Applying Operational Research and Data Mining to Performance Based Medical Personnel Motivation System

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Employee motivation factors



Payment as a multi-tier motivation system

- Fixed payment vs Performance based payment
- Typical forms of payment:
 - Direct product unit-based
 - Indirect product unit-based
 - Time-based salary system

• Performance based payment:

- The prerequisite for performance related remuneration is the ability to define regularly measurable work results and their qualitative parameters.
- By linking employee pay to individual and team work results, managers can use the remuneration system to promote high performance culture, teamwork, and foster other organizational objectives.

A glance to Healthcare sector

Health expenditure as a share of GDP, 1960-2009, selected OECD countries



Source: OECD Health Data 2011.

How to create a performance based remuneration in healthcare..?

Application of performance based remuneration methodology in 5-steps:

- 1. Selection of performance indicators (KPIs)
- 2. Applying priority distribution method to rank and evaluate KPIs
- 3. Applying new remuneration scheme
- 4. Evaluating results
- 5. Fine-tuning the remuneration scheme

Selection of performance indicators (1)

Main steps:

- **Step 1:** Generate a comprehensive list of clinical, financial and management indicators, derived from available sources, e.g. key performance indicators used internally, HPO performance related indicators applied by insurance agents.
- **Step 2:** Filter indicators which are practically measurable and applicable for financial incentives calculation and assign them to job profiles.
- **Step 3:** Transform interrelated indicators by combining them.
- **Step 4:** Preliminarily prioritize the indicators (final ranking of indicators will be done using PDM method).

Selection of performance indicators (2)

Additional steps for comprehensive analysis:

- **Step 5:** Identify dependable indicators, which were not selected for the financial incentives model. This can be achieved by applying statistical regression analyses tools.
- **Step 6:** Identify any specific factors leading to unsatisfactory values of selected indicators. We propose to apply data mining methods, such as association rules analysis upon the data prepared in step 5.

Step 7: Update each job profile's performance criteria list per organizational unit based on the results of steps 4-6.

 Step 8: Use the PDM method to rank and weight quantitative and qualitative criteria and calculate performance related pay.

Applying Priority Distribution Method to rank and evaluate KPIs

Tricky questions:

- Which key performance indicator is "more important": LOS or patient rehospitalisation rate?
- How to evaluate soft skills in the team work?
- How financially evaluate surgery team work performance?

Tricky answers..?

• And how to get a consensus consolidated answer..?

Priority Distribution Method

- The Priority Distribution Method belongs to the family of multi criteria decision support methods, based on expert pairwise comparison of criteria.
- In 1977 T. L. Saaty proposed a multi-criteria decision support methodology Analytic Hierarchy Process (AHP) to rank alternatives by pairwise comparison.
- The application of PDM to the financial portion of an employee remuneration package is beneficial under the following conditions:
 - 1. the employees are working in teams or shifts and have similar job profiles,
 - 2. a variable salary part or performance bonus is applicable,
 - 3. it is impossible to directly and precisely evaluate the productivity of the employees.

PDM in a nutshell (1)

- PDM is based on the expert evaluation of qualitative and quantitative features of the object, i.e. job profile, in comparison with each other.
- The method prioritizes a group of objects in ascending or descending order, depending on the magnitude of their characteristics manifestation, thus calculating their ranks. Using pairwise comparisons, the relative importance of one criterion over another can be calculated.
- For each object PDM defines relative weighting, which expresses the rank of each object's characteristics and helps to prioritize the criteria.
- The reduction of a comparison result range just to three categorical values, as proposed in PDM, is very helpful: <less important>, <equal> or <more important>.

PDM in a nutshell (2)

Criteria comparison matrix:

Criteria pair			Average			
	1	2	3	4	5	priority value P^
w1 & w2	>	٨	>	>	٨	>
w1 & w3	×	V	II	٧	V	×
w1 & w4	>	=	>	<	>	>
w1 & w5	>	>	>	>	>	>
w2 & w3	<	<	>	=	<	<
w2 & w4	=	Ħ	=	~	<	=
w2 & w5	<	>	<	<	<	<
w3 & w4	>	>	>	>	=	>
w3 & w5	>	=	=	=	=	=
w4 & w5	>	=	V	×	=	×



Fig. 1. Complex employee performance value indicator

$$Salary_{\text{var},i} = Salary_{fix,i} \times K \times PVI , \qquad (10)$$

Where

 $\begin{array}{l} \underline{Salary_{rar,i}-i-th} \ employee \ variable \ salary \ part \ (performance \ related \ pay); \\ \underline{Salary_{fix,i}-i-th} \ employee \ fixed \ salary \ part. \end{array}$

PDM application in healthcare inpatient facilities - use case scenario

- Performance related remuneration model for a hypothetical inpatient healthcare facility is provided.
- PDM was used to create a performance related payment model for a hospital's ward physicians and nurses.

Nurse performance evaluation indicators

Code	Criteria
k ₁	Work hours x shift coefficient x medical
	qualification coefficient
k ₂	Accumulative number of registered
	issues and claims per quarter
k ₃	Teamwork ability (half year/yearly)
k ₄	Personal discipline (half year/yearly)
k ₅	Average quarter length of stay to
	average LOS ratio
k ₆	Mortality rate to average mortality rate
	ratio
k ₇	Frequency of pressure sore in
	bedridden patients to average
	frequency ratio
k ₈	Practiced hygiene level
k ₉	Patient satisfaction level
k ₁₀	Participation in internal training
	programs

Performance related value matrix for ward nurses and physicians

	Criteria rank weights and employee performance values									
Criterion weight value P' for nurses	0,14	0,09	0,08	0,12	0,07	0,11	0,10	0,10	0,12	0,08
Criterion weight value P' for physicians	0,17	0,08	0,06	0,10	0,06	0,13	0,10	0,12	0,12	0,07
Employee's personal criterion value	p';	p'2	p';	<i>p</i> ′₄	p's	p's	p'7	p's	p',	p'10

Table 14. Performance related value matrix for ward nurses and physicians

Methods and tool sets for monitoring PDM efficiency

- Activity 1: Collect and analyze the change of each criterion K over time (time series analyses)
- Activity 2: Calculate correlation coefficient to determine the influence of criterion weight to the measured values of PDM indicators.
- Activity 3: Perform direct association rules analyses, i.e. generate rules on acquired PDM indicator values and analyze the interdependent rules.
- Activity 4: Perform comprehensive association rules analyses, i.e. generate rules on all available indicators collected from an HPO's medical information systems, e.g. HIS, EMR.

Discussion and results

- A novel methodology, which provides methods and guideline for performance indicators selection, their ranking, and monitoring of motivation system outcomes, is proposed.
- Strength of the proposed methodology is twofold:
 - the application of multi-criteria decision support method PDM resolves problems of a biased approached for performance criteria selection and ranking.
 - Applying data mining methods for monitoring and evaluation of the motivation system outcomes, provides necessary feedback.
- Described methodology needs practical approbation.
- Next step is to continue developing tools for semi-automated monitoring, which would benefit healthcare provider organizations in human resource management processes.

Thank you for your attention!

Any questions...?

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