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OPTIMISATION OF HUMAN RESOURCE ALLOCATION IN THE PROJECT LAUNCH PHASE (RAMP UP) FOR ACTIVITIES ORIENTED OPERATORS: A CASE STUDY

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Abstract
In this article we aimed to examine the issue of human resource allocation in new start-up projects for companies with a large operator-oriented capacity, where the human factor has a strong impact on the company's performance indicators. Indeed, we have focused on reducing the risks related to poor resource allocation planning, namely, customer stoppage, excess inventory, material shortage, technical unemployment, by controlling the evolution of the performance of production operators.
Keywords: Resource Allocation, Performance Evolution, Competence, Ramp Up, Regression.

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INTRODUCTION

The problematic of human resources allocation is more and more raised, especially with the continuous evolution of the industrial management control. Indeed, good governance depends on the control of all the variables in relation with the company, internal and external. As such, until today the performance of the human factor remains the most uncertain and the most difficult to estimate within the company. For several reasons, the main one is the escape of the human factor from all the modelling frameworks and doctrines to which it proves to be unpredictable and inconsistent.

In the industrial context, and against the concern for the rational use of human resources in the planning of activities, one current of thought saw the genesis with the new millennium; that of the management of competences in the domain of human resources management. The purpose of this is to capitalize on the competences acquired by the company, to train staff, and to better allocate competences to tasks by allowing optimal performance through the adaptation of the human agent to the position/task preferred by the company. This is the case of large production company's oriented operators, well known here in Morocco, in several activities, i.e. textile, cabling etc. It is in this case that the need to manage its operating competences well is essential in the face of the overall efficiency of the plant.

Therefore, the concept of competence was introduced; according to ISO 9000 is defined as the demonstrated ability to apply knowledge and knowhow. In general, competence is formalized by: "verb as precise as possible-complement" mentioning the context of implementation, for example, to build a methodology for analysing the expectations of the public of a media library.

STATE OF ART ON MODELING THE COMPETENCE

The management and control of Performance is always in situation. It is dependent on the context (Sector, Activity, Work environment ...). It is not enough to know how to do something in order to be able to do it in an optimal way, but several variables are interacting. Many research carried out until now in libraries have confronted several obstacles, and have focused on the modelling of competence and its impact on industrial performance. This research is divided into two categories:

Modelling without impact on industrial performance:

In the problem of allocation in planning or scheduling (Bellenguez-Morineau, 2006 and Trilling, 2006) competences were modelled as a material resource that is able or not able to execute a task. In addition, some authors have classified competences as a variable ordered according to a very specific hierarchy that presents the ranking of their respective levels. This classification consists of selecting for each task the best candidate with the highest level of competence (Nasibov et al. 2004). Another classification has been set up and studied (Herrera et al. 1999) (Otero et al., 2009) (Pépiot, 2005) (Huang et al. 2009), which consists in separating competences into two categories, acquired and required. The gap between the competences required and the competences acquired of the different actors amounts to calculating a distance between the numerical levels of competences acquired and required (Pépiot, 2005). While for (Huang et al. 2009), the gap is the result of superimposing the membership function of each acquired level on that of each required level. Other researchers (Bennour & Crestani, 2007) have been interested in quantifying the impact of the individual and collective dimensions of Human Resources competences in the estimation of the modulation rate of the nominal performance of the different trades involved in the execution of activities.

Modelling with impact on industrial performance:

Operational performance varies according to the duration of a task, and this duration differs from one actor to another according to the competences he possesses. Indeed, several researches are interested in studying the impact of competence on industrial performance. In the (Bennour, M , 2005) model, the impact of individual and collective competences permits us to estimate the nominal rate of performance. While (Gruat La Forme F.A , 2006) proposed a model for assigning actors according to three levels, structural, quantitative and qualitative, while introducing competence levels in the form of the operator's performance on the order of fabrication. The authors in this study aim to distribute the workload equitably while maintaining a stable competence level.

Until today the integration of competences in problematics that aim at optimizing operational performance is still a topical issue. In this context (M. Karabach, 2014), has integrated the competences of the technicians in the modelling of the processes of the maintenance activities by cellular automata (AC's), based on a "spatio-temporal" dimension, in order to optimise the performance of the Maintenance department. (A. Khabir et al 2019) considered competence as a constraint when allocating human resources using the AHP methodology.

PROBLEMATIC

The management of new projects in the context of companies with a large production capacity oriented operators, must consider the human factor as the management of the latter strongly impacts the performance indicators of the company. The effect of the human factor in companies can be noticed in the phase of estimating the number of resources to be allocated for the satisfaction of customer demand. All aware of this problem, the leaders or project managers try to use the history and the feedback of experience of the starting phases of the old projects to try to estimate a planning of the allocation of the project resources namely, planning of recruitment and training, supply of raw material, allocation of material resources, Storage Space, etc. However, this estimation generates unsatisfactory indicators and additional costs not foreseen. Indeed, a bad estimation of the increase in operator performance implies:

- Delay or early recruitment of operators
- Delay or Early Purchase of Material Resources.
- Late or anticipated supply of the Material.
- Excess or insufficient stock
- Insufficient storage space or unused space (not optimized).

