

ADAPTIVE REFERENCE SYSTEM: A TOOL FOR MEASURING MANAGERIAL PERFORMANCE

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ABSTRACT. Within this paper we have assembled a proposal to build an Adaptive Reference System (*ARS*) which is used to evaluate organization's performance. *ARS* can adapt easily to any organizational environment change by tracking three very specific values: Standard Value ($ARS(Cr, SV)$), Expected Value ($ARS(Cr, ExV)$) and Actual Value ($ARS(Cr, AV)$). These values need to be acknowledged and fairly well-identified by the decision maker and/or well-computed inside each industry field in join with each evaluation criterion. Each such assembly of these values in the context of an evaluated criteria set grouped by a very specific Area of Interest (*AoI*) constitute a powerful *key indicator* we can use to track the organization's performance level by the chosen *AoI* which can be an actual department of the organization (Sales, Accountancy, etc.). The adaptability capacity of the *ARS* resides in its historical stored context of all the above *key indicators* which can be tracked in time to evaluate the *decision performance* by individual context (natural state).

1. INTRODUCTION

A traditional decision making system evaluates the probability of a certain scenario to take place. That means it is an activity that is evaluated BEFORE making decisions. Like this, the system is empowered with a quasi-complete set of parameters that help the managers to take the best suitable decision

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1998 *CR Categories and Descriptors.* 62Cxx [**Decision theory**]: 62C86 – *Decision theory and fuzziness*; 68Mxx [**Computer system organization**]: 68M20 – *Performance evaluation; queuing; scheduling*; 68Uxx [**Computing methodologies and applications**]: 68U35 – *Information systems (hypertext navigation, interfaces, decision support, etc.)*; 90Bxx [**Operations research and management science**]: 90B50 – *Management decision making, including multiple objectives*; 91Bxx [**Mathematical economics**]: 91B06 – *Decision theory*.

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based on that fixed context. But this only helps good/average companies to maintain their routinely course.

Making the leap from good/average to great (i.e. excellence in performance) needs more than that. To make such leap most of the time you need to “think out of the box”. Thinking out of the box can be risky of course (which explains why risk-averse Organizations have difficulties in implementing such measures), but yet extremely worthy if it turns out positively.[16] In order to train a mind to “think outside the box” you need to evaluate performance, identify thinking patterns, improve the worthy patterns (or implement them if missing) and apply them on a bigger scale. That means you need to evaluate the activity AFTER making decisions and use it as a context for future decisions.[27]

The hardest to replace in any Organization is a Manager. On the free market, when you do so, you naturally lose confidence of your shareholders, clients and more generically everybody critically depending on your services.[33] So, in order to avoid that, good/average companies reduce the risk of doing so by using decision support system tools, while the great companies reduce that risk with specific training of improving it’s decision makers’s mind set. [15]

In any organization, the evaluation process serves as an input to provide decision-makers with knowledge and evidence about performance and good practices.[19][29][32] Based on credible, objective, valid evidence-based information, evaluation can be a powerful tool that can make programs and projects.

Building an Adaptive Reference System for the evaluation of the business performance of an Organization is a mandatory operation. Adaptive because the market is in continuous change and companies need to keep up (adapt to new context) and performance because non-performant companies are naturally forced to leave the game of business.

This paper is the first from a series of papers dedicated to inducing performance throughout a continuous loop of measuring THE REALITY (that is the Organization’s Actual Values against Industry and Technology specific criteria) and deciding next best steps to be taken in order to preserve the Organization’s growth and culture.

The structure of paper is as follows. After this introductory section, next one introduces the mathematical model used. Next two sections are devoted to the configuration structure, described in the third section, and evaluated in the fourth one. Fifth section presents the results of evaluation, followed by conclusions and further work.

In order to ease perception, we have capitalized all nouns that represent the main actors of this paper.

