The Mystery of Job Performance: A System Dynamics Model of Human Behavior

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Abstract

In the knowledge age, human resources decide about success or failure of an organization. How can management cause employees to act in a way that organizational goals are achieved, i.e. to perform? Using system dynamics we model job relevant mental processes and behavior of an employee. Our system dynamics model builds on in behavioral science well established ability, motivation, and opportunity theory. The effects of different human resource management policies and practices on job performance of an employee can be simulated. This helps management practitioners to identify sustainable human resource management policies and practices. Furthermore, our research contributes to closing an existing research gap. The link from human resource management policies and practices to performance is still not fully understood. The causal loop diagram of our model facilitates the critical discussion between scholars from different fields of research about relevant elements and interdependencies of this link. As a result, our model will shed some light on the 'black box' of human resource management.

Keywords

System Dynamics, human resource management, human behavior, simulation

Introduction

As the employees being not just a cost factor but one of the most important assets of any organization [Golding, 2010], human resource management (HRM) plays an important role for actual and future success. However, until now there is no golden key how to adequately organize the human resource management system. This offers plenty of room for researchers who are requested to extend our understanding on how human resources can be managed to maximize productivity and enhance creativity [Combs et al., 2006]. It is the sound understanding of how HRM policies and practices impact organizational performance which is essential for the implementation of a sustainable HRM system.

We build a system dynamics model to investigate how HRM policies and practices impact performance of an employee, i.e. behavior in the job. System dynamics is especially suited to model and simulate complex real world phenomena [Garcia, 2009]. Our model considers the physical and psychological state of the employee. We conducted an in-depth literature review in fields like organizational behavior, industrial psychology, and management science in order to identify relevant moderator and mediator variables [Baron and Kenny, 1986]. These variables and their relations are used to design the causal loop diagram which in turn is converted into a stock and flow diagram. Our model is not only intended for the practitioner to implement a sustainable HRM system but also for the scientist as it contributes to closing an existing research gap.

The Black-Box of HRM

Within the last 20 to 25 years, researchers all over the world have built a rich body of knowledge about a possible linkage between HRM and performance. Nevertheless, we are not much wiser about this topic [Guest, 2011]. Despite impressive progress in research on HRM and performance, David Guest concludes

> We have made little progress in establishing ways to measure an HR system. Indeed, it is salutary that we still do not know which practices or combinations of HR practices have most impact nor when, why or for whom they matter. There is a risk of neglecting some core questions in favour of statistical rigour and abstracted empiricism. [Guest, 2011, p. 10-11]

Even though empirical studies show strong evidence that HRM has an impact on organizational performance [Purcell and Kinnie, 2007], the precise mechanisms at work still remain a mystery to us. Up to now, the so called 'black box' of HRM [Becker and Gerhart, 1996], which holds the moderating and mediating variables as well as their causal relations, is locked. Unfortunately, we only have some ideas but no clear picture about the elements in the box.

There is consensus among scholars that a causal link must exist which flows from HRM practices through employees to organizational performance. In one of the most frequently cited empirical study, with 3,452 firms from all major US industries, Mark Huselid finds considerable support for the hypothesis that investments in HRM are associated with corporate financial performance [Huselid, 1995]. The positive impact on profit is in part due to lower turnover and higher productivity. Other HRM influences may exist but could not be identified. Using data from 22 local government authorities in Wales, job satisfaction and organizational commitment are identified as two mediating variables in the 'black box' [Messersmith et al., 2011]. Influencing these variables builds higher organizational citizenship behavior which in turn increases overall performance. An empirical study of 76 business establishments from 56 Japanese companies shows some evidence for the hypothesis that the collective human capital as well as the degree of social exchange within an establishment mediate between HRM and organizational performance [Takeuchi et al., 2007]. According to an empirical study of 174 work groups, employees' attitudes and behavior may be important mediators [Gardner et al., 2001]. The importance of attitudes and behavior is confirmed by Rebecca Kehoe and Patrick Wright in their recent study of 56 self-contained business units in a large food service organization [Kehoe and Wright, 2013]. In addition, the empirical study of 178 organizations of the Greek manufacturing industry reveals that the impact of HRM policies on organizational performance is not only mediated by attitudes and behavior [Katou and Budhwar, 2010]. Furthermore, the skills of the employees are also an important factor.

Performance of an Individual

Organizations intend to enhance performance by influencing the behavior of the staff [Sonnentag and Frese, 2002]. Right attitudes in conjunction with right behavior force individual employees to perform, i.e. to act in a way that contributes to organizational goals. In the context of this paper, performance is defined as synonymous with goal directed behavior in an organization. The performance of an employee, i.e. behavior towards organizational goals, is usually measured in a performance appraisal process [Fletcher, 2001]. In this process line managers evaluate the performance of the subordinates in a written report.

The special challenge for HRM is: how to force individual behavior into an intended direction. This is important, because it is not the organization that performs but the employees [Kozlowski and Klein, 2000]. To unlock the 'black box' it seems essential to identify the elements that influence employees' behavior and the causal relations [Becker and Gerhart, 1996]. The identification of elements and relations would also allow answering the question why an application of well-intended HRM practices does not necessarily result in positive employee outcomes. After having analyzed data from both managers and employees across organizations in the UK of different size, Harvie Ramsey et al. conclude that not everyone benefits from managerial intervention [Ramsay et al., 2000].

According to John Campbell, declarative knowledge (e.g. goals, principles), procedural knowledge and skills (e.g. cognitive skills, physical skills, interpersonal skills), and motivation (choice to perform, level and persistence of effort) are determinants of job performance [Campbell et al., 1993]. Motivation can be defined

> as the processes that account for an individual's intensity, direction and persistence of effort toward attaining a goal [Robbins et al., 2010, p. 140]).

An employee will only perform when he both can and wants to fulfill tasks that are assigned to him [Delaney and Huselid, 1996]. A well-educated researcher for example is unlikely to perform if he lacks motivation. On the other hand, a highly motivated hairdresser with no experience in flying planes will not succeed in a pilot's job.

Even though an employee may have the knowledge and motivation to accomplish a designated task, without a corresponding environment, among others equipment and cooperation, he will probably fail. Hence, an employee has to have the opportunity to participate. Opportunity includes all external variables that influence individual performance. It

> consists of the particular configuration of the field of forces surrounding a person and his or her task that enables or contrains that person's task performance and that are beyond the person's direct control [Blumberg and Pringle, 1982, p. 565].

