A Study on the Foundations of the Occurrence of Errors in Subjective Measurements

Carlos Alberto Ferreira Bispo

Edson Walmir Cazarini

Engineering School of Sao Carlos
University of Sao Paulo
Rua Santo Antonio, 142 – 13632-000
Pirassununga, Sao Paulo, Brazil

Abstract

Background
Due to the increasing need to better understand organizational elements, subjective measurements are gaining more and more space.

Problem: *What are the grounds to claim that subjective measurements allow for more possible measurement errors in relation to objective measurements?*

Purpose: *To establish the necessary foundation to affirm that subjective measurements allow more measurement errors in relation to objective measurements.*

Methods: *a comprehensive review of the literature on subjective and objective measurements was performed in order to establish the grounds of the problem outlined.*

Results: *postulates on subjective measurements were elaborated and the main sources of subjective measurement errors, based on those postulates, were outlined.*

Conclusions: *With the postulates and sources of errors outlined in the article, it was possible to formulate a theoretical framework that allowed us to better understand why subjective measurements are more subject to measurement errors in relation to objective measurements.*

Keywords: Human resources. Uncertainty modeling. Subjective measurement. Sources of errors in subjective measurements. Postulates of subjective measurements.

1. Introduction

The study for the elaboration of this article was also used alongside other studies for the development of the doctoral thesis of the first author under the guidance of the second author. Currently, the struggle for increased competitiveness, quality and productivity are making managers and researchers give increasing attention to small details of organizational management, whether in for-profit or non-profit businesses or government agencies, i.e., in all types of organizations. Thus, details that were overlooked in the past, now may be an organization's competitive or qualitative differential. Decision-making processes are becoming increasingly complex and small details can make a big difference in the results obtained by the decisions taken. It is necessary to evaluate thoroughly the various organizational elements using increasingly sophisticated methods, techniques, and tools. The greater emphasis is being place on use of objective measurements acknowledged in theory and practice. However, due to the increasing need to better understand organizational elements, subjective measurements are gaining a growing space.

1.1 Formulation of the problem

The current world is changing rapidly, primarily through the globalization offered by the revolution of information technology and communication. Companies of all sizes and industries are being forced to frequently adapt to changes of several types, imposed by the socio-economic, market, organizational, political, and environmental scenarios, both nationally and internationally. Therefore, how to know whether the changes made in the company, business, or production are well suited to the needs imposed?

The need for ongoing evaluation of the evidence to show that "organizational health" and its ability to adapt to such changes then appears, as well as a better assessment of the scenario in which the organization and its organizational elements are inserted.

Most organizational data is obtained via objective measurement using proven tools of the Quantitative Methods as Linear Programming, Dynamic Programming, Statistical Theories of Decision, etc., producing indicators such as productivity, attendance, turnover, market share, inventory levels, profitability, production capacity, levels of resource allocation, etc.. However, these data often cannot fully describe attributes such as behaviors, effects, some of the features or properties of the elements that make up the organizational management. Therefore, there is a need to use subjective measurements to better evaluate and examine these attributes, allowing for greater understanding and better management of organizational elements. However, it is stated that the use of subjectivity allows for the occurrence of more measurement errors and, consequently, less credibility regarding the data obtained. Nevertheless, recent scientific methods have employed subjective measurement to the development of organizational indicators. Thus, the problem to be addressed in this article appears: What are the grounds to claim that subjective measurements allow for the occurrence of more measurement errors in relation to objective measurements?

1.2 Purpose

Based on the problem outlined, the purpose of this paper is: to develop the necessary foundation to affirm, on the due grounds, that subjective measurements allow for more measurement errors in relation to objective measurements.

1.3 Methods

We performed several theoretical studies, based on the relevant literature on subjective and objective measurements, in order to establish the grounds given in the problem outlined.

1.4 Scope and limitations of the studies

The publications used to develop the theoretical framework on subjective measurements were multidisciplinary, involving topics such as Social Sciences, Humanities, Medical Sciences, and Exact Sciences. The results can be applied to such areas, yet the emphasis of the studies of this article was placed on organizational management.

2. Objective Measurement and Subjective Measurement

Objective measurement employs methods, procedures, or instruments that do not make use of subjectivity, and is normally carried out in conditions of repeatability, allowing to obtain results with very small measurement errors, which are neglected in most circumstances. It involves quantitative variables, both of discrete and continuous types. For example, measurements of weight (mass), volume, distance, density, speed, size, height, volume, sales volume, number of employees, number of computers, etc..