2. BACKGROUND (RELATED WORK)

2.1. Definitions.

Definition 1 (Business Culture). *The Business Culture is related to behavior, ethics, etiquette and more. A business culture will encompass as Organization's values, visions, working style, beliefs and habits.* [18]

Definition 2 (Evaluation Framework). *The Evaluation Framework is a plan that an evaluation will focus on, particular issues of importance. In particular, every framework is based on a set of underlying values and principles and an evaluation is defined as an activity that judges worth.* [14]

Definition 3 (Reference System). *A Reference System is a system that uses coordinates to establish position or an organized structure for arranging or classifying.* [34]

Definition 4 (Referable Reference System). *A Referable Reference System is a reference system that is capable of being assigned or credited to, capable of being referred, or considered in relation to something else.* [34]

Definition 5 (Adaptive System). *An Adaptive System is a system suited, given or tending to adaptation; characterized by adaptation; capable of adapting.* [34]

Definition 6 (Adaptive Reference System). *A reference system is said to be adaptive (i.e. **Adaptive Reference System, ARS**) when:*

- *Its set of criteria is opened in range (i.e. you can add/remove criteria from the set);*
- *The weights (level of importance) of each criteria to be measured is opened to subjectivity and natural impulse (i.e. you only set the scale range, like from 0 to 10, but when you think of a specific criteria you feel it is either 3 (not so important) or 8 (pretty important));*
- *The grouping of criteria by category is opened (i.e. you can freely create categories and subcategories like Industry specific, Technology specific, etc.) and you can freely switch/move criteria from one category to another;*
- *You can track generic entities downwards and upwards from macro to micro (i.e. either the Organization full scan, or a specific Department, a specific Team inside a Department, down to a specific Employee);*

2.2. Motivation. We need to perform periodical and continuous evaluation of performance in order to remain in the game of business. For instance we need to know if the company made any profit. For this reason we need to evaluate

Income versus Expenses. Evaluation is a process that critically examines a program. It involves collecting and analyzing information about a program's activities, characteristics, and outcomes. Its purpose is to make judgments about a program, to improve its effectiveness, and/or to inform programming decisions. [23][13][14]

Building a referable reference system requires criteria from within the specific technical context of that system (i.e. accountancy, sales, juridical, IT, etc.). Living now-days, forces any reference system to become extremely adaptable in order to remain a referable reference system.

While most researchers focus on how to evaluate a certain technology better or a certain technology artifact better or more structured [1][2][25], we are trying through this current study to implement a mathematical model which could help middle to top managers get the big picture of the entire functional structure performance. And of course we have a good motivation for that: this mechanism should address those managers who want to rely on this alternative.

In order to accomplish this goal, our study is based on two European pillars: first is the long forgotten pioneer of management who developed the concept of harmony between all actors involved in an Organization's production activity, that is the polish researcher Karol Adamiecki [3][17], who developed starting 1896 a production tracking diagram romantically called *Harmonograf* or *Harmonogram* and the second is the former Romanian interwar Liberal Minister of Economy who had a considerable activity as an economist and philosopher, Petre Țuțea, who developed a personal reference system which we would like to adapt and apply to any actor designed to be involved in an Organization's production activity and for the sake of performance should be the subject of an Evaluation [30]. Those three universal references would be a person's position considering himself (self conscience), the group he/she belongs to (collective conscience) and the universe he/she belongs to (universal conscience) which we would like to analytically expose to the three methodological activities of modern research: **observation, experimentation and reasoning**.

2.3. Goal. Building the Adaptive Reference System (*ARS*) is the first step in performing reliable evaluation of an Organization's assets, culture and performance. It is the ground floor and foundation of an Organization's sustainability. Building a Reference System is mandatory in order to evaluate an Organization's activity and performance [21], but now-days the challenge is to be able to adapt your Reference System in order to follow the constantly changing context of the market. [22][24]

This paper proposes a method to build such an *ARS* based on Industry Standard Values and Self Expectations of Industry Values measured against THE REALITY (i.e. Actual Values - the output data of and after each Evaluation Session).