Consequently, Appelbaum et al., who have analyzed the US manufacturing industry, emphasize three requirements needed to successfully implement a HRM system [Appelbaum et al., 2000]: incentives, skills, and opportunity to participate. Incentives are aimed at employee's motivation. In contrast to Campbell's model, skills encompass declarative knowledge as well as procedural knowledge and skills. Appelbaum et al. assume that people perform if they have the knowledge, skills, and abilities (KSA) to accomplish a give task. Furthermore they need to be motivated and have the opportunity to participate. KSA, motivation, and opportunity form the core of the so called AMO theory. This theory argues that performance P_i of an individual i is some function f of his or her ability A_i to perform, his or her motivation M_i to perform, and the opportunity to perform in the job O_i [Boxall and Purcell, 2011]:

$$p_i = f(A_i, M_i, O_i) \tag{1}$$

The AMO theory is well established in HRM research since its emergence in 2000 [Boselie et al., 2005]. The ability A_i to perform has to be understood in a broader sense. It includes an employee's knowledge, skills and abilities (KSA). In order to be consistent to AMO literature without omitting the KSA concept we will use "ability (KSA)" throughout the text when we refer to the ability to perform.

Modeling Mental Processes and Human Behavior

Our intention is to build a detailed model of individual performance upon the AMO theory. This model should allow to study how different HRM practices affect individual performance. Besides being of relevance for the practitioner, our approach will contribute to organizational and management research by filling an existing research gap. Research in these fields is shaped to a great extent by verbal theorizing [Adner et al., 2009]. This is somehow remarkable, because formal theories like analytic methods, simulation, and formal logic offer certain advantages compared to the use of informal theory presented in natural language. The application of formal methods contributes to precision and transparency, guarantees logic consistency, and offers the ability to identify unanticipated implications [Adner et al., 2009]. However, not every formal method is equally well suited in modeling individual performance. Human behavior on the micro-level is determined by nonlinear, complex, and dynamic phenomena and hence nearly intractable to analytic methods. It is the ability to handle dynamic systems with complex nonlinearities, delays, and feedback processes which is one of the strengths of system dynamics [Sterman, 2000]. This makes system dynamics a useful resource to aid in understanding and in predicting human behavior [Vancouver and Weinhardt, 2012].

Within scientific literature a wide range of system dynamics models can be found that are concerned with modeling and simulating mental aspects of human beings in an organizational context. John Sterman for example offers in his path breaking book 'Business Dynamics' a model of how individuals manage their workloads [Sterman, 2000, pp. 159]. Another model in the same book depicts how workforce quality and loyalty are influenced by perceived career opportunities and wages [Sterman, 2000, pp. 376]. Henk Akkerman and Kim van Oorschot model among others how employee's motivation, satisfaction, and training influence productivity [Akkermans and van Oorschot, 2005]. Jeffrey Vancouver et al. apply system dynamics to model how a newcomer to an organization seeks building up job relevant knowledge [Vancouver et al., 2010]. Andreas Gregoriades presents a model to study how factors like fatigue, motivation, and stress result in human errors [Gregoriades, 2001]. A system dynamics model of workers' willingness to be employed in the construction industry is presented by Ramya Kanaganayagam and Stephen Oguiniana [Kanaganayagam and Ogunlana, 2008]. This model takes into account commitment to the organization, necessity of having a job, achievement, and job satisfaction respectively dissatisfaction. Again in the context of the construction industry, Mingyu Shin et al. study the decision-making process of a worker regarding safe behavior by the use of system dynamic [Shin et al., 2013]. Their model includes factors like optimistic recovery or habituation.

All these examples and many more (see e.g. the proceedings of 'The International Conferences of the System Dynamics Society' for further studies) show that system dynamics can be successfully applied to model mental processes in a job context. However, our literature review did not find a single system dynamics model which is based explicitly on in management and organizational science well-established AMO theory. According to Vancouver and Weinhardt, one reason is that

> Theorists in management and organizational science rarely use computational modeling to support theoretical development or refinement, particularly at the micro level of analysis [Vancouver and Weinhardt, 2012, p. 602].

In addition to system dynamics, scientific literature offers a wide range of methods for modeling and simulating mental processes and human behavior. First to mention is the so called Belief-Desire-Intention (BDI) framework. In this framework, behavior of an individual depends on three states: beliefs, desires, and intentions [Rao and Georgeff, 1995]. Belief is the informative, desire is the motivational, and intention is the deliberative component of the system. The implementation of BDI models usually draws back on temporal logic [Wooldridge, 1998]. Zaho and Son use the BDI framework and temporal logic to model decision making of a human operator in an automated manufacturing system [Zhao and Son, 2008]. In another paper by Bosse et al. the reasoning process of an individual who is reasoning about another individual is modeled using this framework [Bosse et al., 2007]. Similar to BDI is the PECS reference model [Schmidt, 2000]. This reference model allows to model the physical conditions, the emotional state, the cognitive capabilities, and the social status of an human being. The behavior of an individual can be described by state transfer functions [Schmidt, 2005]. The human behavior in panic situation is modeled as an application of the PECS reference model [Schneider, 2008].

Another established approach for modeling human behavior is fuzzy logic. Fuzzy logic models are based on simple rules in the form IF x THEN y with x and y being fuzzy variables [Zadeh, 1973]. A person's decision making process can be mimicked by a set of certain fuzzy rules. For instance, Martínez-Miranda et al. model human behavior at work in this way [Martínez-Miranda et al., 2006]. Cai et al. apply fuzzy logic to model the risk behavior of workers in a coal mine [Cai et al., 2013].

Even more techniques to model mental processes and human behavior exist. Pérez-Pinillos et al. present a model of human reasoning which integrates emotions, drives, preferences, and personality traits [Pérez-Pinillos et al., 2012]. Their model is based on automated planning and uses the planning domain definition language (PDDL) (see e.g. [McDermott et al., 1998] for a description). Pentland and Liu take a different approach [Pentland and Liu, 1999]. Internal mental states of a human being control human behavior. The transitions between different states are controlled by transition probabilities. Hence, human behavior can be predicted by building a Markov model. In the paper by Athavale and Balaraman, a computational model of human behavior in the software project management context is presented [Athavale and Balaraman, 2013]. Behavior is determined by knowledge aspects, personality aspects, and self-efficacy aspects. Unfortunately, the technique used to define the rules that impact the mental states and the behavior is not explicitly described.