Subjective measurement employs methods, procedures, or instruments that make use of the subjectivity of the observers, according to the postulates of subjective measurements outlined in Section 4, which, using measurement instruments outlined in Section 3, can provide measurement errors outlined in Section 5. In this manner, even in conditions of repeatability, results may be different in each measurement, allowing for results that may be placed on both ends of the scale used. Examples of this measurement are: level of perceived quality or satisfaction with products and services, the degree of involvement of people participating in a project, satisfaction level of customers, employees, etc..

As an example of the obtaining of quite different results in subjective measurements measuring the same attributes of a measurand, Table 1 shows data obtained in a field research conducted and published in Bispo and Cazarini (2007). As one may observe in the two columns relating to Survey 1 on the degrees obtained for the favorable evidence, the highest score given was nine and the lowest score was zero, thus, close to the sheer scale used. In the same survey, the degrees obtained concerning the contrary evidence also showed a similar range, i.e., the highest score reached the upper limit of the scale (ten) and the lowest score was one, approaching the lower limit of the scale (zero). In Survey 2, using another method, the amplitude decreased slightly but was still high for the two levels of evidence, with some values reaching the maximum threshold of scale and others reaching the minimum threshold.

Survey 1 – Brazilian broadcast TV system				
	favorable evidence		contrary evidence	
	highest score	lowest score	highest score	lowest score
Question 1	8.0	0.0	10.0	2.0
Question 2	9.0	1.0	10.0	2.0
Question 3	9.0	0.0	9.0	2.0
Question 4	9.0	0.0	10.0	1.0
Question 5	8.0	0.0	10.0	2.0
Question 6	8.0	1.0	10.0	2.0

Survey 2 – Brazilian printed journalism system				
	favorable evidence		contrary evidence	
	highest score	lowest score	highest score	lowest score
Question 1	9.0	4.0	9.0	2.0
Question 2	9.0	2.0	9.0	1.0
Question 3	9.0	2.0	8.0	3.0
Question 4	9.0	1.0	10.0	2.0
Question 5	9.0	2.0	9.0	0.0
Question 6	10.0	4.0	9.0	1.0

Table 1 – Highest and lowest score attributed at field research published in Bispo and Cazarini (2007)

3. Instruments Used in Subjective Measurements

There are several types of measurement instruments, both for objective and subjective measurements. For subjective measurements, there are several types of instruments used in several areas of knowledge, such as Psychometrics, some of which are adopted in organizational management. The literature has different classifications of instruments for subjective measurements. A classification based on Triviños (1994), Richardson (1999), Patton (2002), and Minayo (1994 and 2004) is presented, which meets the interests of the organizational management area:

1) **Questionnaire** – consists in surveying the opinions of a group of people belonging to a particular group, with respect to the subject under investigation, with proper scientific basis. Basically, there are two types of questionnaires: closed and open. They can be applied separately, as needed, or in combination, that is, the open questionnaire complementing the closed one.
2) **Interview** – it is characterized by direct contact between the surveyor and the surveyee, when they express their opinions about a subject, their perceptions of an event or situation, their interpretations or their experiences through the questions and the very perception of their reactions. There are three types of interviews: closed or structured, semi-structured, and open or free.
3) **Observation** – it is an instrument based primarily on visual observation. The observer's research field is quite large and depends only on the research objectives and the pre-formulated hypotheses. This type of instrument allows for the capture of verbal and nonverbal data, forms of conduct and behavior, lifestyles, cultural traits, spatial organization of groups and society, etc.. The main limitation is the very difficulty of this task, which is difficult, delicate, complex, and sometimes exhausting. There are three types of observations: directed or structured, free, and participative.
4) **Documental** – data collection through written materials and other documents; memoranda and correspondence; publications and official reports; personal journals; letters; artwork; photographs; memorials; and other documentary records. According to Godoy (1995a and 1995b), this is a rich source of data. Its main advantage is the documentary evidence of the data. The disadvantages include: the difficulty of access to restricted documents; the poor physical condition of some documents; the difficulty of extracting data and information that meet the objectives of the survey.

4. Some Postulates on Subjective Measurements

During the literature review, we observed almost no publications on some of the foundations of subjective measurements, such as: principles, characteristics, properties, restrictions, etc.

