence of some event like winning an award or a computer program breakdown.

For our purposes, an important problem is the role of time in the discrete event systems. In the traditional continuous-time and discrete-time dynamic systems, the values of state variables usually continuously change as time elapses. In the *discrete-time systems*, which are relevant to our discussion, it is convenient to assume the existence of a clock the ticks of which change the values of state variables. So, if an event (clock tick) does not occur, then the value of state variables does not change with time. The state transitions are therefore synchronized by the clock which, if ticking, triggers the occurrence of some event (or no events), followed by possible changes of values of state variables, etc. So, the clock alone is responsible for any possible state transition and is a natural independent variable in all input, state, and output functions. Such systems are therefore called *time-driven systems*. On the other hand, in the *discrete-state systems*, the values of the state variables change only at certain points in time through instantaneous transitions which are associated with events which should happen (usually some set of events) so that a specific transition could occur. At various time instants, which need not be known in advance and need not coincide with clock ticks, some event(s) can occur. It defines a distinct process through which the time instants when the event occurs are determined. The state transitions are then implied by the combination of these asynchronous and concurrent event processes which need not be independent of each other. Such systems are the so-called *event-driven systems*.

It is obvious that the modeling and analysis of event-driven systems are more complicated mainly because of the existence of asynchronous event-timing mechanisms to be specified. For our purposes, a discrete event system is a *discrete-state, event-driven system*, that is, its state evolution depends entirely on the occurrence of asynchronous discrete events that happen at some time instants and trigger some changes. The event-driven property refers to the fact that the values of state variables can only change at some discrete time instants which correspond to occurrences of asynchronously generated discrete events. Therefore, if a set of events causing state transitions can be specified, then the time does not serve the purpose of driving the behavior of such a system. The events correspond to switches from one mode of operation (state equation) to another.

Among many questions and problems related to the discrete-time event-driven systems, one can ask: (1) how much time the system spends at a particular state, (2) how soon a particular state can be reached, (3) if a sequence of events be completed by a particular deadline, etc.

Within the field of discrete event systems, many models are considered. In the case of using the idea of a state transition equation, which is relevant to our work, the two main classes of models are: automata and the Petri nets, which basically differ in how they represent information on the state variables, and how the discrete event model of a system is built from discrete event models of the system components. In both models, the analysis and synthesis problems are typically addressed by making use of the structural properties of the transition structure in the model.

In this dissertation, we operate within the second main class of models developed for the discrete event systems which are traditionally based on the Petri nets. However, in order to better represent complex dynamic processes and cover more complicated event-driven mechanisms which characterize the problem considered, we will use a new, powerful extension of the Petri nets, the so-called Generalized Nets (GNs), originally introduced and then considerably extended by Atanassov. The Generalized Nets make it possible to formalize, analyze and algorithmize many more types of behaviors and properties of the discrete-event systems than even the modifications and extensions of the Petri nets themselves.

3.2 Generalized Nets

Generally, the real-world complex system – exemplified by the system of executive compensation design considered in this dissertation – involves multiple communicating units (subsystems) with a sophisticated modes of dynamic interaction between the constituent units and their behavior emerges from the information flow. These systems constitute a (potentially synergistic) combination of the continuous and discrete ones, and involve some event-driven systems as important components. Such a combination of (sub)systems exhibiting various modes of operation is by itself very difficult to formalize and analyze. The dynamics of such discrete event-driven systems is in general event-based (event-driven), asynchronous and concurrent. The addition of asynchrony and concurrency makes it even more difficult to model and analyze. On the other hand, in reality the events take some amount of time which is variable. This implies that the discrete event-driven dynamic system must, first of all, be able to represent the asynchronous behavior of the system.

Second, the concurrency requires an intuitively appealing and tractable theory which is provided by the Petri nets that is a mathematical modeling technique for the description of distributed, event-driven, asynchronous and concurrent systems. Graphically the Petri net is represented as a directed bipartite graph in which the nodes represent transitions (i.e., events that may occur, represented by bars) and places (i.e., conditions, represented by circles). The directed arcs define which places are preconditions and/or postconditions for which transitions.

The basic model of the Petri net has been then improved in many directions, and many extensions have been proposed, for instance, stochastic Petri nets, timed Petri nets, colored Petri nets, to mention a few.

However, even the most comprehensive and recent extensions of the Petri nets do not involve sophisticated mechanisms which may be crucial for an effective and efficient formulation, analysis and solution of many complex real-world problems. For instance, they do not make it possible for the tokens to accumulate history, to have transitions with multiple inputs and outputs, use various timescales, etc.

The most successful attempt at devising new nets which would not have the above-mentioned deficiencies and limitations, and which would show many more relevant functionalities, has been the introduction of Atanassov's Generalized Nets in 1982 which have enjoyed since then a great popularity and found numerous applications.

In this dissertation, the use of Atanassov's Generalized Nets is proposed as a proper approach for the formulation, analysis and algorithmization of the executive compensation design problem. The main reason is that the inherent complexity of the problem, and its event-driven structure clearly indicates that only the Generalized Nets can provide tools and techniques for an adequate modeling. Mainly, the Generalized Nets, like other nets meant in a similar sense, contain tokens which transfer from one place to another, each token enters the net with an initial characteristic, during each transfer the token receives a new characteristic and as a result of a sequence of transfers the consecutive characteristics accumulate, forming a history; transitions can have more complex structure and form, there can be various timescales, etc.

3.3 Formal Definition and Main Properties of the Generalized Nets

The Generalized Nets have been presented in some detail in the dissertation. However, due to the fact that the new model is meant for the problem in an area in which domain experts have limited knowledge of mathematics, our presentation will be constructive and comprehensible to domain experts, and convincingly showing the power of the Generalized Nets for the problem considered.

Each place in the Generalized Net has at most one arc entering and at most one arc leaving it. The places with no entering arcs are called input places and those with no leaving arcs are called output places. Graphically, the input places are always at the left-hand side of the transition, and the output places are always at the right-hand side of the transition. A transition becomes potentially fireable when tokens enter the input place, and becomes fired when they are transferred towards the output places of a transition. A transition becomes active at a given time moment and remains active until another predefined moment. The transitions can be complex objects that contain m ($m > 1$) input places and n ($n > 1$) output places. When we have the Generalized Net models of some processes that flow in parallel, we can use many timescales or a single one, taking into account moments when separate events in the particular processes occur. In practice, time is assumed to be discrete, proceeding in discrete steps.

To just briefly present the very idea of the Generalized Nets, it is formally defined by the ordered tuple which includes: a set of transitions, a function specifying the priorities of transitions, a function specifying the priorities of places, a function specifying the capacities of places, a function determining the truth values of the predicates of transition's conditions, a function yielding the next time-moment for which a given transition can be activated, a function yielding the duration of an active state of a given transition, a set of tokens, a function specifying the priorities of tokens, a function specifying the time-moment when a given token can enter the net, the time-moment when the Generalized Net starts functioning, an elementary time-step related to the global time-scale, the duration of the functioning of the Generalized Net, a set of all initial characteristics that the tokens can receive when they enter the net, a characteristic function that assigns new characteristics to every token when it makes a transfer from an input to an output place of a given transition, and a function yielding the maximum number of characteristics a given token can get.

3.4 Functioning of the Generalized Net and Transition Algorithms

The concept of the Generalized Net is much more general and complex than the concept of the Petri net, even in any of its extended forms, because it encompasses many more possible types of behavior. Therefore, the algorithms for the transitions of token transfers are also more complex, and also more general than those of the Petri nets. Generally speaking, in the Petri nets the parallelism boils down to a sequential firing of the transitions. The order of their activation is usually probabilistic or dependent on the transitions' priorities if they are available. The algorithms employed in the Generalized Nets make possible a wider and deeper modeling of the described process. The algorithms for the tokens transfer take into account the priorities of the places, transitions and tokens, i.e., they are more comprehensive and precise.