In contrast to these methods, system dynamics offers the advantage of providing a full methodology from the system representation to the simulation model. The causal loop diagram represents the system in a qualitative fashion. This diagram visualizes the elements of the system and their relations. Due to the clear structure, such diagrams can be understood even by non-experts in system dynamics. This facilitates the discussion between experts from different fields of research, i.e. psychology, management science, or organization theory. Furthermore, the in social psychology and behavioral science usually applied models for identifying and analyzing mediator and moderator variables [Baron and Kenny, 1986] can be transformed into causal loop diagrams. The causal loop diagram in turn is the foundation for the stock and flow diagram. The stock and flow diagram is the quantitative representation of the model. The formal transformation process from the causal loop diagram to the stock and flow diagram should ensure that the quantitative model matches the qualitative model.

The System Dynamics Model of Individual Performance

Based on the AMO theory we developed a system dynamics model for individual performance. Our model shows the causal interdependencies between ability (KSA), motivation, and opportunity. It also illustrates how and by which other factors these model variables are influenced. Furthermore, it allows studying how different HRM practices affect individual performance outcome. This will shed some light on the 'black box' of HRM.

All model variables and parameters include an abbreviation after their name which will be used within the text. Abbreviations with small letters are used for parameters representing the system boundaries and capital letters for variables. The high-level overview of our system dynamics model is depicted in figure 1. According to the AMO theory, performance (P) of an individual is determined by its ability (KSA) (A), motivation (M), and opportunity (O) [Appelbaum et al., 2000]. All variables do have a positive relationship to performance. As achieving goals increases motivation (Locke and Latham, 2002) a reinforcing loop (R 1, M→P) between M and P is introduced.

We will build sub-models for all three core elements before integrating them into a holistic model.

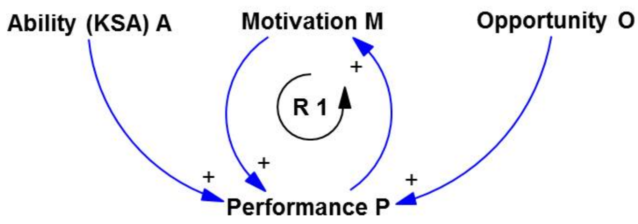

Figure 1: Overall view of the model

The ability to perform sub-model

The ability to perform sub-model is shown in figure 2. Within the context of this paper, ability to perform is a multidimensional construct oriented on the knowledge, skills, and abilities (KSA) competence model [Stevens and Campion, 1994]. A construct can be referred as multidimensional

> when it consists of a number of interrelated attributes or dimensions and exists in multidimensional domains [Law et al., 1998].

Knowledge is what an employee has learned in school, by training, or by job experience. Skills are things he can do and ability is a special talent or a personality quality. Knowledge and skills can be improved by learning (LE) through training (tr) or experiences in the current job (EX) [Oliva and Sterman, 2010]. The latter is determined by the amount of time the person has already spent in his actual position (tj) [Combs et al., 2006]. However, ability (KSA) (A) does not grow infinite but is subject to erosion. Organizations are no longer stable and predictable but subject to constant change [Baar et al., 2014]. These changes in the work environment (ec) result in knowledge, skills, and abilities becoming obsolete over time. The introduction of new technologies or procedures in the workplace are examples for such changes [Elias, 2003].

Furthermore, ability (KSA) is influenced by health (HE), i.e. the physical and psychological state of the person. Even a well-educated employee will be handicapped by a temporary illness. It has been proven that a high level of workload (wl)

over a longer period of time causes fatigue and therefore has negative consequences on health [Homer, 1985]. Age (AG) also has an impact on health. The older an employee gets the higher the probability of suffering from disease [WHO, 2011].

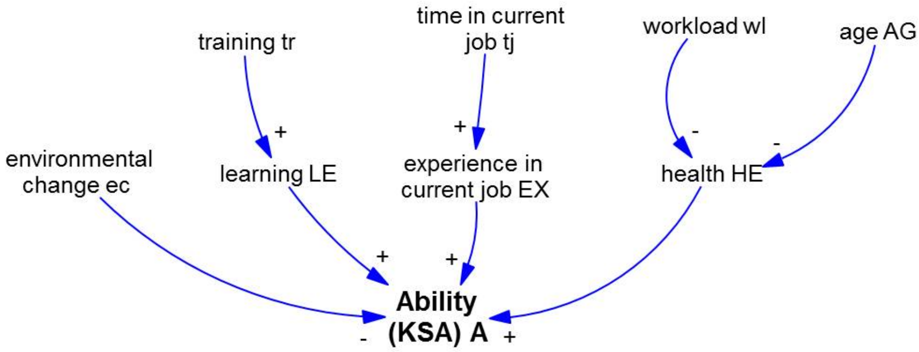

Figure 2: Ability sub-model

The opportunity to perform sub-model

The opportunity to perform (O) depends to a great extent on the design of the workplace and the social system the individual is part of (figure 3). Work procedures, technology, leadership, and cooperation impact an individual's opportunity to participate in the job. Furthermore, opportunity also includes expectations and goals set by senior managers. Taken together, opportunity contains all aspects relevant to an employee's assignment which are out of his or her direct control. Opportunity to participate is directed to answer the following questions

> Does the employee have adequate tools, equipment, material and supplies? Does the employee have favourable working conditions, helpful co-workers, supportive work rules and procedures, sufficient information to make job-relevant decisions, adequate time to do a good job and the like? [Robbins et al., 2010, p. 180]

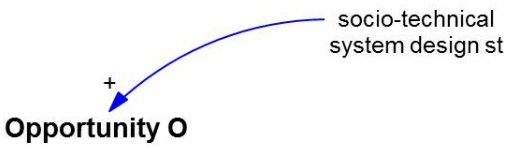

Figure 3: Opportunity sub-model

We subsume all these different aspects in the socio-technical design of the job (st) [Trist, 1981]. We deliberately set the model boundary at this point and do not disaggregate this parameter. In order to answer the above questions, many variables and relations would have to be taken into consideration. Due to this, modeling the work environment of an employee would result in a complex system dynamics model on its own. Nevertheless, introducing the socio-technical design (st) as an parameter and as an 'anchor point' at the same time offers the possibility to extend our model in the future. In practice, this means moving model boundaries further into the work environment.