In order to give a basic rationale for subjective measurements, an extensive study had to be carried out, the results of which became postulates of subjective measurements. These postulates, according to the dictionary definition and the literature, are sentences or propositions that need not be proven or demonstrated, and are considered obvious or resulting from a general consensus. Considering that the subjective measurement is always performed using the subjectivity of people, the following are considered as postulates:

1. **Peculiarities of the human being** – the results of subjective measurements are always influenced by individual peculiarities, such as: personality, character, ethic, morality, behavior, feelings, or emotion; the main emotions include: acedia, affection, ambivalence, anger, angst, annoyance, anticipation, anxiety, apathy, awe, boredom, calmness, compassion, confusion, contempt, contentment, courage, curiosity, depression, desire, disappointment, disgust, doubt, ecstasy, embarrassment, empathy, emptiness, enthusiasm, envy, epiphany, euphoria, fanaticism, fear, frustration, gratification, gratitude, grief, guilt, happiness, hatred, homesickness, hope, hostility, humiliation, hysteria, inspiration, interest, jealousy, kindness, loneliness, love, lust, melancholia, mono no aware, nostalgia, panic, patience, pity, pride, rage, regret, remorse, repentance, resentment, righteous indignation, sadness, self-pity, shame, shyness, suffering, surprise, suspicion, sympathy, wonder, worry;
2. **Personal goals** – depending on the combination of each individual's peculiarities, purposes, goals and personal interests, family, and work are different from person to person (ENSSLIN, 2001; BAZERMAN, 2007), as well as the strategy on how to achieve them;
3. **Heuristics** – according to Tversky and Kahneman (1974), Gilovich, Griffin, and Kahneman (2002), and Slovic et al. (2000), heuristics are adaptive cognitive mechanisms that simplify the human judgment (analysis, evaluation, subjective measurements, etc.) to deal with more complex situations, reducing it to a minimum level that provides an acceptable outcome, yet they can provide errors or trends in results; its use allows the result to be satisfactory for the intended purpose, making its use more frequent, while, consequently, errors and trends also become more frequent; despite the potential impairments caused for its use, it is difficult to imagine the use of strict rules in all human judgments; as examples of situations in which heuristics are used, the following can be cited: lay assessment of a person's health conditions based solely on visual observation, evaluation of a person's performance based on a brief and rapid analysis of results obtained by it; assessment of the qualities of a product or service based on a brief and rapid analysis of attributes that are easier to view, other kinds of superficial judgments based on simplicity of the evaluation and the quick obtaining of minimally accepted results;
4. **Cognitive maps or mental models** – they are mental representations constructed by individuals, based on their interactions, learning, and experiences with the environment surrounding them, fulfilling the functions of understanding and giving meaning to their reality (SWAN, 1997); cognitive maps do not imply an exact copy of the (complex) environment, but a representation or simplified template that provides a picture and an image and an approximate context of this reality (LASZLO et al. 1995); they are always being updated through the incorporation of new information and experience (CZANYI, 1995); each individual constructs their subjective mental models and live their "reality" in the context of these models, but to belong to one culture, individuals must share the similar "realities";
5. **human interpretations** – interpretations (used in subjective measurements) are human products, historical constructions of scientific practices that employ methods that are also derived from our own construction, making use of theoretical categories created, structured, developed, refined, transformed, and applied in the course of our practices of observation, measurement, experimentation, and theorizing, during our individual and collective interactions with the world (LACEY, 1998; CSANYI, 1995);
6. **complexity of measuring** – depending on the level of knowledge of this complexity, subjective measurements can reveal only parts of their reality, hiding other parts (NEVES, 1996);
7. **limitation of truth –** truth is an asymptotic function of accumulated knowledge in both objective and subjective bases. However, not even the synergism between them can guarantee the complete elucidation of truth, of close proximity could be achieved, but not always the full domain (BUNGE, 1976);
8. **personal development** – as we experience events, meet people, observe what is going on, and interact with the world, our interpretations tend to improve (PIDD, 1998), and as we increase our knowledge, training, experience, culture, and maturity, both general and technical and specific, about the measurand, our subjective measurements tend to improve (SCHMITZ et al., 2006);

9. **available knowledge about measurand** – the measurement represents a characteristic of an attribute of the measurand, according to the universe of knowledge available about it (PEREIRA, 2004), with the evolution of Science, new knowledge often appears on both the attributes of the measurands and the relationships between them; thus, paradigms, laws, theories and axioms/postulates are also often improving (KUHN, 2006), enabling better subjective measurements;
10. **respect toward the values of others** – "[...] As tastes, values are not discussed. [...] Scrutiny by the others of a person's values of a person, or choices that derive from them, is seen as a kind of violence against them" (LACEY, 1998, p. 37).