3.5 Generalized Nets and Other Types of Petri Nets

It may be interesting to contrast the Generalized Nets to some extensions of the Petri nets. To mention a couple of some more relevant differences, tokens of the Generalized Nets are not colored as in the colored Petri nets, Generalized Nets have no generators of random numbers as in the stochastic Petri nets, Generalized Nets have no inhibitor arcs as in the so-called super nets, etc. On the other hand, the Generalized Nets have some new components that make it possible to describe various components of the extended Petri nets in terms of the Generalized Nets. The Generalized Nets also have, like all other extensions and modifications of the Petri nets, a static structure and dynamic elements, that is, tokens. The Generalized Nets have temporal components as the time Petri nets, E-nets, PRO-nets, generalized E-nets, etc. but they can be non-time-invariant, because the Generalized Nets can have three global temporal constants: the one corresponding to the initial moment (due to some absolute timescale) in which the Generalized Net starts its functioning; an elementary time-step of the process, described by the Generalized Net, and the duration of the functioning of the Generalized Net. The modifications and extensions of the Petri nets are not related to an absolute time-scale, i.e., they can function at every time-moment and this does not influence their functioning. This scale is very useful when we like to describe two or more parallel (and concurrent) processes. The static structure of the Generalized Net is similar to that of the E-nets and the generalized E-nets. The dynamical elements of the Generalized Net are the tokens (which also exist in other nets) but here the transition conditions also have a dynamic character. What is very important, the Generalized Nets have a new, fourth component, a "memory". The tokens enter the Generalized Net with some initial characteristics and during their transfer from an input place to an output place, they acquire new characteristics, not necessarily the same for all tokens. Therefore, the tokens become "individuals" with their own "history". A similar idea of individual properties has been proposed in the context of the colored Petri nets and in the predicate/transition nets, but therein the information related to former colors, or symbols of tokens, is not saved. Here, the tokens keep their characteristics so that their history can be traced and used in the next moments of the functioning of the Generalized Net.

Therefore, from our point of view, we can summarize the very advantage of using the Generalized Nets in our context as to provide a means for a more advanced modeling of complicated real processes.

3.6 Reduced Generalized Nets

In this context, we should also mention the concept of a reduced Generalized Net which involves some simplified properties and definitions that can be important for dealing with practical problems. The price to be paid is that the reduced Generalized Nets have a much more complex graphic structure in the sense of a higher number of transitions and places. The characteristic functions and the transition condition predicates of the reduced Generalized Nets are also more complex because they contain all the necessary information. The number of tokens in the reduced Generalized Net is also greater than the number of tokens in the corresponding ordinary Generalized Net. However, the use of the reduced Generalized Nets seems to be much easier for the practitioners, also in our case.

3.7 Some Further Extensions of the Generalized Nets

Some other extensions of the Generalized Nets are the Intuitionistic Fuzzy Generalized Nets (IFGNs), Color Generalized Nets, Generalized Nets with interval activation time, Generalized Nets with stop-conditions, Generalized Nets with tokens possessing enhanced memory capabilities, and several more. While these will not be explicitly used in this dissertation, they contain some interesting modeling capabilities and additional aspects of the structure and functioning of the Generalized Nets which are worth investigating in the further development of the model presented in this dissertation.

Chapter 4

A New Model for the Determination of Management Compensations Using Atanassov's Generalized Nets

4.1 Introductory Remarks

The Generalized Nets have been used to derive a novel model of the design of management compensation. We will now present its essence and main elements.

First, the model is placed in the broader perspective of a Total Reward System discussed together with the importance of proper structuring of the compensation system for executives to support the company's goals and attracting, motivating and retaining managers. The process of design of the compensation system is initiated with the setting of a wide spectrum of benchmarks, expectations and constraints. Moreover, it is also required that the system to be designed provides the flexibility and adjustability of the executive compensation package to varying external conditions and factors, even very extreme ones. This all proceeds in a dynamic manner, by performing consecutive steps which are triggered by some external and internal events, and the outcome of which triggers or influences other events.

4.2 Reward Systems, Executive Compensation and Their Role in Attaining the Company's Goals

The main purpose of a reward system in a company, institution or organization is to attract, motivate and retain competent employees who would contribute to the fulfillment of the company goals – short-term and long-term, as well as strategic. The reward system should be fair and equitable, taking into account the value of particular employee for the company. The design of a rewards strategy which is basically what companies face while deriving their reward systems, is clearly a very complex problem and contains many elements and issues to be solved, notably: (1) rewards strategy philosophy, that is, a statement about how a rewards strategy will support business strategy and needs of the company's stakeholders, (2) goals of rewards strategy, that is, the determining and prioritization of evaluation criteria, types of rewards, that is the choice of a list of reward types with their description and relative importance, (3) relative importance of various rewards in the sense of setting the importance of rewards relative to other tools applied in influencing and motivating employees' behaviors, (4) selection of measures that should be used in the design of rewards including decision about the level in the organization at which the criteria will be measured (organization-wide, team, individual) and decision about which elements of total rewards will be associated with those measures, (5) selection of competitive market reference points, that is, the selection of peers and competitors that should form the benchmarks and to which employees will compare their compensation in terms of its competitiveness, (6) competitiveness of rewards strategy, that is, to make decision on a desired competitive position versus selected competitive market reference points, company's level of rewards to be below, equal or above the market, (7) updating of rewards strategy, that is, the definition of criteria and process(es) for amending the rewards strategy or some of its elements, (8) data and information management, that is, the selection of information sources, approach(es) and method(s) of data processing, tools used in decision support as well as reporting, (9) guidelines for solving conflicts, that is, the development of methods and processes for resolving conflicts, and (10) communication strategy, that is, to make decision about the intensity and contents of communication of rewards strategy with key stakeholders and employees.

4.3 The Role of Compensation Systems for Motivating Executives

It is usually assumed (cf. virtually all literature positions on the executive compensation already mentioned in our list of references) that the main elements which can motivate employees, i.e. the main parts of a reward system in the company in question, can be summarized as: (1) compensation which stands for the salary and wages which are meant to satisfy an employee's basic needs (of course, basic needs need not be low; often they can be high in the case of executives!), (2) benefits which are additional, intrinsic rewards that are usually in the form of a **benefit package offered to each employee, (3) recognition which constitutes a "soft", psychological, intrinsic reward that usually boils down to an acknowledgement of the employee's good performance, (4) appreciation which is another "soft", intrinsic, reward bestowed to an employee which can be a hand written appreciation note or words by a supervisor.**

4.4 New Generalized Nets-Based Approach to the Executive Compensation Design

The new Generalized Nets based model of executive compensation presented in this dissertation is an extension of the source model proposed by Atanassov, Kacprzyk and Sotirova, with some new interpretations, clarifications and analyses. In our approach to the structuring of the process of executive compensation design, we focus first on internal company goals and initially, for the time being, exclude from considerations external stakeholders, for clarity and constructiveness of the model.

The three goals for the process and model considered are: (1) to optimize the executive compensation to maximize its value to a company (in the sense of contributing to the attainment of company's goals) and to an executive (in the sense of being attractive to him or her and making it possible to attract and retain the best employees), (2) to dynamically calculate the cost of executive compensation to the company and benefits to an executive to respond to a fast changing and highly competitive environment, (3) to provide a tool for the CEO, compensation committee, Board of Directors, human resource (HR) professionals to evaluate alternatives and conditions of the executive pay package and their impact on the company's functioning and performance in static and highly dynamic scenarios.