The motivation to perform sub-model

Just as ability to perform and opportunity to perform, motivation to perform is a multidimensional construct. It includes aspects like effort, job satisfaction, and organizational commitment. This aggregation keeps the model as simple as possible without losing to much information. Although the aggregation goes along with a loss of accuracy, it will support an understanding of the main dependencies. The corresponding sub-model is depicted in figure 4.

Motivation is in positive relation to the actual physical and psychological state (HE) of the employee. Workload (wl) influences health and motivation. With workload being too high the employee may not reach his or her goals. This will result in diminishing motivation. However, the opposite causes the same effect. Having nothing to do at work causes boredom and a feeling of being useless. Negative effects on motivation are the result [Fisher, 1999].

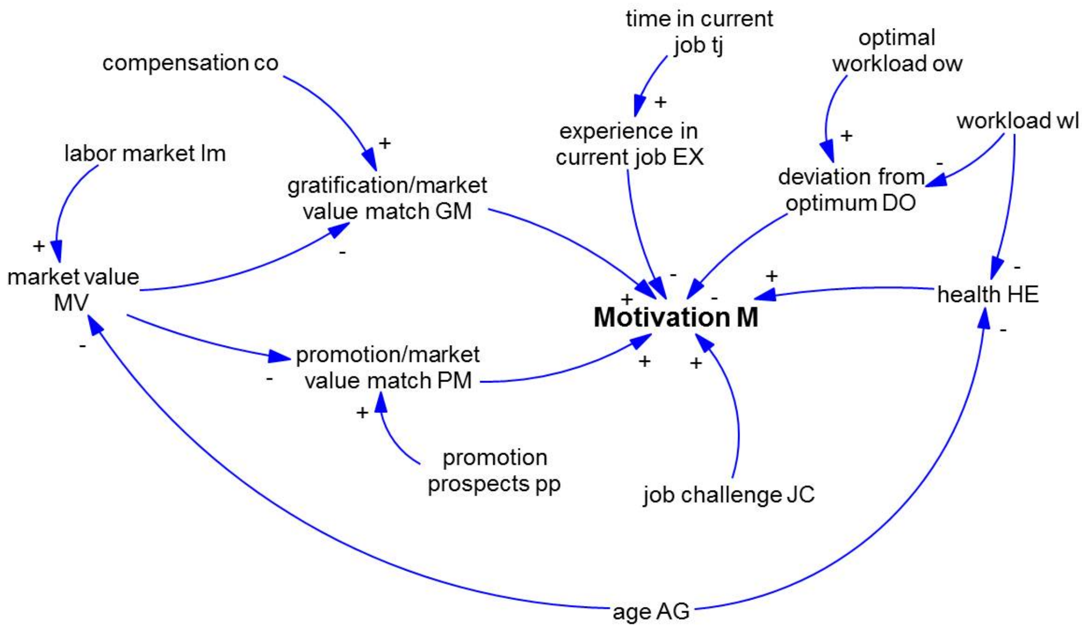

Figure 4: Motivation sub-model

Doing the same job over a long time leads to more experience but also to job routine and job boredom. Therefore, time spent in current job (tj) has a negative indirect effect via experience (EX) on motivation.

The value of an employee on the labor market (MV) impacts job satisfaction and organizational commitment [Mobley, 1979]. Compensation (co), i.e. incentives and salary, in relation to what is paid in other organizations (GM) has an influence on motivation [CIPD, 2002]. The higher this relation, that is the actual job is well paid, the higher job satisfaction and organizational commitment are [Herzberg er al., 2010]. While gratification considers the actual state, promotion prospects (pp) takes the future into account. Employees evaluate career prospects they have in their organization against potential career paths in other organizations (PM) [Hess et al., 2011]. On one hand, this evaluation is connected to personal goals, development, and growth. On the other hand, career opportunities in the organization do play a role. Just as gratification, promotion prospects in consideration of market value have an influence on motivation. The better the career prospects in the organization the higher motivation is [Herzberg er al., 2010]. We assume that the market value (MV) of an employee is determined by age (AG) and the actual condition of the labor market (lm).

Another important aspect concerns job challenge (JC), i.e. expectations and goals set by senior management compared to the actual qualification. An under-qualification, i.e. a challenging job, results in higher job satisfaction whereas an under-utilization causes the opposite [Rose, 2003].

The AMO model

The three sub-models we have presented do not stand in isolation. Rather, all three sub-models relate to one another. Figure 5 presents the complete model. Relations connecting the sub-models are depicted with bold arrows.

Opportunity (O) directly influences motivation (M) [Locke and Latham, 2004]. The work environment impacts organizational commitment and job satisfaction [Gardner et al., 2001]. For instance, grievances dramatically diminish organizational commitment and job satisfaction. Expectations and goals set by senior management define job-skills necessary to fulfill a given task. Therefore, opportunity in combination with ability (KSA) (A) specifies if an employee is under-qualified or over-qualified for the job (JC). In addition, opportunity (O) impacts health (HE). This is true for unsafe work conditions as well as for a stress producing work climate.

Learning (LE) depends on an employee's willingness and effort to acquire new knowledge and skills. For this reason, a link between M and LE is introduced. Value of an individual on the labor market (MV) is significantly dependent on his or her knowledge, skills, and abilities.

The causal loop diagram reveals five loops which determine model behavior. Three balancing loops and two reinforcing loops can be identified from the diagram.

Reinforcing loop (R 1, M→P) has been discussed before. The second reinforcing loop (R 2, M→LE→A→P) exhibits the feedback effect of ability (KSA) (A) on motivation (M).

The first balancing loop (B 1, M→LE→MV→ GM) takes the path from motivation (M) over market value (MV) and gratification/market value match (GM). Instead of including GM, the second balancing (B 2, M→LE→MV→ PM) contains promotion/market value match (PM). The remaining balancing loop (B 3, M→LE→A→JC) represent the feedback structure via job-skills and personal-skills.