5. Types and Main Sources of Error in Subjective Measurements

It has been argued that subjective measurements are more subject to measurement errors than objective measurements. We developed postulates that serve as grounds for the origin of these errors. This section provides the results of studies on the main types of subjective measurement errors, as well as their main sources of error, partly published in Bispo and Cazarini (2008) and subsequently improved with the evolution of the studies. Knowing more about such items, it is possible to minimize the occurrence of these errors.

5.1 Types of measurement errors

There is consensus in the literature on the two main types of measurement error: random and systematic. Some authors add the gross error and sampling error, among others that are more specific and only occur in some types of measurement.

Sampling error will not be discussed here as there are already several publications in the area of Statistics outlining the subject, such as Levine et al. (2000) and Bussab and Morettin (2002).

Gross error can be easily identified and the best way to detect it and fix it is through the investigation of so-called outliers, i.e., results that are very dispersed in small in relation to the average of measurements taken; such values are easily noted for being incompatible with the measurand. For example, in an organizational environment survey (BISPO, 2006), due to the lack of clear explanations on how to fill out the questionnaires, some employees (including those with lower education levels) to fill them out in a wrong way, with results that are totally incompatible with the reality of any business. Another example: in customer satisfaction survey, due to a failure of procedure during the search, the results are inconsistent with the reality of any business, hence the name of the error.

JCGM 200 (2008, p. 22) defines systematic error as

> "component of measurement error that in replicate measurements remains constant or varies in a predictable manner. […] A reference quantity value for a systematic measurement error is a true quantity value, or a measured quantity value of a measurement standard of negligible measurement uncertainty, or a conventional quantity value. […] Systematic measurement error, and its causes, can be known or unknown. A correction can be applied to compensate for a known systematic measurement error."

This type of error usually indicates a trend caused by one or a number of sources of errors. Systematic errors can occur due to failures such as: instrumental, observational, theoretical, or environmental. The design of these failures is being presented in the following subsections.

JCGM 200 (2008, p. 22) defines random error as

> "component of measurement error that in replicate measurements varies in an unpredictable manner. […] A reference quantity value for a random measurement error is the average that would ensue from an infinite number of replicate measurements of the same measurand. […] Random measurement errors of a set of replicate measurements form a distribution that can be summarized by its expectation, which is generally assumed to be zero, and its variance.

These errors result from random variations in measurements, deriving from factors that can not be controlled or that, for some reason, could not be controlled during the measurements. They are caused by temporary, variable, unpredictable, and inevitable situations that modify the outcome of the measurements.

Therefore, they are also called accidental errors. By its very nature, are they not eliminable or correctable. Its control is carried out statistically.

According to Vuolo (1996), systematic and random errors may occur simultaneously during the measurements. Due to the characteristics of both types of errors, only systematic errors can be managed in advance, allowing for its minimization. In most objective measurements, systematic errors can be minimized and neglected. Subjective measurements have more sources of systematic errors and it is necessary to try to minimize them and estimate their level of occurrence in order to provide credibility to the measurements taken by the validity and reliability.

5.2 Sources of systematic and random subjective measurement errors

Some of the few publications presenting sources of systematic errors in subjective measurements are Tversky and Kahneman (1974), Patton (2002) and Hammond, and Kenney and Raiffa (2004). The results of the studies conducted to identify the main sources of this type of error are presented below:

- **different behavior** – related to postulates 1 and 2, it occurs when people who are being targeted by subjective measurements have a behavior that might affect the results of these measurements; they may be intentional (e.g., to benefit or harm somebody) or emotional (e.g., due to shyness regarding the measurement, fearing negative effects of future measurement results, or generating great expectations about the future effects of measurement results);
- **selective perception –** related to the combination of the postulates 1, 2, and 3, it allows one to see just what is most important to the observer (meter). It may be due to the lack of training, simplification of the measurement (heuristics), or it may be intentional (e.g., to benefit or harm somebody by observing only what is convenient, intentionally ignoring what is not appropriate for a certain purpose);
- **intrusive measurement** – related to postulates 1 and 2, it occurs when, for whatever reason, the reality could not be fully revealed, affecting the measurement results, for example, due to intentional or accidental deviations of financial or material measurements, or even the intentional non-compliance with procedures, rules, etc.;
- **memories of previous assessments** – related to postulate 3, it occurs when the measurement results are obtained by memories of previous measurements, simplifying the measurement, yet not portraying the reality of the current measurand;
- **availability** - related to postulates 3, 4, 5, 6, 8, and 9, it is one of the heuristic methods of Tversky and Kahneman (1974) and differs from the previous type of error as, in the latter, memories are related to past measurements; in this type of error, the measurements are influenced by memories of past experiences or information; for example, if we ask a group of people to estimate the degree of violence in certain city, it is more likely that people who have already gone through some fact related to urban violence, or have been moved by any situation(s) connected to the subject, will evaluate this issue differently from people who have had no problems to in this sense or are not as influenced by the events that occurred on this subject; another example, in asking a measurement on any subject, people will base their responses on their available knowledge, even if it has been outdated for many years, no longer constituting the reality of the measurand;
- **similarity** – related to postulate 3, it is one of the heuristics of Tversky and Kahneman (1974) – representation; it is determined by the great similarity of a particular measuring with others of the same type, leading to a tendency to repeat the measurements of the already-known measurer in the one being measured; for example, when measuring the perceived quality of certain items of a measurand, when the same measurements have already been performed in another similar measurand (it occurs mainly with vehicles, equipment, tools, electronics, etc.);
- **automated response** – related to postulate 3, it occurs when the measurement results are obtained without further analysis or evaluation, i.e., the data is obtained by a superficial analysis or evaluation providing, minimally acceptable results that do not necessarily reflect the reality of the measurand, simplifying analysis and human judgment, thus practicing the law of least effort;

- **anchoring and adjustment** – related to postulate 3, it is one of the heuristics of Tversky and Kahneman (1974), improved in Hammond, Keeney, and Raiffa (2004), Kahneman (2003) and Bazerman (2006); it occurs when a person tends to adjust the answer based on some initial value available to serve as an anchor, usually leading to a trend in the results; for example, in evaluating an attribute regarding the quality of a product or service, when the same attribute or similar products or services have been given the score 7.0 (seven), there is a tendency towards the assignment of that value to the attribute of the product or service being evaluated.
- Due to the few existing publications on the sources of systematic errors in subjective measurements, especially those covering the area of organizational management, an exploratory study has been developed, the results of which are presented in the following subsections.

5.2.1 Errors due to instrumental and theoretical failures

The main error provided by instrumental failure of in subjective measurements is related to postulate 8 (personal development). It occurs with the inappropriate use of the instrument that is best suited to reach the required measurement, i.e., the use of the right tool, yet with failures in its employment. For example, a survey to determine the level of customer satisfaction with services provided by a company using a survey valid, reliable instrument which, not by failure of the instrument, but by faulty procedures of the instrument, resulting in data that does not adequately portray the reality of the company, however, without (more easily identified) gross errors, in which the volume of services is increasing and the survey results indicate strong dissatisfaction regarding the services provided. After the failure is noticed, there is a need to review those procedures.

The main error provided by the theoretical failures is also related to postulate 8 (personal development) and consists in the wrong choice of a measurement instrument. For example, using a questionnaire to assess the degree of customer satisfaction with products or services to assess the degree of employee satisfaction with the company or conduct an organizational environment survey. Another example is to use a short questionnaire to assess the degree of customer satisfaction with products or services, when the purpose is to make a full and immediate analysis of the consequences of this degree of satisfaction for sales, production, sales, profits, etc.. Therefore, a summarized instrument is being used to achieve the goal of making a full analysis of the scenario in question, i.e., an instrument, which is inappropriate for the measurement purposes, is being used. This error also occurs with the use of a subjective measurement instrument without the checking of its validity and estimation of its reliability.