The proposed executive compensation design process involves five action steps (Figure 4.1).

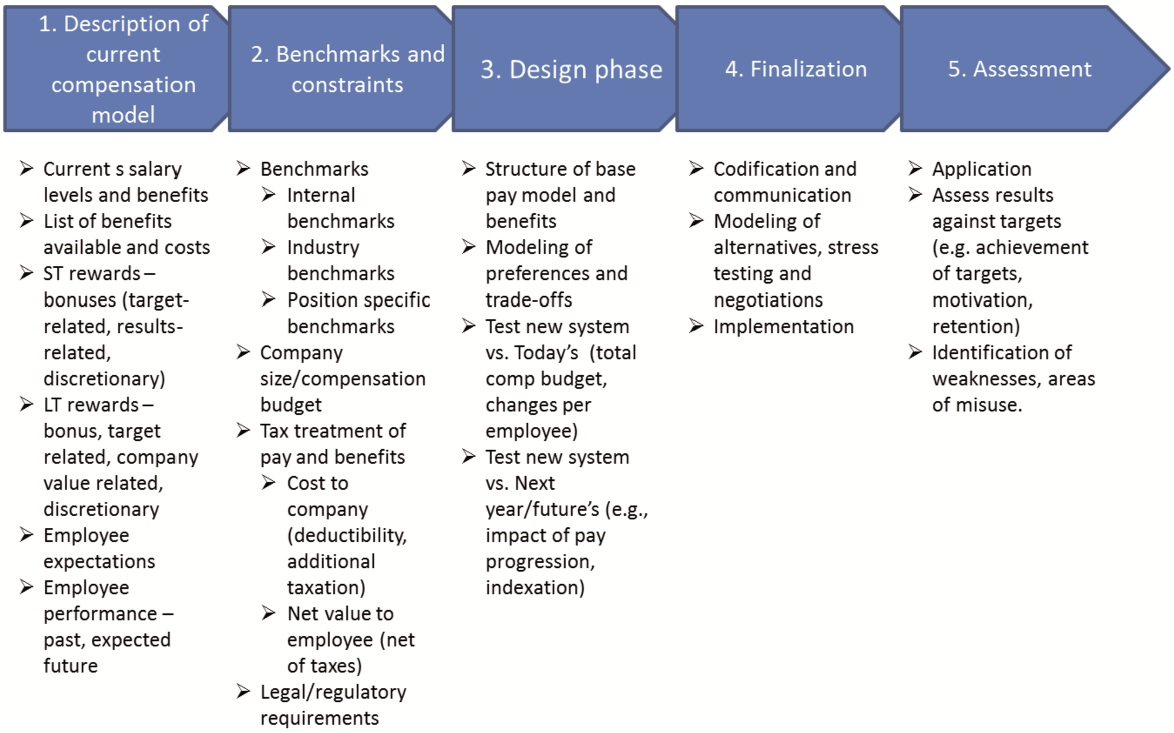

Figure 4. 1 Steps and tasks in the executive compensation design process

- **Step 1: Description of the current compensation model:** An important goal of this step is to understand the current drivers, variables and constraints of the existing compensation model.
- **Step 2: Benchmarks and constraints:** This step makes it possible to introduce (or fix) various benchmarks, survey data as well as external and internal constraints which are relevant to the executive compensation design model being developed.
- **Step 3: Design phase:** This step is the most important element that reshapes the standard template of the compensation model with data inputs from the existing compensation system and external benchmarks, with internal and external rules and constraints which are relevant in an iterative and dynamic process of designing, analyzing and testing of the new executive compensation design model.
- **Step 4: Finalization:** This step includes the codification of the proposed new compensation model as well as the modeling of various alternative implementations, with stress tests for extreme cases; this phase ends with the implementation of the new model.
- **Step 5: Assessment:** At this step, the new executive compensation design model is run for some specific cases, its effectiveness is monitored and assessed, and potential weaknesses are found, documented and evaluated.

The above listed consecutive steps of the proposed model can be summarized as follows.

Step 1: Description of the current compensation model

The first step in the proposed executive compensation design process, shown in Figure 4.2, focuses on the compilation of the presumably most crucial source information, that is about the current salary levels for different positions and grades of the executives together with benefits as well as short-term and long-term rewards such as target and result oriented bonuses.

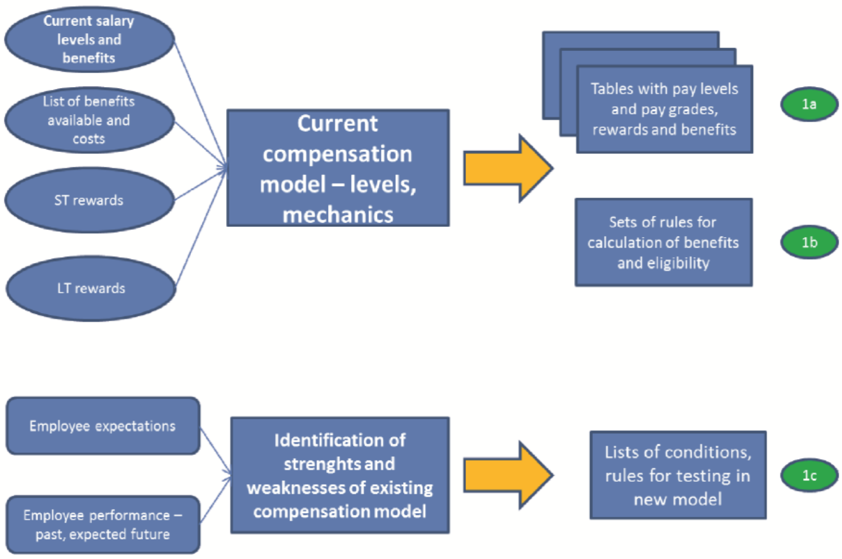

Figure 4. 2 Description of the current executive compensation design model

By gathering the above sets of information, we can – first – spot and mark (for future analyses) trends or inconsistencies of the existing executive compensation model because -- for instance -- some larger, though unjustified, differences can be seen, both within the company and with respect to what exists on the job market. Moreover, the above data sets make it possible to verify the existing executive compensation model to targets and budget levels of the company in question, as well as to see if it is consistent with the company's goals and strategy. The second element of this action step is the compilation of executives' expectations, both monetary and non-monetary ones, as well as those related to the structure of their compensation or mechanisms of how to pay managers for their performance together with information of how the employee's performance is related to targets and goals of the company. Based on this data, the first partial analysis can be performed to identify if the current compensation model is functioning in a proper way in the sense of an adequate stimulation of the performance of the individual executive, his or her effectiveness and efficiency. The key outputs of this action step are tables with pay levels and pay grades together with rewards and benefits (primarily monetary), sets of rules for the determination of their eligibility for the particular executives, and then ways of calculating the benefits. A list of conditions and rules should be derived for testing in the new model.

Step 2: Benchmarks and constraints

The second step, illustrated in Figure 4.3, is focused on the gathering of sets of benchmarks as well as rules and constraints that describe the competitive environment within which the executives operate and make it possible to perform a dynamic modeling of the new compensation model.