This is why it is necessary to control the performance of production operators.

For our case study, the project manager of a company that operates in the automotive industry specializing in the manufacture of car seats must plan the ramp up of a new project. During the planning, the project manager must estimate the competence level of the sewing operators for the planning of the different phases of the launch of the project.

The estimate of the competence development for this company is based on a standard history for all projects, workstations, and all operators.

This estimate is not correct since the performance depends on the competence of the operators, in this sense we have tried to find a relationship between the level of competence and the performance of the operators, in order to reduce the differences between the estimated and real performance of production operator.

DEFINITION AND PARAMETERIZATION

Operational performance in the industrial environment is defined as the capacity of a player to carry out well-defined operations, this capacity is compared in relation to a theoretical load (Objective) defined by the methods managers and business experts, it varies from one player to another according to his competence and it evolves over time through practice and exercise.

We consider that a competence is the set of characters, knowledge (Theoretical and Procedural), and mastery of the Task (Carrying out the operation in compliance with standards (Technical, Method, Quality, Safety, etc...), the actor's availability, and the competence, that an actor possesses and that can be implemented to guarantee a performance.

So for our case an operator is not recognized as competent unless he uses in an efficient way these resources characteristic of competence (Knowledge, Mastery, Availability and he must be authorized on the post) to carry out an operation or a task by reaching the defined objectives (Quality, Cost and deadlines).

The resources of Competence

1. Knowledge of an actor i in a position j (Cij):

Knowledge is a potential relative to actors that is acquired and developed through formal education and vocational training. This Knowledge is necessary for the accomplishment of a task. Two types of knowledge can be distinguished.

- Theoretical knowledge: it is the knowledge about, the Job, the work standards, and the environment of the work station, which facilitates the integration of the operator.
- Procedural knowledge: this is the knowledge, operating methods, customer requirements (quality criteria), which allows the operator to have a decision-making power during the realization of the operation.

2. The Mastery of an actor i in a position j (Mij)

These are the techniques and tools acquired and developed by the operator through technical and practical training or through feedback, which enable the actor to perform a task in accordance with the defined requirements. The Masters are decomposable in:

- Operational Mastery: it is the knowledge of the tools and practices to perform a task. Indeed it is the ability to produce.
- Quality Control: they provide information on the ability to produce good quality products and to keep this quality level stable.

3. Seniority of actor i in position j (Aij)

The seniority represents the amount of time the actor has spent either executing an operation or undergoing training. To master a Task or an operation the actor must spend a continuous period of training and execution without having breaks. This is why seniority in the position has a direct influence on Performance,

4. Ability of actor i to occupy position j (Hij)

These are characteristics that describe the ability of an individual to work in a position without any physical or moral pain; they can be broken down into:

- Medical Ability: it gives information on the criteria that the individual must meet in order to work in a position without harming his health (example: the individual must not have an allergy to the Component of the position,).
- Physical Ability: provides information on the criteria that the individual must meet in order to be better adapted to the dimensions of the workstation (e.g. height, weight, etc.).

This character is relative to the workstation or the task to be carried out, it is a requirement imposed by the trial and Formalized by the trade experts (in our case they are the Method Managers and the Trainers), therefore after passing a Medical test the judgement is either Authorized or Not Authorized. Therefore, after passing a Medical test, the judgement is either Authorized or Not Authorized:

$$H_{ij} = \begin{cases} 1 & \text{if the operator is ability} \\ 0 & \text{if the operator is not ability} \end{cases} \quad (1)$$

5. Availability of actor i to occupy position j (Dij)

Availability represents the fact that the actor is available to occupy the position or perform a task.

$$D_{ij} = \begin{cases} 1 & \text{if the operator is available} \\ 0 & \text{if the operator is not available} \end{cases} \quad (2)$$

The performance of an actor

Let i and j $\in$ N

Either the T set of tasks of a PT workstation .or kt the set of competences needed to perform the task, t∈T .