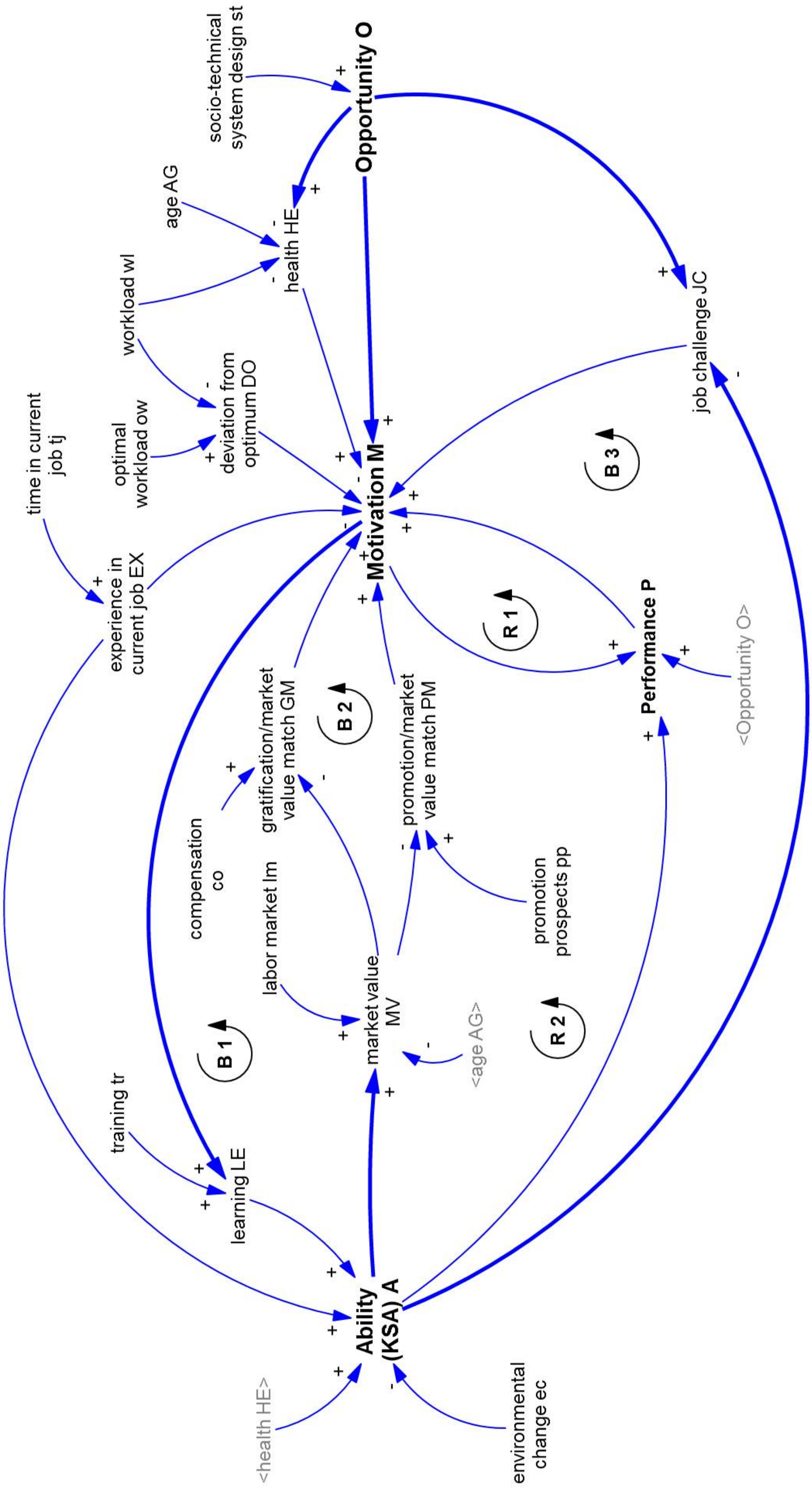

Figure 5: Causal loop diagram of the AMO model

The Stock and Flow Model

Building on the causal-loop diagram we have implemented the stock and flow diagram in VENSIM® [Ventana systems, 2014]. This diagram (see appendix) contains a total of four stocks: one for ability (KSA) (A), one for health (HE), and two for the actual level of positive respectively negative motivation. Splitting motivation (M) into two stocks avoids negative stock values. Opportunity (O) is not modeled as a stock. We assume that work conditions do not accumulate but change instantly by managerial intervention. However there exists a technical reason not to implement opportunity (O) as a stock. In our model opportunity (O) only depends on the parameter *st*. Parameters form the model boundary and connect the model to its environment. As exogenous variables they have a memory and can themselves be regarded as stocks. The auxiliary model variable opportunity (O) just transforms the value of the parameter *st*.

Performance is calculated by a simple formula (see [Siemsen et al., 2008] and [Tuuli, 2012] for a discussion on this topic):

$$P = (A * M * O)/pa \tag{2}$$

The parameter pa is a constant and is used to scale down P to a value at about 100. A value of 100 is used as being a reference for an average value. Scaling P helps to ensure consistency with the variables ability (KSA) (A), motivation (M), and opportunity (O). As it is for example with ability (KSA), a performance level of 100 means average performance.

Basically, parameters in the model can be divided into four groups. The first group of parameters is used to model different personalities (see e.g. [Digman, 1990] for a deeper discussion). This is necessary, because no two human beings are identical:

> People have not only different amounts, but also different kinds of motivation. That is, they vary not only in *level* of motivation (i.e., how much motivation), but also in the *orientation* of that motivation (i.e., what type of motivation). [Ryan and Deci, 2000]

Some people for example gain motivation mostly by extrinsic rewards, like money or status, whereas for other people the intrinsic motivation is more important.

The second group of parameters is used to simulate management interventions. Adjusting parameters like training *tr* or compensation *co* enables users to simulate different HRM policies.

Another group of parameters represents the external environment, like the labor market (*lm*) or the socio-technical design of the workplace (*st*).

The last group contains parameters for technical aspects of the model. Even though all these parameters could be integrated into formulas a separation significantly contributes to an understanding of the model.

Model Validation

We have checked our model for: data validity, conceptual validity, and operational validity [Sargent, 2011]. Validation has to substantiate

> that a COMPUTERIZED MODEL within its DOMAIN OF APPLICABILITY possesses a satisfactory RANGE OF ACCURACY consistent with the intended application of the model [Schlesinger et al., 1979, p. 104].

All values for parameters and stocks have been tested whether they are appropriate and accurate or not. While most parameters contain real world data, it is nearly impossible to validate parameters used for modeling the personality of an employee. However, restricting the latter to values between zero (no influence) and one (high influence) for the latter should represent real world to a great extent. The same problem holds for stocks. Motivation (M) and ability (KSA) (A) are multidimensional concepts. Hence, we decided to use a value of 100 for an average value. Higher values represent above average and vice versa. This is also true for health (HE).

Validation of the underlying conceptual model has been done throughout modeling as part of the quality assurance process [Coyle and Exelby, 2000]. All variables and relations have been derived from and checked against literature within the fields of management science, organizational behavior, and industrial psychology. Conceptual validity included a critical reflection of the model boundaries as well.