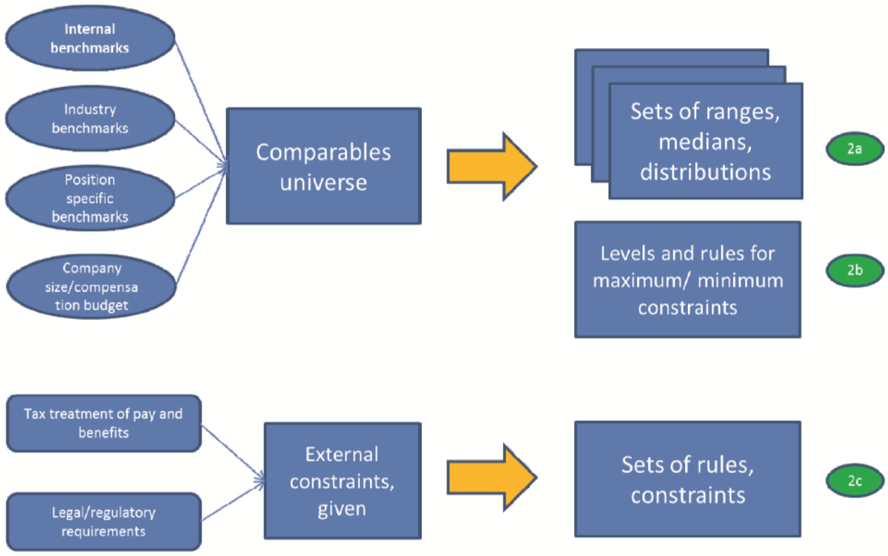

Figure 4. 3 Benchmarks and constraints for the executive compensation design model

The benchmarks have to include data from internal benchmarking (between company subsidiaries in a particular country or region, or countries of operation), industry benchmarking (primary in the same country, region or industry) and position specific benchmarking as well as information about the size of the company and executive compensation budgets that are used by similarly sized competitors. This set of data will make it possible to determine sets of value ranges, medians and distributions to be later used in the modeling process.

Another group of data to be elicited and included is related to the external constraints that need to be considered in the design of the executive compensation model. In particular, this should include the specifics of the local legal and tax system as well as some industry specific requirements. Those sets of rules and constraints will be used in the following step to adjust and test the proposed executive compensation model for compliance, effectiveness and efficiency.

Step 3: Design Phase

The design phase of the executive compensation design model, illustrated in Figure 4.4, boils down to the gathering of sets of benchmarks as well as rules and constraints that describe the competitive environment within which the executive compensation design process takes places.

This phase is evidently the most important and the most complex element of the proposed model as it involves the data inputs together with rules and constraints which are used to develop the blueprint version of the executive compensation model. This version is transformed first into a proposal of a new executive compensation model, which finally becomes the new compensation model. The proposed model and approach starts with a template of the executive compensation model which includes all elements of the executive compensation system in the situation considered, that is, a base pay, base pay modifiers (such as pay grades), target related and results related rewards, etc. The numeric values of these elements are not yet considered.

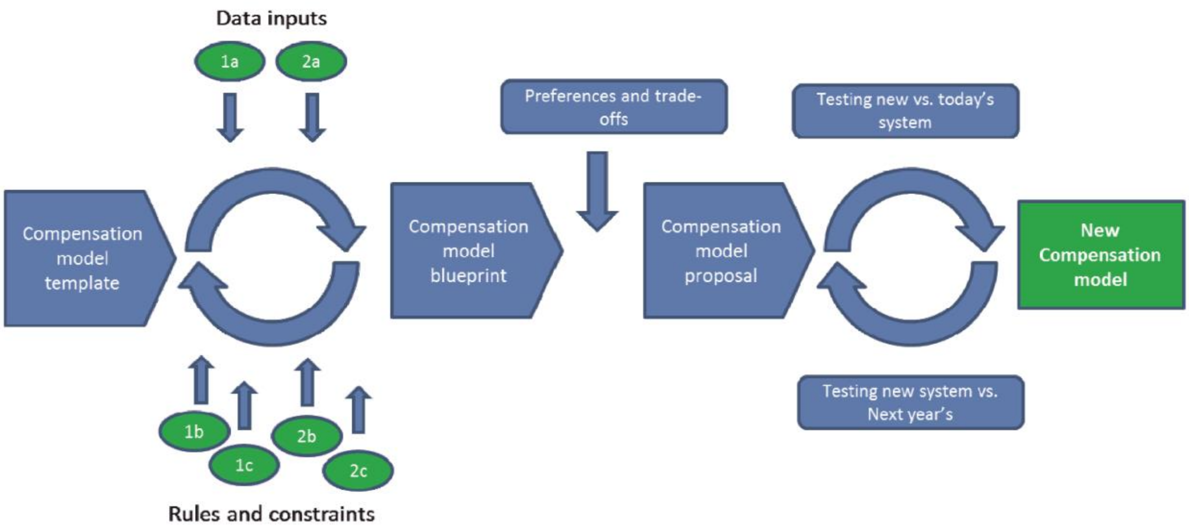

Figure 4. 4 Design phase in the executive compensation design model

The second phase of this step includes an evaluation of preferences and trade-offs to eliminate the criteria that cannot be met and to finalize core elements of the proposed executive compensation model. This phase of the design process involves an iterative testing of the proposed model against the present goals and the present executive compensation design system, and against new targets and goals. This is done for the verification of the applicability and efficiency (in particular a cost – effect type analysis) of the new executive compensation proposal. The final product of this action step is a proposal of a new executive compensation model which consists of a core model and sets of variable elements together with performance criteria and rules/constraints.

Steps 4 and 5: Finalization and assessment

The final action steps in the design and implementation of the new executive compensation model start with the finalization phase (Figure 4.5), in which the newly proposed executive compensation model undergoes stress tests to verify its flexibility and to possibly correct any improper performance for outliers and various compensation alternatives.

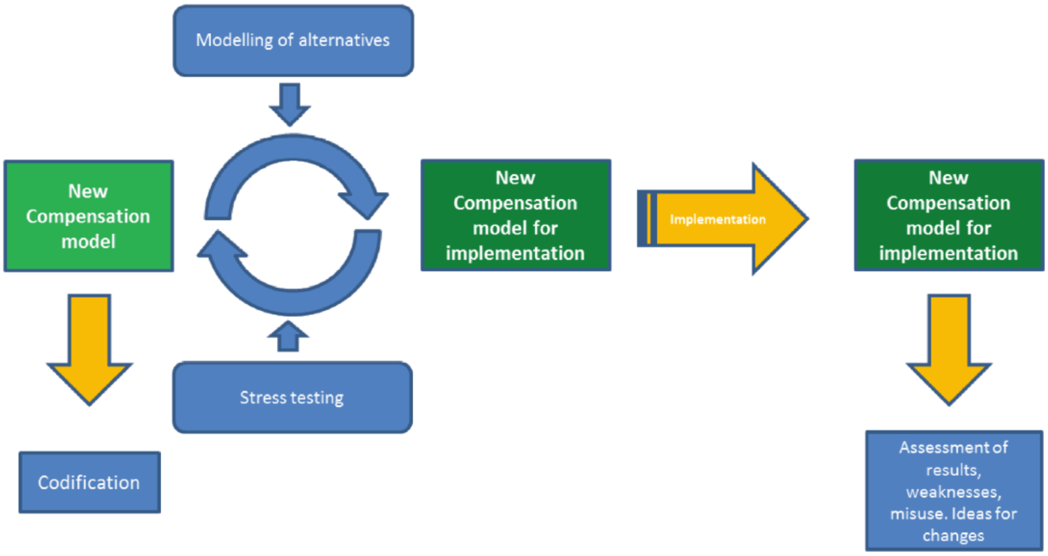

Figure 4.5. Finalization and assessment of the executive compensation design model

At the same time, the new executive compensation model is codified into procedures and manuals, and at the same time its practicality and cohesiveness are verified and corrected. The final step includes the implementation and assessment which includes an implementation of the new executive compensation model in the specific company or organization in question, starting with a pilot implementation and a later staged rollout. At this action step, the new compensation model is constantly monitored and fine-tuned by verifying the executive performance against targets of the company and individual targets set of the particular executives or managers. Moreover, the past performance is compared to that obtained as a result of the new model, and also the performance of the old model is simulated.