3. MAIN CONTRIBUTION

3.1. The mathematical model. The mathematical model should be as flexible enough to be applied from small structures like the Employee himself/herself, up-going to evaluating Teams, then Departments, and why not, looking from a market's perspective, an executive manager should be able to position his own Company among the competitors on a free market. In fact, we can already rely on a business performance model built by Jim Collins [8] which can help companies make the leap from the state of good/average to great/excellent. Also Karol Adamiecki, according to Edward Marsh's study has proven that implementing harmonical means inside a collaborative system improves productivity up to 400% [31].

We have chosen three performance indicators such as: *Standard Value* (what do others do in a similar context - and we mean here the average of competitors), *Expected Value* (how would we like to be perceived in such a context) and *Actual Value* (the reality since last evaluation as from inside the context) consciously applied to specific target should provide a relevant enough visual sight of the current behavior of the chosen target. It would not be a lie when stating that those indicators need pure talent carefully mixed with proper education and experience which is the core of a successful decision making manager. And starting from this premiss we will furtherly define each future Alternative in the Decision Matrix as depending also of the evaluation results which is there to define the additional context which has followed the implementation of a Decision Alternative.

Definition 7 (Standard Value). *The Standard Value (SV) represents a numerical value explicated as from commonly available market markers of each Evaluation Criterion.*

Definition 8 (Expected Value). *The Expected Value (ExV) represents a numerical value explicated as the Organizations forecasted marker of an Evaluation Criterion;*

Definition 9 (Actual Value). *The Actual Value (AV) represents a numerical value computed during an internal evaluation process applied over an Evaluation Criterion;*

Definition 10 (Evaluation matrix). *The **Evaluation Matrix** E (see Table 1), has the following elements:*

- *the ES rows represent consecutive Evaluation Sessions;*
- *the C columns represent Criteria that which the Organization has been evaluated;*
- *each column gathers three split sub-columns each corresponding to the three performance indicators;*
- *the Evaluation Matrix's elements represent values measured against each performance indicator of each Evaluation Criteria, as follows:*
 - *k is the market marker value of an Evaluation Criteria,*
 - *x is the expected rate value of an Evaluation Criteria and*
 - *r is the result value of an evaluated Evaluation Criteria;*

TABLE 1. The Evaluation Matrix

Evaluation Sessions	C_1			C_2			...	C_n		
	SV_1	ExV_1	AV_1	SV_2	ExV_2	AV_2		SV_n	ExV_n	AV_n
ES_1	k_{11}	x_{11}	r_{11}	k_{12}	x_{12}	r_{12}	...	k_{1n}	x_{1n}	r_{1n}
ES_2	k_{21}	x_{21}	r_{21}	k_{22}	x_{22}	r_{22}	...	k_{2n}	x_{2n}	r_{2n}
...
ES_m	k_{m1}	x_{m1}	r_{m1}	k_{m2}	x_{m2}	r_{m2}	...	k_{mn}	x_{mn}	r_{mn}

The classical model of a multi-criteria decision model expressed in the Table 2 [28][20], gets inreached by the Evaluation Matrix E (as is Table 1) which constitutes the continuous context that states grounds for materializing a decision alternatives tree and becomes as in Table 3.

$$D = \{A, S, R, P\} \xrightarrow{\text{transforms to}} D_x = \{A, S, R, P, \mathbf{E}\}$$

where diving in details shows us:

$$S = f(E) \xrightarrow{\text{triggers}} P = f(E) \xrightarrow{\text{explains}} A = f(E) \xrightarrow{\text{as in}} A = f(S, P)$$

Taking into account all of the above, the classical Decision matrix representation (Table 2) receives the Extended Context computed by the Evaluation Matrix (Table 3):

where:

- the Decision Alternatives A are taken in the historical context of the previous Evaluation Sessions: $A = \{A_1, A_2, \dots, A_m\}$ - the context is supposed to be improved since you can track Decision Alternatives taken in a similar context pattern;

TABLE 2. The Decision Matrix

<i>Decision Alternatives</i>	<i>NaturalStates</i>			
	p_1	p_2	\dots	p_n
	S_1	S_2	\dots	S_n
A_1	r_{11}	r_{12}	\dots	r_{1n}
A_2	r_{21}	r_{22}	\dots	r_{2n}
\dots	\dots	\dots	\dots	\dots
A_m	r_{m1}	r_{m2}	\dots	r_{mn}

TABLE 3. The Decision Matrix in the context of Evaluation Session T (which constitutes the **Extended Context**)

	<i>DecisionAlternatives</i>	<i>NaturalStates</i>			
		p_1	p_2	\dots	p_n
		S_1	S_2	\dots	S_n
<i>EvaluationSession_T</i>	A_1	r_{11}	r_{12}	\dots	r_{1n}
	A_2	r_{21}	r_{22}	\dots	r_{2n}
	\dots	\dots	\dots	\dots	\dots
	A_m	r_{m1}	r_{m2}	\dots	r_{mn}

- the natural states S are situations the decision maker evaluates when building a decision alternative: $S = \{S_1, S_2, \dots, S_n\}$;
- the results R are the consequences of each Decision Alternative in the context of a natural state, explained as quantitative measurements: $R = \{r_{ij}, 1 \leq i \leq m, 1 \leq j \leq n\}$, numbers representing the NET consequence, either a gain (if positive, $r_{ij} > 0$) or loss (if negative, $r_{ij} < 0$);
- the probabilities P are associated to the natural states S and state the probability of the corresponding natural state to take place: $P = \{p_1, p_2, \dots, p_n\}$;

Still, disregarding *Software Development* which is a pretty mathematical field, over-numbered and over-computed [5] or *Manufacturing/Production* field which is maybe even the straighter one (you commonly have X volume of matter which goes by recipe R into Y volume of lose and Z volume of output artifacts, while $X = Y + Z$ to check the volumes efficiency) we can compute the **Standard Value** of a given field by relying on that specific field's **evaluation criteria** and is a quest of assembling data by the subjectivity of the deciding person (manager). The 99% accurate such standards, can only be achieved on mature industries. [6][7]

Example:

- (1) *Software Development*: Everybody knows there is no such thing as a bug-free software product, but rather a stable version of that software which means it has reached an acceptable balance of compromise. So on a scale of 0 to 10, such Standard Value will never be 10.
- (2) *Auto Industry*: To compute the Standard Value to help you evaluate the market sales of class A vehicles, you can rely on public studies developed by various institutes of statistics and it will be different for each period of evaluation.

The **Expected Value** in this case is indeed the toughest because the deciding manager should have that special sense and should be truthful enough to envision the entity's potential in its natural context. Setting the right expectations should bring back nothing but positive results in terms of building a healthy system based on natural grounds (meaning not artificial nor artificially inseminated).

Of course units should not be scrambled so values should be measured against their siblings as well as computed to each other. This means all of these indicators should be signaled in numbers. The bigger the number which indicates the scale range, the bigger the granularity, the more accurate the evaluation.

Example:

- (1) For the *Software Department* we will use a scale from 0 to 10 as in 0 for Completely Unsatisfactory, up to 10 for Extremely Satisfactory. And for the Meeting Deadline criteria fellow colleagues from the shared market agree the Standard Value is 9, out of which we can have an Expectation Value of 8.
- (2) For the *Sales Department* we will use the same scale of 0 to 10, equally quoted, but, as it is field of public interest (transparency towards shareholders and fiscal authorities), Jim Collins shows us results of real studies where Standard Value is rather 3 or 4, while Expected Value is 7 and Actual Value is 10 [8].