For operational validity we have explored the simulation output behavior under different experimental conditions. We have followed a qualitative approach in order to examine whether the system produces 'reasonable' results or not. For this purpose, parameters have been set to different values and the behavior of the system has been analyzed. We did not forget about testing for extreme values to identify 'abnormal' behavior. The test for operational validity was a twofold process. In the first step the sub-models have been examined independently from each other. However, validity of the sub-models is only a indication that the complete model is valid but does not guarantee it. Hence, in the second step the complete model has been checked for validity by analogy.

One important aspect has to be mentioned. A lack of longitudinal empirical studies concerning job performance prevents the model to be checked against empirical results. However, we hope that our model will be a stimulus for further empirical studies. This in turn will allow us to conduct some deeper validity checks in the future.

Human Behavior in the Workplace

We configure our model to simulation different HRM practices for analyzing the simulation results with respect to performance. The scenarios we study are called *standard scenario*, *training scenario*, and *increased scenario*.

Figure 6 depicts the results of the *standard scenario*. It shows the changes in motivation, ability (KSA), and opportunity of an employee who enters the organization at 25 and retires at the age of 65. Model parameters are set in a conservative way. The employee is paid the market price (*co*), there are some promotion prospects (*pp*), training (*tr*) is set to 2%, and workload (*wl*) is 100%. The design of the socio-technical system (*st*) the employee is part of rests at a constant value of 100. Simulation indicates that ability (KSA) increases from start on and stays at a high level throughout 480 months (time steps). This is among others due to uninterrupted training and gains in professional experience. However, motivation and performance follow a different pattern. Motivation climbs within the first 10 years, but drops sharply afterwards. At the end of the employment phase, motivation recovers slightly. Although ability (KSA) rests at a high level, this does not prevent performance from following nearly the same trend as motivation.

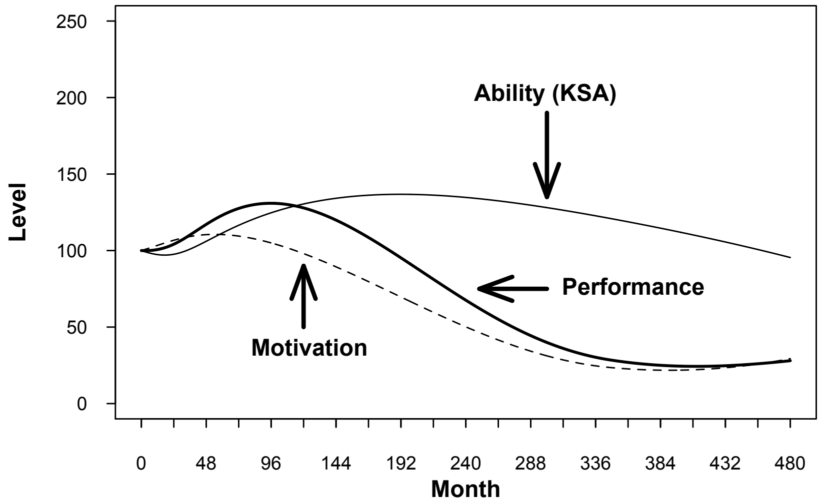

Figure 6: Simulation results of the *standard scenario*

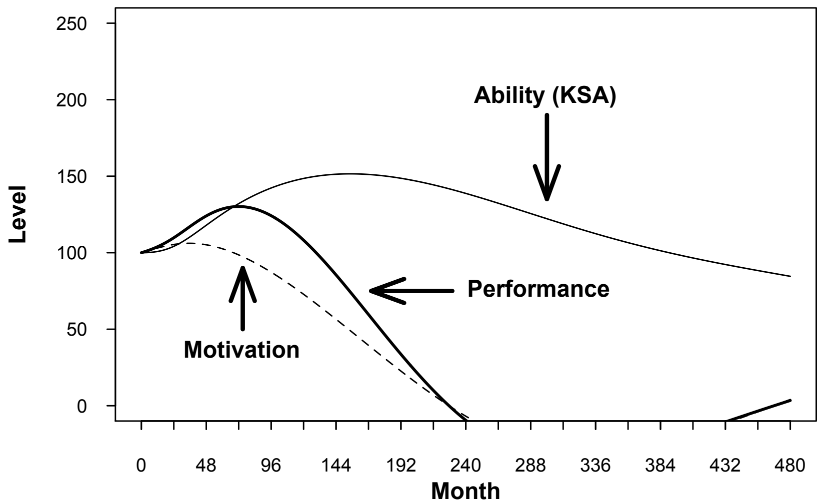

Figure 7: Simulation results of the *training scenario*

What happens if management decides to apply some skill-enhancing HRM practices? To simulate the *training scenario* we set the correspondent parameter (*tr*) to

5%. All other parameters stay untouched. In contrast to what should be expected performance of the employee plunges after a short peak (figure 7). Performance and motivation even become negative. The reason for this is that the employee will constantly suffer from his or her over-qualification with drastic negative impacts on his or her motivation. Beginning at about month 240, negative motivations towards his job overwhelm. The results are counterproductive workplace behavior and dysfunctional job performance [Martinko et al., 2002]. In practice the employee will either be laid off or quit the job before reaching retirement age. This simulation run supports the finding of Gardner et al. that skill-enhancing practices are positively associated with turnover [Gardner et al., 2011].

One thing has to be mentioned. As we are focusing on the performance related behavior in this paper, we omit other job relevant behavior like turnover and absenteeism. A decision for turnover or absenteeism is made by an employee if certain variables fall below a threshold. Turnover will for example occur if motivation is dramatically decreased. In contrast, absenteeism is triggered by a low health status. We have implemented these mechanisms in another model [Block and Pickl, 2014].