A task may require (n) competences (k), these competences are defined by the technical experts during the industrialization phase and they are measured by a workload in Minutes Produced (Ct_{tk}), therefore The workload of a task t is equal to:

$$CT_{tk} = \sum_{i}^{n} ct_{kti} \quad (3)$$

- $P_{t,k,j}$ the performance of an actor J, this performance is defined by the actor's ability to achieve a task t using a competence k and calculated as follows :

$$P_{t,k,j} = \frac{C_{t,k,J}}{CT_{t,k}} \quad (4)$$

- With $C_{t,k,j}$ the real load of a task t effected by an operator j who proceeds a competence k.

$$c_{tkj} = \sum_{i=1}^{i=n} (Qi * Ti) \quad (5)$$

Q_i: the Good Production Quantity of the reference cover i ;
T_i: Cycle time of the cover reference i
So the performance is optimal in the case where $P_{t,k,j}$ =1 i.e. $CT_{t,k} = ct_{t,k,j}$. Otherwise the performance will be

$$0 < P_{t,k,j} < 1.$$

CASE STUDY: PLANNIFICATION OF A RAMP-UP FOR THE ACTIVITY OF SEWING SEAT COVERS.

To study the evolution of performance over time, we carried out an experimental study (in a company with a large capacity of production oriented operator) which aims to follow the evolution of the performance of production operators who are assigned to a new start-up project.

To satisfy the criterion knowledge, mastery and expertise, two categories of actors (each category contains 10 operators) were selected by using a test:

- a quiz-type knowledge test,
- a technical test (execution of the operation on the machines),
- Classification according to the seniority of Operators in similar Positions.

The first category contains operators who have already worked in the same trade (in our case: assembly of car seat covers) and who know the standard and requirements of the sector (in our case: standard and requirements of the automotive industry), the second category contains operators who do not know the trade and have not worked in the automotive industry, both categories have taken the same training (duration and content), the objective of the defined Performance to be achieved for both categories is 100%.

Data Analysis and Modelling

Regression modelling is frequently used for machine learning and data science. Indeed, the results obtained by its techniques are exploitable and easy to use. There are different types of regressions, each with its advantages, disadvantages, and conditions of use. For our case study, we studied the relationship between Performance, Knowledge, Mastery and Expertise and the number of repetitions (in days), i.e. the evolution of performance over time. Indeed, we will study

- The relationship between the dependent variable performance (P1) of category 1 (inexperienced operators) and the independent variable n (the number of repetitions),
- The relationship between the dependent variable performance (P2) of category é (Experienced Operators) and the independent variable n (the number of repetitions).

On a sample of 20 operators divided into 2 categories:

- Category A: contains 100% new and inexperienced operators.
- Category B: contains 100% of operators with experience in a similar position.

The first category is operators who do not know the trade and have not worked in the automotive industry,
The second category contains operators who have already worked in the same trade (in our case: assembly of Car Seat Coverings) and who are familiar with the standard and requirements of the sector (in our case: standard and requirements of the Automotive industry),
After the follow-up of the two categories of operators during 6 months of work (26 days per month and 8 hours per day) (Table 1), knowing that the two categories have taken the same training (duration and content of the training), the defined Performance objective to be achieved for both categories is 100%.

Table 1: Result of Monitoring the Performance of Operators in Both Categories for 6 Months

Weeks	Performance		Covers quantity	
	A	B	A	B
1	0	0%	0	0
2	20%	0%	39	0
3	45%	3%	87	5
4	55%	6%	106	10
5	65%	11%	125	19
6	70%	18%	135	31
7	75%	27%	145	46
8	80%	36%	154	62
9	85%	45%	164	77
10	90%	60%	174	103
11	95%	67%	183	115
12	100%	72%	193	123
13	100%	76%	193	130
14	100%	80%	193	137
15	100%	83%	193	142
16	100%	85%	193	146
17	100%	87%	193	149
18	100%	89%	193	153
19	100%	91%	193	156
20	100%	93%	193	159
21	100%	95%	193	163
22	100%	98%	193	168
23	100%	100%	193	193
24	100%	100%	193	193
25	100%	100%	193	193
26	100%	100%	193	193
27	100%	100%	193	193

1. Regression Analysis

The choice of the forecast function or regression type depends on the knowledge of the form of the response curve or the behaviour of the system properties. Possible curve forms include: straight, concave, convex, exponentially increasing or decreasing, sigmoid (S) and asymptotic.

The Performance function takes the curve of a Polynomial type function:

$$P_{ij} = P_0 + \sum \lambda_k X_k + \epsilon \quad (4)$$

P_0 is the Initial Performance in this phase,
ϵ is the estimated error in the regression,
The goal is to fit a polynomial on a series of experimental points, in order to describe these experimental points by an easy to use empirical law (but which generally has no physical meaning). The same kind of method (the same algorithm) can be used with functions other than polynomials. Let us consider a set of N experimental points (xi, yi) i=1..N

We try to adjust it by a polynomial P of degree n, and coefficients a0, a1, ..., an (for the method to work, N>n is of course required). If I am not mistaken, R is named "regression function".

2. Data analysis Category A

Since data management is non-linear, we used polynomial regression. For this category (inexperienced operators), the best curve is not a straight line. It is rather a type curve that fits the data points.