Another question is how many criteria should we evaluate? [4] For this matter, we always need to call for the Agile perspective and that means two things: use just enough criteria to give you the right perspective and always be ready to find new measurable criteria to evaluate inside each technology depending of the goal of the measurement. One such goal should be to smother implement change within a company, just as suggested by the Schneider Culture Model [26]. Here are few examples without going to deep in search of overwhelming the system:

- (1) For the Software Development Department:
 - (a) Meet deadlines (estimated versus delivered);

- (b) Bugs delivery (time for development versus time for fixing found bugs);
- (2) For the Sales Department:
 - (a) Sales volume (the total amount computed from all invoices issued by the agent);
 - (b) Consumption (the effort used to produce the sales: phone calls, gas, etc.);

As you can see, and it is not by fortune, we have only chosen criteria which we can take numbered values from satellite software tools; that is the ERP software (which any today-company is using) for the Sales Department and Project Plan software (Microsoft Project, Version One, etc) and Bugs Management software respectively (Team Foundation Server, Bugzilla, Mantis, etc).

The basic idea is to be able to measure while producing without extra-effort and be able to measure in any given circumstances so that we can become Agile enough in taking action, reducing the risks of miss-delivery or not-delivery. In other words, the true challenge for a manager is to manifest his/her agility twice: first when choosing the right set of criteria and second when taking action according to the output results.

3.2. The System configuration structure. This current paper is by far not aiming to be a simple theoretical exposure, but the theoretical foundation of the actual software tool which gathers data and offers valuable output, just as expected. The goal in this case is to build a structure light enough but useful enough. With all the context analysis have taken place (that is the Standard Values and Expected Values indicators set and made peace with), we only need to configure the system so that we can use its potentially powerful reporting component afterward. Further, we use bold capitalized text to refer to the tool's entities. I started configuring the **Company** and made one step forward in flexibility allowing multiple companies (i.e. group of) to be set and like this to be the subject of evaluation for a manager implicated in such a structure on the horizontal axis of an economy exercise.

With the idea of not mixing measure units and stick to the apples basket in mind, we dive deeper and set apples apart by maturity/natural proficiency. So, after configuring all the **Departments** of a Company, we need to set, for the sake of flexibility, the biggest stage of career level for each department and for the sake of esthetic reports we will configure each **Career Level** by *Name* and unique, order-ascending *Value*.

Configuring the **Employees** will require assigning him/her to a Department and decide his/her **Employee Career Level**. We will start configuring the **Evaluation Criteria Set for each Department** and for each criteria we should map well established *Standard Value* and *Expected Value* per each

Career Level. We mean everybody knows that a Senior commonly delivers like 9 out of 10 and a Junior like 3 out of 10 so why push the Junior directly against a Senior and dis-harmonize things, when maturity comes in stages and in time and the natural way of things is to compare children with children, not with adults. For this reason, we will configure the **Evaluation Values** (Actual Values) for the unique pair *Career Level and Evaluation Criteria*.

As performing the evaluation is the key to the entire trial, we are recommending to set apart the Evaluation Criteria by Type. Like this, we will be able to track individually the **Evaluation Criteria per Type** as in “*Technology Specific*”, or “*Company Specific*” (and one could approach more specific granularity) and out of all, we should be able to track any such **Evaluation Criteria per Employee** to follow his/her career development and measure stimuli in between evaluations.