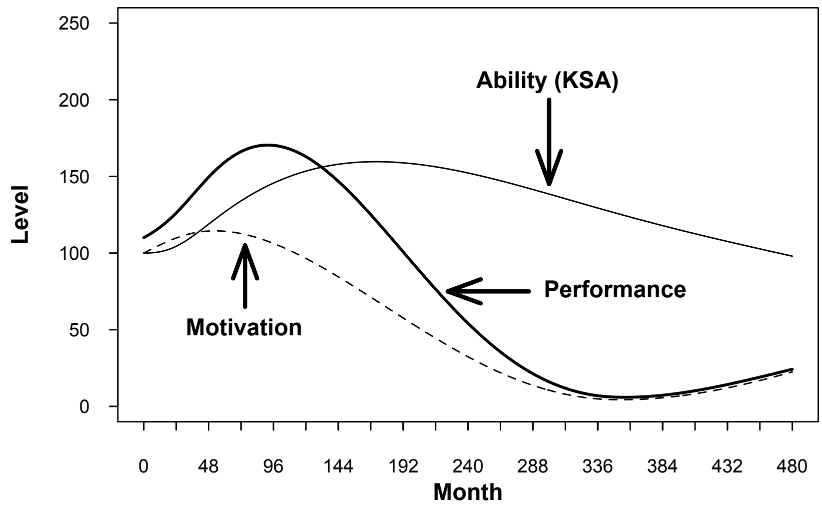

Figure 8: Simulation results of the *increased scenario*

What can management do to counter the performance collapse? In addition to an increase in training ($tr = 0.05$), we raise the employee's salary (co) and adjust the work environment ($O = 110$). Increasing the salary matches his or her higher qualification (A). On the one hand, this means that compensation (co) equals initial market value (MV). On the other hand, adjusting the work environment offers higher challenges to the employee (JC) and therefore should prevent or reduce the negative effects resulting from over-qualification. Now, the simulation of the *increased scenario* depicts a much better pattern (figure 8). However, the employee's performance rests at a low level after the middle of his professional life.

An interesting question is how the *increased scenario* with the increase in training (tr), wage (co), and opportunity (O) behaves in comparison to the *standard scenario.* We can see the result in figure 9. Until about month 200, management intervention obviously results in higher performance. However, afterwards the opposite happens. For the last 280 months, further management interventions are needed to reduce the diminishing performance of the *increased scenario*. This comparison is an example for an once successfully implemented HRM policy dropping in effectiveness over time. For maximum success, it is necessary to frequently adjust the HRM policy according to the actual performance trend.

These examples demonstrate that a singular managerial intervention, i.e. an increase in training effort, is only of short term success and not sufficient for a sustainable HRM policy. Indeed, it seems to be essential to adequately consider all three human resource (HR) policy domains [Lepak et al., 2006]:

1. the HR policies that focus on employee knowledge, skills, and abilities,
2. the HR policies that focus on managing employee effort and motivation,
3. and the HR policies that focus on employees' opportunity to contribute.

According to our model the implementation of a sustainable HRM system depends on the right mix of practices from all three HR policy domains. Keeping the balance seems to be the key.

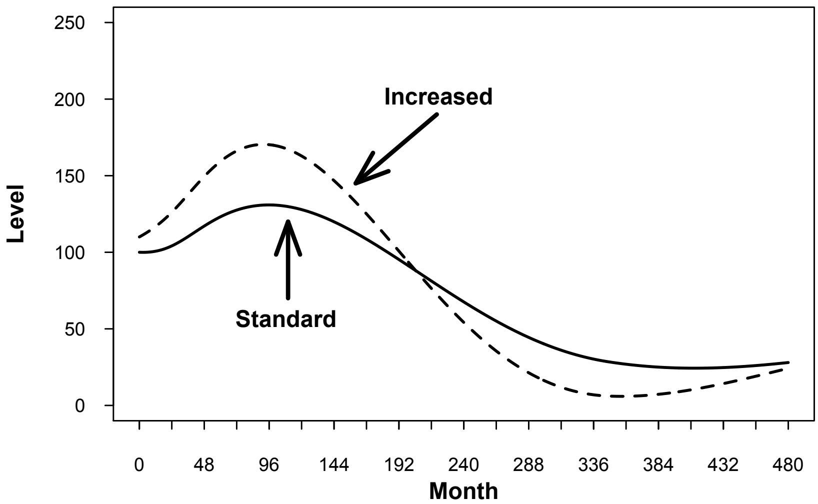

Figure 9: Performance of the *standard scenario* and the *increased scenario*

Discussion and Conclusion

We developed a system dynamics model to investigate the link between HRM and job performance. The model is founded on in HRM research well established AMO theory. This theory states that performance is some function of an employee's ability to perform, motivation to perform, and opportunity to participate. Elements and relations of the model have been identified by an in-depth review of literature in fields like management science, organizational behavior, and industrial psychology. Model parameters enable users to simulate the effects of different HRM policies and practices. Our research is intended to serve for the practitioner as well as for the scientist.

Managers are able to simulate different HRM policies and practices by simply adjusting model parameters. This allows identifying well working and sustainable policies and practices that can be implemented in real life. Simulation in a virtual world is much more preferable than experimentation on the living object where consequences cannot be overseen in advance and harm to the whole organization cannot be excluded [Dörner, 1996]. One weakness of the model presented in this paper is that it is restricted to study the implications of HRM policies and practices on single employees. However, an organization is a social system and actions of colleagues influence each others behavior. Therefore, we intend to integrate this system dynamics model into a broader agent based model [Block and Pickl, 2014]. This hybrid model will allow studying the effects of HRM policies and practices on the whole organization. For instance, it will be possible to identify whether incentives result in an increase in organizational performance or not. Incentives are applied in many organizations in order to motivate employees towards performance. Indeed, the one employee who is granted an incentive will be positively influenced. On the other hand, there is the danger of creating a culture of jealousy and distrust. In this case, good intentions result in the opposite.

Simulation is one method of theory development [Davis et al., 2007]. Hence, management science and behavioral science will also benefit from our system dynamics model. The causal loop diagram facilitates critical discussions about relevant elements and interdependencies among scientists from different fields. Generally, these kinds of diagrams are easily understood compared for example to more subjective fuzzy definitions [Morris et al., 2010]. Our model can be used to initiate further goal oriented empirical studies Theses studies should help to identify the intensity of relations between directly connected variables.

We are well aware that our model shares the disadvantages of all models. As a simplification of the real world, every model is inevitably incomplete, incorrect and therefore wrong [Sterman, 2002]. There is plenty of room for model optimization. For example, the personality of an employee is only implemented in rudimentary fashion. The additional integration of desires and beliefs [Bratman, 1999] could be fruitful. Moreover, the extension of the model boundaries more into the work environment seems to be of interest. This could help to answer the question how much an organization should invest in the work environment.