4.5 Application of the Theory of Generalized Nets to the Proposed Approach to the Executive Compensation Design

The above steps of the proposed model of executive compensation design have been implemented in the form of a Generalized Net, to be more specific a reduced Generalized Net (Figure 4.6).

The proposed Generalized Net model for the executive compensation design consists of nine transitions that represent, respectively:

- the process of Description of the current executive compensation model (transitions Z_1 and Z_2);
- the process of analysis of Benchmarks and Constraints (transitions Z_3 and Z_4);
- the Design phase (transitions Z_5, Z_6 and Z_7);
- the process of Finalization (transition Z_8);
- the process of Assessment (transition Z_9).

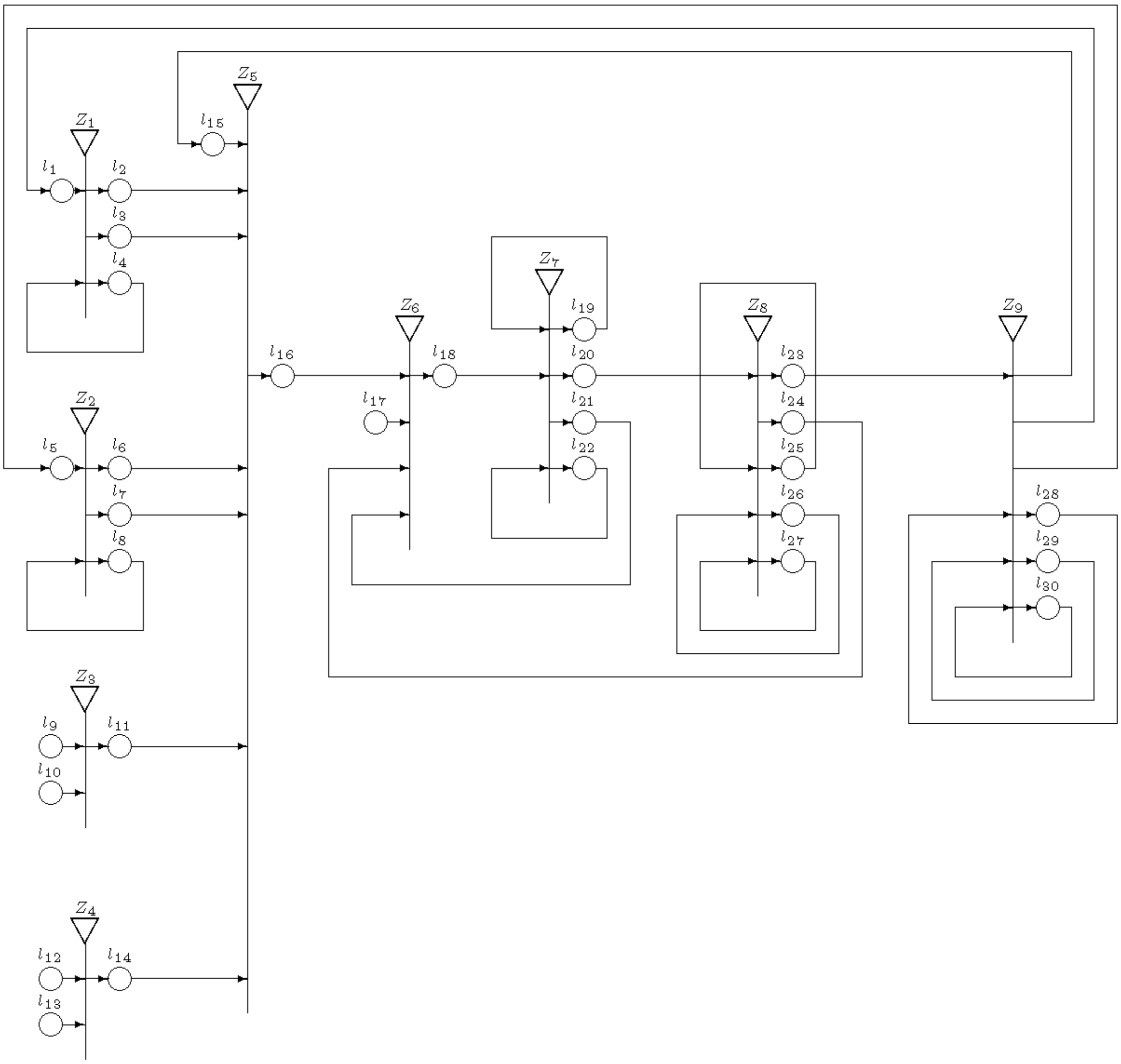

Figure 4. 6 The new Generalized Net based executive compensation design model

The original tokens have the following initial and current characteristics:

- token α in place l_4 with the characteristic: x_{cu}^{α} = "Current salary levels and benefits, List of benefits available and costs, short-term (ST) rewards – bonuses (target-related, results-related, discretionary), long-term (LT) rewards – bonus, target related, company value related, discretionary";
- token β in place l_7 with the characteristic: x_{cu}^{β} = "Benchmarks: Internal benchmarks, Industry benchmarks, Position specific benchmarks; Company size / compensation budget".

Transition Z_1 has the form:

$$Z_1 = \langle\{l_1, l_4\}, \{l_2, l_3, l_4\}, r_1, \vee(l_1, l_4)\rangle,$$

where

$$r_1 = \begin{array}{c|ccc} & l_2 & l_3 & l_4 \\ \hline l_1 & false & false & true \\ l_4 & W_{4,2} & W_{4,3} & W_{4,4} \end{array},$$

where the predicates have the form:

- $W_{4,2}$ = "Tables with pay levels and pay grades, rewards and benefits are prepared";
- $W_{4,3}$ = "Sets of rules for calculation of benefits and eligibility are prepared";
- $W_{4,4} = \neg W_{4,2} \,\&\, \neg W_{4,3}$.

The α token is split into three tokens with the original α token continues to stay in place l_4. The other tokens (α_1 and α_2) enter places l_2 and l_3 and obtain the following characteristics.

- Token α_1 enters place l_2 with characteristic x_1^{α} = "Tables with pay levels and pay grades, rewards and benefits";
- Token α_2 enters place l_3 with characteristic x_2^{α} = "Sets of rules for calculation of benefits and eligibility".

Transition Z_2 has the form:

$$Z_2 = \langle\{l_5, l_8\}, \{l_6, l_7, l_8\}, r_2, \vee(l_5, l_8)\rangle,$$

where

$$r_2 = \begin{array}{c|ccc} & l_6 & l_7 & l_8 \\ \hline l_5 & false & false & true \\ l_8 & W_{8,6} & W_{8,7} & W_{8,8} \end{array},$$

where the predicates are:

- $W_{8,6}$ = "Sets of ranges, medians, distributions are determined";
- $W_{8,7}$ = "Levels and rules for maximum/ minimum constraints are determined";
- $W_{8,8} = \neg W_{8,6} \,\&\, \neg W_{8,7}$.