3.3. The Evaluation configuration structure. The software tool we have previously mentioned offers statistical output as both text and graphical reports just as you can see below. For better results, the evaluation should be organized in consecutive sessions set for a well-defined period of time. The

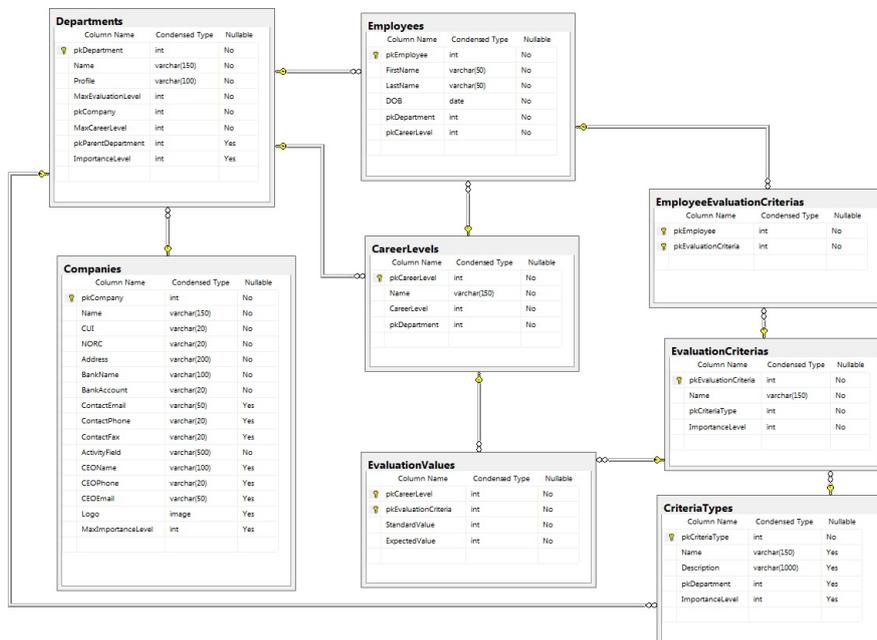


FIGURE 1. The minimal Data Base schema to configure an Adaptive Reference System

time periods should cover calendar periods not shorter than a trimester because evaluating a complex structure as this proposal is significantly time consuming (except the pivot values that can be extracted from other utility software products) AND it takes time to collect all effects of a decision.

Any **Evaluation Session** should be configured by a period of time (*Start Date* and *End Date*) and should have a friendly name, again for the sake of esthetics when creating a report and it should regard a certain Department. Like this we can track progression of either or all Employee, Team, Department and Company and supervise change.

Each Evaluation Session should keep track of the **Evaluation Feedback** so that it can be traced historically and base future decisions upon. Brief information like actual or potential Motivation which could have influenced the Employee's Evaluation Values is more than welcome to be filled-in to help soft-argumentation of a future decision.

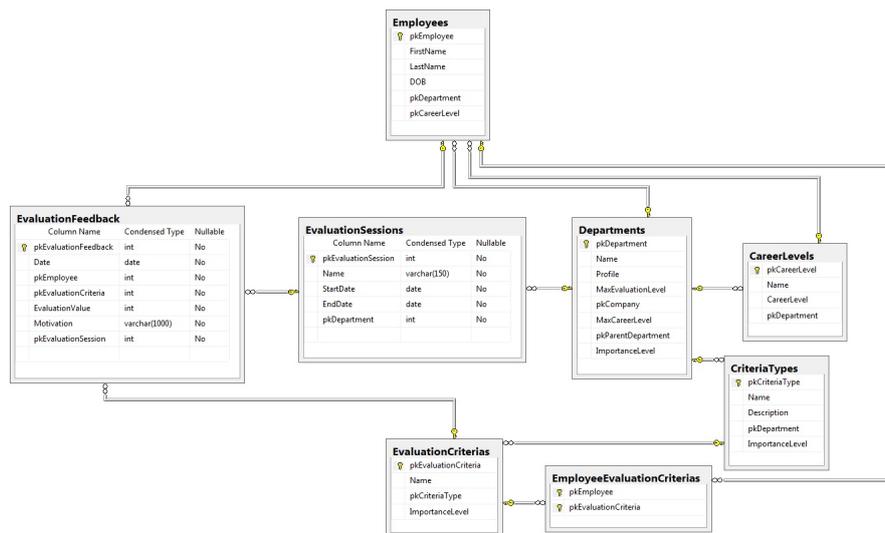


FIGURE 2. The minimal Data Base schema to configure an Evaluation Session

3.4. Experimental evaluation results. The compiled results will be used to develop reports and charts, significant not only for the manager, but for the Company, Department, Team and the individual Employee. The main goal of such statistical reports should not be by far the formality of personnel evaluation, but helping a manager to have a better perspective about the subordinated Entity's potential (Company, Department or Team) which should