Another aspect concerns the multi-dimensional constructs for ability, motivation, and opportunity. Disaggregating these elements could lead to a more accurate model. However, we should be cautious about this. More elements do not necessarily result in a more reliable model. The consequences of more elements are more relations and this increases validation effort significantly. Validation of our system dynamics model has already been very difficult and we are somehow away from a fully validated model. Scientific literature in management and psychology does not always agree on how and to which extent variables influence each other and longitudinal empirical studies are lacking. It is still an open field for research and this reflects in model validation. Moreover, we agree with Peter Boxall and John Purcell when they state

> we should try to avoid contingency models that are 'too thick' - throwing everything plus the kitchen sink - we do need to evolve models

that explain most of the important connections [Boxall and Purcell, 2000].

Although we did not find the key to completely unlock the 'black box' of HRM, we nevertheless shed some light on it. At least, we provide a sound foundation for further research and field studies. Hence despite being wrong, we are sure that our system dynamics model will be useful [Box and Draper, 1987]. Our search for the key will go on.

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Appendix - System Dynamics Model

Table 1: Parameters used to model the personality traits of an employee

Parameter Name	Parameter Description
disease age da	Influence of age on becoming ill
disease workload dw	Influence of workload on becoming ill
entry age ea	Age of the employee when he entered the organization
health threshold ht	Split level of health at which ability is either impacted positively (above) or negatively (under)
influence compensation ic	Influence of compensation on (extrinsic) motivation
influence experience ie	Influence of experience on (intrinsic) motivation
influence health ih	Influence of health on motivation
influence on KSA decrease id	Influence of health on ability (decrease)
influence on KSA increase ii	Influence of health on ability (increase)
influence job challenge ij	Influence of job requirements compared to abilities on motivation
influence on learning il	Willingness and ability to learn
influence opportunity io	Influence of opportunity on motivation
influence performance if	Influence of performance on (intrinsic) motivation
influence promotion ip	Influence of career prospects on (extrinsic) motivation
influence workload iw	Influence of workload on motivation
optimal workload ow	Optimal level of workload
recovery rate rr	Recovery rate when being ill
stress factors sf	Fraction of opportunity causing stress
stress reference sr	Level of opportunity causing no stress (optimal level)

Table 2: Parameters used to model managerial interventions

Parameter Name	**Parameter Description**
compensation co	Payment per month
promotion prospects pp	Career prospects (money)
socio-technical system design st	Job design and work environment
time in current job tj	Time in current job
training tr	Fraction of training
workload wl	Current workload

Table 3: Parameters used to model the external environment

Parameter Name	**Parameter Description**
influence of age ia	Influence of age on the market value of the employee
labor market lm	Payment per ability on the external job market
organizational change oc	Erosion of ability by new technologies etc.

Table 4: Parameters used for technical aspects

Parameter Name	**Parameter Description**
correction for units cu	Used to allow VENSIM® unit check, will be fixed later on
performance adjustment pa	Used to scale performance down (100 = average)

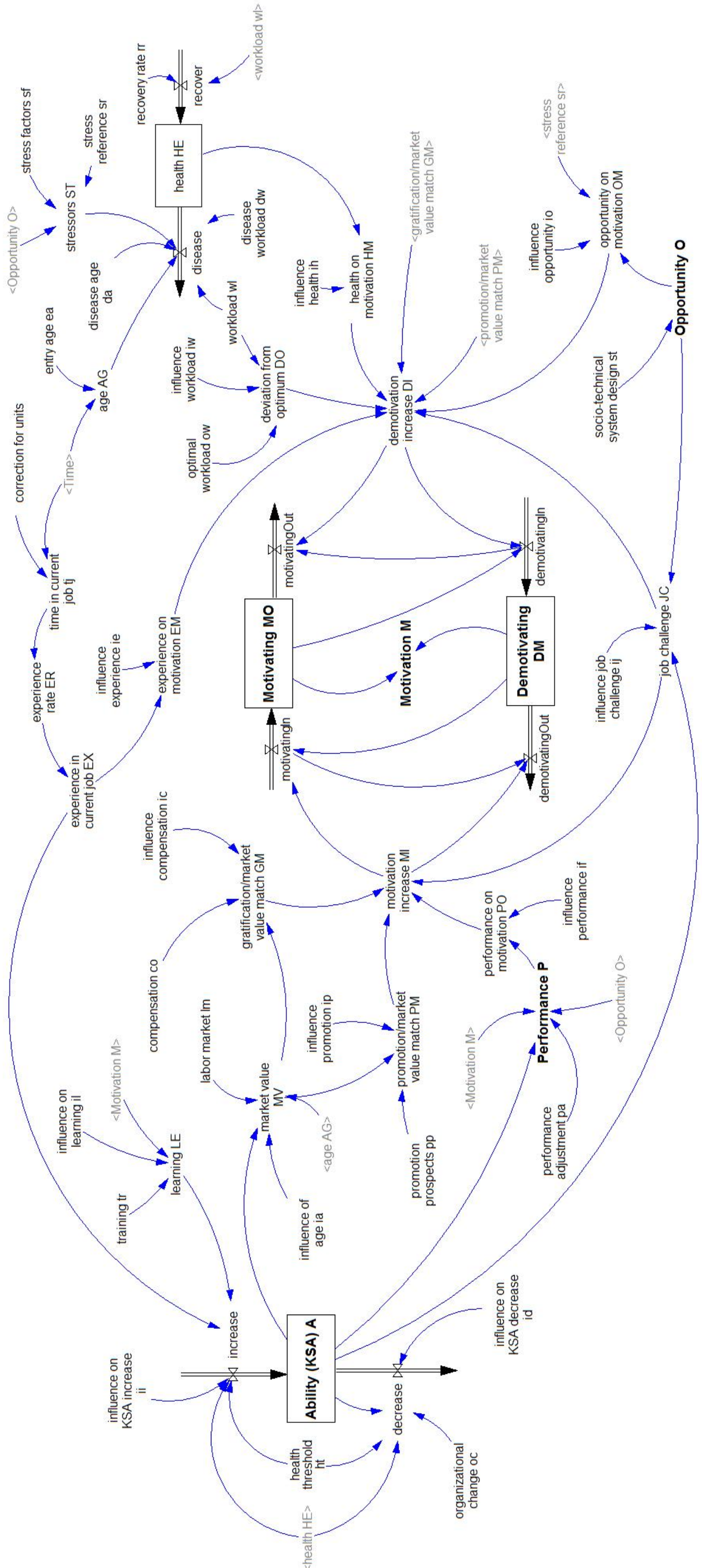

Figure 10: The stock and flow diagram