The β token is split into tree tokens with the original β token staying in place l_8, while the other tokens (β_1 and β_2):

- Token β_1 enters place l_6 with characteristic x_1^{β} = "Sets of ranges, medians, distributions";
- Token α_2 enters place l_3 with characteristic x_2^{β} = "Levels and rules for maximum/ minimum constraints".

For the γ_1 and γ_2-tokens:

- Token γ_1 in place l_9 with the characteristic: x_1^{γ} = "Employee expectations";
- Token γ_2 in place l_{10} with the characteristic x_2^{γ} = "Employee performance – past, expected future".

Transition Z_3 has the form:

$$Z_3 = \langle \{l_9, l_{10}\}, \{l_{11}\}, r_3, \wedge(l_9, l_{10})\rangle,$$

where

$$r_3 = \begin{array}{c|c} & l_{11} \\ \hline l_9 & W_{9,11} \\ l_{10} & W_{10,11} \end{array}.$$

where the predicates $W_{9,11} = W_{10,11}$ = "The identification of strengths and weaknesses of existing compensation model is performed".

The γ_1 and γ_2-tokens unite with token γ in place l_{11} with characteristic x^γ = "Lists of conditions, rules for testing in new model".

For the δ_1 and δ_2-tokens:

- Token δ_1 in place l_{12} with the characteristic x_1^δ = "Tax treatment of pay and benefits";
- Token δ_2 in place l_{13} with the characteristic x_2^δ = "Legal/regulatory requirements".

Transition Z_4 has the form:

$$Z_4 = \langle \{l_{12}, l_{13}\}, \{l_{14}\}, r_4, \wedge(l_{12}, l_{13})\rangle,$$

where

$$r_4 = \begin{array}{c|c} & l_{14} \\ \hline l_{12} & W_{12,14} \\ l_{13} & W_{13,14} \end{array}.$$

where the predicates $W_{12,14} = W_{13,14}$ = "The external constraints are given".

The δ_1 and δ_2-tokens unites with token δ in place l_{14} with characteristic x^δ = "Sets of rules, constraints".

Transition Z_5 has the form:

$$Z_5 = \langle \{l_2, l_3, l_6, l_7, l_{11}, l_{14}, l_{15}\}, \{l_{16}\}, r_5, \wedge(l_2, l_3, l_6, l_7, l_{11}, l_{14}, l_{15})\rangle,$$

where

$$r_5 = \begin{array}{c|c} & l_{16} \\ \hline l_2 & true \\ l_3 & true \\ l_6 & true \\ l_7 & true \\ l_{11} & true \\ l_{14} & true \\ l_{15} & true \end{array}.$$

In place l_{15}, there is one ζ_0-token with the characteristic x_0^{ζ} = "Compensation model template".

Tokens α_1 and α_2 (from places l_2 and l_3), β_1 and β_2 (from places l_6 and l_7), γ (from place l_{11}), δ (from place l_{14}) and ζ_0 (from place l_{15}) merge in a ζ-token that enter place l_{16} with the characteristic x^{ζ} = "Compensation model blueprint".

Transition Z_6 has the form:

$$Z_6 = \langle\{l_{16}, l_{17}, l_{21}, l_{24}\}, \{l_{18}\}, r_6, \vee(\wedge(l_{16}, l_{17}), \wedge(l_{16}, l_{21}), \wedge(l_{16}, l_{24})\rangle,$$

where

$$r_6 = \begin{array}{c|c} & l_{18} \\ \hline l_{16} & true \\ l_{17} & true \\ l_{21} & true \\ l_{24} & true \end{array}.$$

From place l_{17} an η-token enters the net with the characteristic x^{η} = "Preferences and trade-offs". The θ-token that enters place l_{18} obtains the characteristic x^{θ} = "Compensation model proposal".

Transition Z_7 has the form:

$$Z_7 = \langle\{l_{18}, l_{19}, l_{22}\}, \{l_{19}, l_{20}, l_{21}, l_{22}\}, r_7, \vee(l_{18}, l_{19}, l_{22})\rangle,$$

where

$$r_7 = \begin{array}{c|cccc} & l_{19} & l_{20} & l_{21} & l_{22} \\ \hline l_{18} & true & false & false & true \\ l_{19} & W_{19,19} & W_{19,20} & W_{19,21} & false \\ l_{22} & false & W_{22,20} & W_{22,21} & W_{22,22} \end{array},$$

where the predicates are:

- $W_{19,19}$ = "The new system is testing vs. today's system (total comp budget, changes per employee)";
- $W_{19,20}$ = "The result from testing the new system vs. today's system is positive";
- $W_{19,21}$ = "The result from testing the new system vs. today's system is negative";
- $W_{22,20}$ = "The result from testing the new system vs. Next year/future's is positive";
- $W_{22,21}$ = "The result from testing the new system vs. Next year/future's is negative";
- $W_{22,22}$ = "The new system is testing vs. Next year/future's (e.g., impact of pay progression, indexation)".

The θ_1 and θ_2 tokens that enter places l_{19} and l_{22} obtain characteristic respectively:

x_1^{θ} = "Test new system vs. Today's" in place l_{19}, and

x_2^{θ} = "Test new system vs. Next year/future's" in place l_{22}.

The θ-token that enters place l_{21} (from places l_{19} or l_{22}) do not obtain new characteristic.

When the truth values of the predicates $W_{19,20}$ and $W_{22,20}$ are "true", the υ-token enters place l_{20} with characteristic x^{υ} = "New compensation model".

Transition Z_8 has the form:

$$Z_8 = \langle\{l_{20}, l_{25}, l_{26}, l_{27}\}, \{l_{23}, l_{24}, l_{25}, l_{26}, l_{27}\}, r_8, \vee(l_{20}, l_{25}, l_{26}, l_{27})\rangle,$$

where

$$r_8 = \begin{array}{c|ccccc} & l_{23} & l_{24} & l_{25} & l_{26} & l_{27} \\ \hline l_{20} & false & false & true & false & false \\ l_{25} & false & false & false & true & true \\ l_{26} & W_{26,23} & W_{26,24} & false & W_{26,26} & false \\ l_{27} & W_{27,23} & W_{27,24} & false & false & W_{27,27} \end{array},$$

where the predicates are:

- $W_{26,23}$ = "The alternatives are modeled";
- $W_{26,24} = W_{27,24}$ = "New compensation model have to be corrected";
- $W_{26,26} = \neg W_{26,23}$;
- $W_{27,23}$ = "The stress testing of the new compensation model is ready";
- $W_{27,27} = \neg W_{27,23}$.

The υ_1, υ_2 and υ_3 tokens that enter places l_{25}, l_{26} and l_{27} obtain the characteristics, respectively:

x_1^{υ} = "New compensation model, modeled alternatives" in place l_{25};

x_2^{υ} = "New compensation model, evaluated impact on executive compensation of unlikely but probable developments" in place l_{26}, and

x_3^{υ} = "New compensation model, written summary of compensation rules and levels as well as description of targets to be achieved" in place l_{27}.

The υ-token that enters place l_{24} (from places l_{26} or l_{27}) does not obtain new characteristic.

When the truth values of the predicates $W_{26,23}$ and $W_{27,23}$ are "true", the κ-token enters place l_{23} with the characteristic x^{κ} = "New compensation model for implementation".