reflect in a strategy to better position the Entity and further up the Company on a successful trajectory in terms of market.

Figures 3 and 4 contain the results of evaluating the hypothetical employee called Alan Poe hired by the hypothetical software producing company called Some Company Ltd, trying to surprise the entire contextual aspects. Evaluated Values can oftenly accede either Standard or Expected Values which can lead the decision maker to the conclusion of promoting the Evaluated Employee or motivating him/her to keep acceding, maintain the “status quo” and be able to proficiently convert this trend into material which can feed business growth. It can for sure happen that Evaluated Values are constantly bellow Standard and Expected Values which can lead the decision maker to the conclusion of either apply strategy (or different strategy) to stimulate the Employee get better results or inframe the Employee to a lower stage of Career Level where he/she could perform more accordingly.

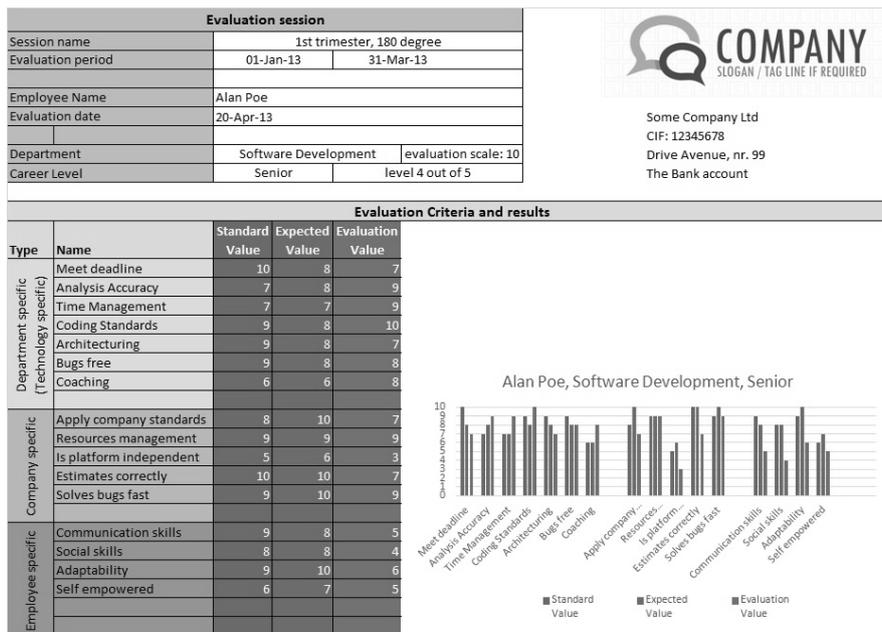


FIGURE 3. Evaluation Session results per one Employee

Normally, nobody makes business plans for 3 months and nobody invests in people just for fun. Improving people’s professional and technical expertise brings back proficiency in process and deliverable and from there starts a chain of positive reactions which is the juice to be stimulated.

Decision making in management is a game of algorithmic if-then-else-end cases. Visual representations such as this one should help the decision maker evaluate the decisions he/she made since the previous Evaluation Session and eventually decide the next moves.