According to the curve we can distinguish three phases of evolution of the Function P (Performance).

Phase I: [1 day -12 days] (the first two weeks)

During the first two weeks of production the operators of category B (Inexperienced) only produce parts that are not in conformity with the customer's specification, in this period the operators have just discovered the process, the activity and the product, that's why this period is quite long. This period is a phase of training and learning by doing in which the actor has a zero performance.

Pij= 0

Phase II: [13 days -132 days] (From the third week to 22nd week)

From the 3rd week the operators start to produce conforming caps. Indeed, their level of expertise and mastery of this development is quite long and slow, the quantity produced increases according to the number of days in production in the station. The evolution of the performance of category B in this phase is a Polynomial function of the 3rd degree.

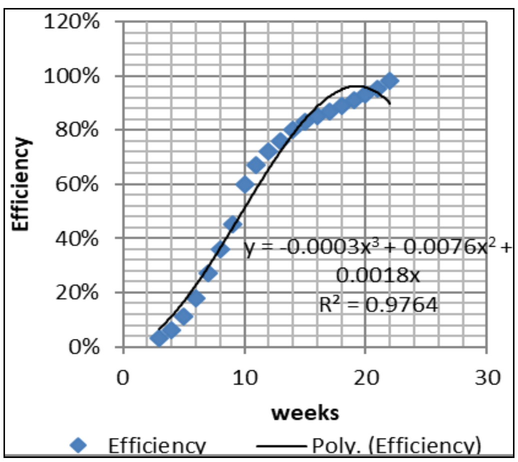

Figure 1: The Figure Represents the Evolution of the Performance of Operators in Category A

The performance of an actor i in position j is

$$Pij= -0{,}0003X3+0{,}0076X^2+0{,}0018X \;\; \forall X \in [3\text{-}22]$$

x is an integer that represents the number of weeks.

Phase III: from the 132 days

During this period the performance of the operators attains the maximum level and becomes constant, this is the phase of maturity of the operators.

The performance of an actor i in position j is:

Pij= Pmax

3. Data analysis Category B

Since data management is non-linear, we used polynomial regression. For this category (experienced operators), the best curve is not a straight line. Rather, it is a type curve that fits the data points.

Phase I: [1 day -7 days] (the first week)

The Performance function of operator i in station j is a null constant

Pij= 0 or 0%;

This phase represents the training period for this category of operators on the workstation (the operators have just discovered the activity). We have also noticed that the operators can produce parts but these parts do not satisfy the quality requirements (they are judged not satisfying the product specifications) and since the calculation of the performance takes into account only good parts, therefore the performance remains null.

Phase II: [8 days -66 days]

The sample size (n=144) is large enough to provide an estimate of the relationship between the Performance variable and the predictor T (number of repetitions).

The model fits the curvature of the data perfectly.

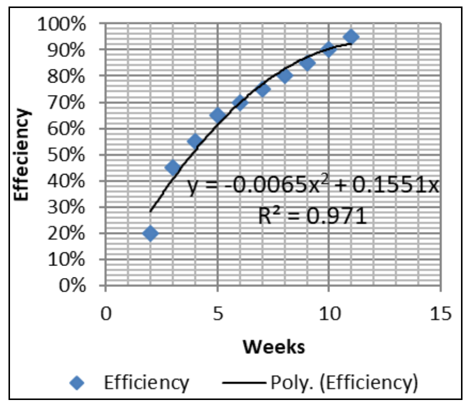

Figure 1: The Figure Represents the Evolution of the Performance of Operators in Category B

On this fitting line, the regression line follows the curvature described by the points. There does not seem to be any systematic deviation from the fit line. Also, the points cover well the entire range of predictor values.

The performance of actor i in position j is:

$$Pij= -0{,}0065X^2+0{,}1551X \quad \text{for } X \in [2\text{-}11]$$

x is an integer that represents the number of weeks on shift.

Phase III: from the 66 days

The Performance of an operator i in position j is a Constant function equal to:

Pij= Pmax=1 or 100%;

This period is the maturity phase, in this period the operators have an Optimal (Maximum) performance which equals the performance defined by the technical experts.

CONCLUSION AND DISCUSION

According to the study that we carried out in the workshop of production of seat covers, we can distinguish two types of the performance evolution of sewers, these two types consists of three phases: the first is the phase of Training and Learning, the second is the development phase of the Mastery and expertise level, and the third is the phase of maturity in which the operator achieves the maximum level of performance.

However, the duration of the phases varied from one category to another, this difference generates several deviations and problems in the case where the project manager does not have prior knowledge of the evolution of the operators involved in the project.

We have put in place for project managers, production and human resources a base for the evolution of operator performance by category which helps minimize the risk due to planning of allocation of resources human.

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