Transition Z_9 has the form:

$$Z_9 = \langle\{l_{23}, l_{28}, l_{29}, l_{30}\}, \{l_1, l_5, l_{15}, l_{28}, l_{29}, l_{30}\}, r_9, \vee(l_{23}, l_{28}, \wedge(l_{29}, l_{30}))\rangle,$$

where

$$r_9 = \begin{array}{c|cccccc} & l_1 & l_5 & l_{15} & l_{28} & l_{29} & l_{30} \\ \hline l_{23} & false & false & false & true & false & false \\ l_{28} & false & false & false & true & true & true \\ l_{29} & true & true & true & false & false & false \\ l_{30} & true & true & true & false & false & false \end{array}.$$

The κ_1, κ_2 and κ_3 tokens that enter places l_{28}, l_{29} and l_{30} obtain the characteristics, respectively:

x_1^{κ} = "New compensation model for implementation" in place l_{28};

x_2^{κ} = "New compensation model for implementation, assess results against targets" in place l_{29}, and

x_3^{κ} = "New compensation model for implementation, identification of weaknesses, areas of misuse" in place l_{30}.

The α_0 and β_0 tokens that enter places l_1 and l_5 obtain characteristic: $x_0^{\alpha} = x_0^{\beta} =$ "Current compensation model".

The ε token that enters place l_{15} obtains the characteristic x^{ε} = "Compensation model template".

This completes the model's operation. Therefore, at the end we obtain, via the characteristics of the ε-token, the new executive compensation model which has been the aim of our research.

4.6 Concluding Remarks

The new model has been tested with a real-world example. For clarity of the presentation and for making it possible to understand and use the model proposed by domain experts in management, economics, human resources (HR), etc., whose command of mathematics or computer science may be limited, not up to the level of the very area of Generalized Nets, and even the model of management compensation proposed in this dissertation, the model is presented in a simple setting and in a comprehensive way.

Chapter 5

An Example of Management Compensation Determined by Using the New Generalized Net Model

We consider here the problem of how to determine the management compensations of the Chief Financial Officer (CFO). In a company he or she is the executive who is primarily involved in and bears the responsibility for managing the company's finances which usually includes financial planning, management of financial risks, accounting, financial reporting, etc. Moreover, in view of a rapidly increasing role of data analytics, the Chief Financial Officer may also be responsible for the analysis of financial data. The term CFO is widely used all over the world though it certainly comes from the American business world and company structures. In many other countries, notably in Europe, instead of the term "Chief Financial Officer" the companies can use other terms, notably the "Finance Director" and sporadically, in smaller companies, "Chief Accountant". The Chief Financial Officer is typically the key person for budget development and management, forecasting, investment projects and also the raising of financing for company operations and expansion. The Chief Financial Officer, although sometimes considered to be a back-office function, is actually a key contact person between the company and financial markets, banks, investment analysts and various providers of capital. The role of the Chief Financial Officer has become visibly more important in fast globalizing commerce and operations where companies operate in multiple locations, via multiple legal entities and in multiple currencies. In today's business the Chief Financial Officer (CFO) has become almost as important as Chief Executive Officer (CEO). The Chief Financial Officer together with the Chief Executive Officer are responsible for the day-to-day running of the company, and both report to the Board of Directors (in some countries called the Supervisory Board) and are charged with the maximization of the value of the company which may include the maximization of the share price, market share, revenues, etc. Needless to say, these aspects can be crucial for both private owners, shareholders but also the state as the owner. More specifically, the Chief Executive Officer is meant to implement the organization's mission, strategy and attainment of key economic indicators. The Chief Financial Officer provides crucial communication with financial markets as to company's plans and actual results as well as securing an adequate financing of the company's activities.

The choice of the Chief Financial Officer as the example in this dissertation is therefore, on the one hand, justified by a well-defined scope and responsibilities and skills associated with this position, and the fact that very often this position is occupied by similarly experienced managers. On the other hand, there is a wide availability of various benchmarks for the particular types of executive compensations which can be found, for instance, in a literature because, due to a crucial importance of this management position for the operation of virtually all companies, aspects related to the Chief Financial Officer position have been for years of intense interest of theoreticians and practitioners of management and human resource specialists. Now, we will describe how the main elements of the new model for determining the executive compensation using the Generalized Nets for the case of the Chief Financial Officer.

5.1 Benchmarks and Basic Assumptions

The model proposed consists of 9 transitions which will also be taken into account in the case of the Chief Financial Officer:

1. Description of the current compensation model (transitions Z_1 and Z_2):

We take into account the following aspects:

- Management position: Chief Financial Officer;
- Sector: fast moving consumer goods (FMCG), retail, engineering, transport – spedition – logistics (TSL), finance, banking, insurance, human resources (HR);
- Location of the company: capital town, large town, small town;
- Company size, i.e. the number of employees: up to 200, 200-500, 500-1000, above 1000;
- Base salary;
- Bonus (the Short-term (ST) rewards) The Long-term (LT) rewards will not be considered due to the complexity of their analysis in the context of our model;
- Benefits, the Yes/No values (to be assigned at later stages): company car, laptop computer, mobile phone, private health care, company apartment, fitness card.

2. Analysis of Benchmarks and Constraints (transitions Z_3 and Z_4):

This includes:

- Tables with benchmarks to be used as references for position and location specific benchmarks which contain ranges of base salaries for the position of the Chief Financial Officer for 3 types of such positions and for 2 different locations: Warsaw, i.e. the capital, and other large towns;
- Sets of rules for the calculation of benefits and eligibility for granting them.

The benchmarks used in the example are as follows:

(a) The salary benchmarks for the Chief Financial Officer and related positions;

(b) Position and location (city) specific benchmarks;

(c) Position specific benchmarks – salaries asked by the candidates;

(d) Salaries offered to top executives, professionals and managers, as well as main benefits;

(e) Most welcome (“best”) gross salaries;

(f) A yearly distribution of executive compensation in some selected companies relevant to this dissertation;

(g) The average executive compensation (base pay and bonus) in relations to the size of the company (market capitalization) for some companies relevant to this dissertation;

(h) The medians of remunerations of executives and board members of companies which are relevant to this dissertation;

(i) The medians of total compensations of top executives and board members for various industries.

3. Design phase

We start the design phase with:

- Management position: Chief Financial Officer;
- Base salary;
- Bonus;
- Benefits, the Yes/No values (to be assigned at later stages): company car, laptop computer, mobile phone, private health care, company apartment, fitness card.

4. Finalization phase

The above example is developed to show the operation of the new executive compensation model for the Chief Financial Officer in a company. This should be clear as the conditions, tests, etc. employed are both those which are usually employed in this field in practice and are presented in a clear and intuitively appealing way. In the most practical cases, the model will be employed for the presentations of some possible alternatives (scenarios) for some different base pay levels, bonus levels and list of benefits, all of them being within the boundaries of the constraints. Then, the alternative of managerial compensations determined by the model can be used as the best options from which a final specific managerial compensation for the particular case considered would be selected.

5.2 Results

The model has been used for the design of executive compensation system for two medium-size companies in Poland, one manufacturing company and one from the FMCG (fast moving consumer goods) sector. The examples are real-life but the names of companies and their locations, and all details that could indicate a specific company or person involved had to be anonymized as a condition to use the data, following the strict General Data Protection Regulation (GDPR) of the European Union. The results obtained by using the new Generalized Nets model presented in this dissertation will be presented in a simpler, more transparent and comprehensive form of verbal results which summarize the tabular and numerical results obtained by using the Generalized Nets.