For the honest purpose of improving performance, the same Set of Evaluation Criteria should be applied periodically to the same subjects and other type of representations should be built to evaluate progress. The challenge is to keep changing and adjusting the decisions until you can identify a pattern that can inflate an ascending trend in each of an Employee's performance. [9][10][11]

Also, it will be challenge to influence an ascending trend of the same Employee on all of the evaluated Criteria. Different people have different strong areas and weak areas, so it is natural they perform different when evaluated by different criteria, BUT as long as the values of their weak areas do not affect the entity's behavior by being too weak by the Company's Expected Value.

You can see bellow a cumulative representation of the same set of Evaluation Criteria being performed with different occasions. In this case, trimestrial Evaluation Sessions which have been performed more or less at the middle of the first month after each calendar trimester end.

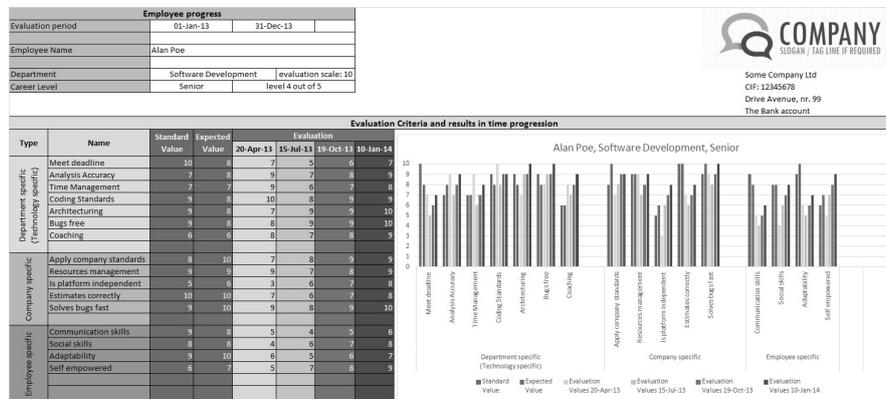


FIGURE 4. Employee retrospective over multiple Evaluation Sessions

4. CONCLUSIONS AND FUTURE WORK

Defining the above *Adaptive Reference System* requires a special kind of effort and skills. The pain-point in succeeding to do it relies in the native potential of the decision maker to do the following:

- (1) identifying the criteria set that meet two conditions each: it is relevant for the industry (the parent set) and it is relevant for My Organization (the subset); *and*
- (2) computing, for each criterion, the values (Standard, Expected and Actual) and use each resulting key indicator as specified in this paper and by following the specific scenario for each respectively.

The benefits of using an *ARS* is to reach an accurate acknowledgment of reality and expectations and use it as solid grounds for future decisions. We have developed the tool in order to raise the accuracy of a decision in such a complex environment, where the amount of data is so big that it makes it virtually impossible to use without computed assistance. [12][13][14] The resulted evaluation should influence managerial decisions in present and future planning, strategies and policies by providing targeted recommendations to decision makers. All evaluation users should participate actively in the entire evaluation process to ensure that recommendations are practical, relevant and realistic.

Building a *Reference System* is widely accepted to be mandatory in order to evaluate an organization's activity and performance, but now-days the challenge is to be able to adapt such a *Reference System* in order to follow the constantly changing context of the market.

Building this proposal of an *Adaptive Reference System* is the first step in performing reliable evaluation of an organization's assets, culture and performance. It is the ground floor and foundation of an organization's long term sustainability.

The current paper is the baseline of argumentation for all of our future papers which are intended to give a complete survey over the everyday challenges of any organization's activity to reflect its behavioral status:

- (1) Define the *Organization's Culture* using the above Key Indicators to actively and persistently evaluate it;
- (2) Define mathematical models to assist an organizational to perform the *Culture leap from Actual to Expected values and goals*; and
- (3) Define methodological and mathematical models to assist an organization through a *Change Perturbation in the context of the Expected Culture*.

Future notions we would also like to track and give a description to are the *Agility Indicators* of the decision makers who either build the organization's culture, build the organization's evaluation criteria set or build the motivation, means and context to respect the organization's expected culture.

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