The cases considered are:

Case 1

A medium-size manufacturing company, located in small town in Poland with 300 employees. The company faces a serious problem that their current, very experienced, Finance Manager (ca. Chief Financial Officer in our terminology), who has been with the company for the last 20 years, is to retire soon. The company wants to insource all of its accounting, that is, to move all accounting to the company's internal departments, to provide a faster reporting cycle and to facilitate and improve financial analyses. Therefore, the Chief Executive Officer and the company's Supervisory Board have decided to search for a Chief Financial Officer level candidate with experience in an international company, preferably from the same industry. The current Finance Manager is earning PLN 20 000 (PLN stands for the Polish Zloty, and 1 Bulgarian Leva is ca. PLN 2.20) gross monthly salary and a bonus of 5-10% of the annual salary as a short-term reward. He is also provided with a company phone, laptop and while using his private car he is refunded per km traveled.

The situation can be summarized as follows:

- The above-mentioned current pay for Finance Manager is at the top of range for this position and similar companies;
- For the level of Chief Financial Officer, the minimum salary is PLN 25 000 and the maximum salary is PLN 50 000;
- The location of a company outside of a large city will require a higher pay and additional benefits (in particular an apartment rental and a company car);
- The compensation structure to be offered will require to be more in line with standards of an international company in particular the upper bonus level should be 50% of the base pay;
- The Chief Executive Officer of the company is currently earning PLN 40 000 gross salary per month and the Chief Financial Officer can earn a maximum of PLN 35 000;
- The current short-term incentives of the Chief Financial Officer are not codified so that he/she is open to any new compensation system;
- The Supervisory Board has decided that it is willing to find the best available candidate due to significant challenges that the company faces and an urgent need to introduce new budgeting, controlling and reporting procedures, and the company can afford the best candidate.

In the design phase of the model the following results have been obtained for the compensation for the new Chief Financial Officer:

- The base salary of PLN 35 000;
- A short-term incentive system with an annual bonus of 10-40% of the base salary (values obtained in the runs of the model for different benchmarks);
- The additional benefits: a company car, 50% subsidy to apartment rental, a company mobile phone and laptop.

In the finalization phase of the Generalized Nets model, this new compensation scheme shown above has been tested with compensation expectations of potential candidates interested in the position of the Chief Financial Officer in the company considered. The following concerns of the candidates have been identified:

- Candidates with experience in international companies have expected the salary of PLN 40 000 gross per month and the bonus of up to 25% of the base salary;
- Local candidates with an appropriate experience have expected the salary of PLN 35 000 and the 50% bonus of the base salary;

- All candidates have indicated the location of the company (in a small city) as a major disadvantage and concern.

By taking into account the above concerns the proposed compensation model has been modified as follows:

- The base salary of PLN 37 500;
- The short-term incentive system with the annual bonus of 35% of the base salary;
- The additional benefits: a company car, a fixed amount towards apartment rental, a company mobile phone and laptop.

Case 2

A medium-size, fast growing FMCG (fast moving consumer goods) company with a strong brand and a highly attractive work atmosphere located in Warsaw, the capital of the country. The company has 50 employees and plans to grow to 100 in the next 2 years. The current Finance Manager works with the company for 3 years but since the growth of the company is expected, the Chief Executive Officer and the Supervisory Board plan to create a new position of the Chief Financial Officer and consider either internal promotion, to promote somebody already employed, or external hire. Due to a relatively small size of the company, the Chief Executive Officer, as the founder and a large shareholder of the company, is not ready, and in a position, to offer a high compensation package.

The current Finance Manager is earning PLN 15 000 gross monthly salary and an annual bonus of 10% of salary, and he is not part of any long-term incentive scheme or a stock option program. The Finance Manager is provided with medical insurance, gym membership, company mobile phone and laptop. The company does not have company cars.

In the first transition of the Generalized Nets model, the analysis of benchmarks and constraints, we have obtained the following results:

- The current pay for Finance Manager is at the median for this position;
- The minimum salary of the Chief Financial Officer in Warsaw is PLN 25 000, and the maximum salary is PLN 50 000;
- Most, practically all, benchmarks for the position of the Chief Financial Officer are for larger companies;
- The company is highly attractive, offers a good work-life balance, and that is why it can pay below (to some extent, of course) the industry average;
- The compensation structure will need to provide a higher variable part to align the compensation with the results of the company;
- The Chief Executive Officer, as the founder and a large shareholder of the company, can fully decide as to the compensation model for the new position of the Chief Financial Officer.

In the design phase of the Generalized Nets model proposed the following compensation model for the new position of the Chief Financial Officer has been obtained:

- The base salary of PLN 20 000;

- The short-term incentive system with the annual bonus of 10-25% of the base salary;
- The participation in a long-term incentive scheme (to be decided later when it will be introduced by the company);
- The additional benefits: medical insurance, gym membership, company mobile phone and laptop.

In the finalization phase of the Generalized Nets model, this new compensation scheme was tested with compensation expectations of potential candidates interested in the position in question and the following concerns have been identified:

- Highly experienced candidates with international experienced have expected the base salary of PLN 30 000, no short-term incentive scheme but a guaranteed long-term incentive scheme;
- Promising but less experienced local candidates expected the base salary of PLN 20 000 and the 10-20% bonus, and a small share in a long-term incentive system.

By taking into account the above concerns, the proposed compensation model has been modified to the following one:

- The base salary of PLN 20 000;
- A short-term incentive system with the annual bonus of 10-20% of the base salary;
- Participation in a long-term incentive scheme (to be decided later when it will be introduced by the company), the additional benefits: medical insurance, gym membership, a company mobile phone and laptop.

The results obtained have been evaluated with the help of professional managers and human resource (HR) specialists who have very positively assessed the results considered to be justified and reasonable.

Chapter 6

Concluding Remarks and Possible Future Directions of Research

To summarize this short resume of the dissertation, it can be said that the use of Atanassov's Generalized Nets for the design of executive compensation, which is one of very important problems faced by businesses in all countries and of many types of ownership, has proved to be successful. The Generalized Nets have made it possible to formally present many aspects and relations of this inherently dynamic, asynchronous and parallel process, and they provide algorithms which are numerically efficient.

The main contributions in the thesis can be summarized as follows:

1. For the first time, an informal introduction to the Generalized Nets theory was given with the aim to be suitable for managers, economists, human resource professionals and other relevant domain experts.
2. A GN model of executive compensation system design was constructed and applied to two real Polish companies, and the executive compensation packages, as determined at the output of the GN-model, were compared against the existing alternatives and have shown to be considerably better aligned with company's goals.

The results obtained have been very positively evaluated by domain specialists.

6.1 Some Future Directions: Use of InterCriteria Analysis

The use of the Generalized Nets opens many new perspectives for future research. Among them one can mention, first of all, the use of Atanassov's Intercriteria Analysis to reduce the set of characteristic features describing the problem which can be very high for complex real world problems because they can include, for instance, many microeconomic and macroeconomic indicators. Moreover, it may be very interesting and challenging to use more elements of the theory of discrete event systems to extend the method.

Author's Publications Related to the Dissertation Thesis

1. Atanassov, K., Kacprzyk, A., Skenderov, V., & Kyuchukov, A. (2007) Principle generalized net models of the activity of a petrochemical combine. *Proceedings of the 8th International Workshop on Generalized Nets*, 26 June 2007, Sofia, Bulgaria, pp. 38–41.
2. Kacprzyk, A., & Mihailov I. (2012) Intuitionistic fuzzy estimation of the liquidity of the banks: A generalized net model, *Proceedings of the 13th International Workshop on Generalized Nets*, 29 October 2012, London, UK, pp. 34–42.
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8. Kacprzyk, A. (2019) Some Remarks on the Potentials of the Generalized Nets as an Effective and Efficient Tool for Solving a Multitude of Practical Management and Economic Problems. *Issues in IFSs and GNs*, Vol. 14, 2018/19, pp. 92–112.