5.2.2 Errors due to observational failures

The exploratory study identified some errors that act exclusively on subjective measurements. The first one is related to postulate 5 (human interpretations) and the differing levels of demand to which people are subject in each subjective measurement, as shown in Figure 1. Therefore, many people subjectively measuring the same measurand, will follow their respective levels of demand, which usually differs from person to person and can reach very different results, leading to a greater dispersion of data, i.e., more measurement errors. For example, in subjective measurements performed on attributes such as: customer satisfaction, employees, suppliers, investors, organizational environment, quality of products or services, evaluation of the company's image in society, etc., there may be different levels of demand regarding these items among the meters, providing different results.

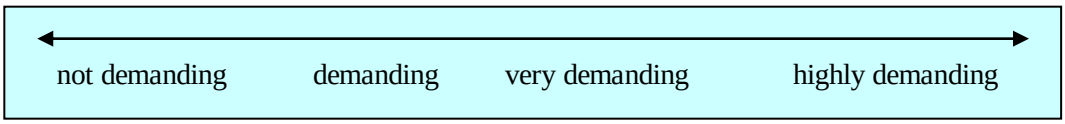

Figure 1 – Different levels of demand to which people are subject in each subjective measurement

The second type of error resulting from observational failures is related to postulates 4 (cognitive maps or mental models), 6 (complexity), 7 (limitation of truth), 8 (personal development), and 9 (available knowledge on the measurand). It refers to the errors occurred during subjective measurements when meters have different levels of perception of the properties, characteristics, effects, behaviors, or some other type of attribute to be observed in the measurand, as shown in Figure 2, not constituting selective perception. For example, when measured subjectively, in the same measurand, attributes such as perceived quality, perceived eminent risk, assessment of competency, assessment of motivation, etc., some meters have a better perception of these attributes than others, contributing to a greater dispersion of data.

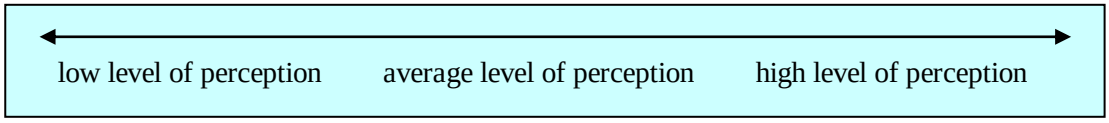

Figure 2 – Different levels of perception to which people are subject in each subjective measurement

The third type of error resulting from observational failures is related to postulate 8 (personal development) and occurs with different levels of influence during subjective measurements. All individuals are subject to influences, however, there are meters that are more susceptible and others that are nearly immune to them, as shown in Figure 3.

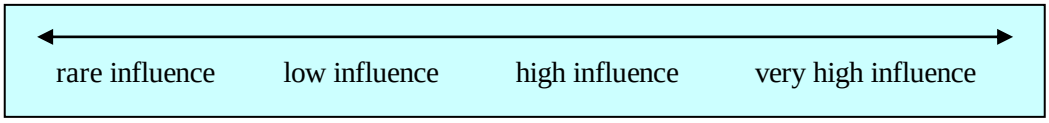

Figure 3 – Different levels of influence to which people are subject in each subjective measurement

5.2.3 Environmental failures

The fourth type of observational error failure, i.e., environmental failure, is the most complex of them. It consists of are several environmental or systemic influencing factors that affect people during subjective measurements, as shown in Figure 4. The error provided by these influencing factors are related to postulates 5 (human interpretations) and 8 (personal development). Each of them has different levels of influence on people for subjective measurements, however, a stronger influence of these factors is enough to leading to an undesirable trend in the results. These influencing factors are:

- **influence of public opinion –** the influence that can affect people, for example, in subjective measurements after disasters, scandals, or another important events for the public with direct or indirect relation with the company;
- **affective influence –** affective relationship between the meters and the measurand, violating the neutrality required for a good subjective measurement; this affection may be positive (e.g., liking or loving) or negative (e.g., disliking or hating);
- **ethical and moral influence –** items that are different from person to person and may influence meters both positively and negatively, i.e., the excess or lack of ethics and morality may compromise subjective measurements; for example, moral and ethical issues have affected public opinion and are jeopardizing some cutting-edge research, such as genetic engineering, food engineering, and robotics, and may affect subjective measurements in a company if the meters are also influenced by these items; in another example, those issues have affected public opinion regarding the level of satisfaction with the work of parliamentarians, members of the executive, NGOs, etc.., and may influence subjective measurements that assess them;
- **political influence –** the level of political pressure during subjective measurements that can provide undesirable trends in the results; for example, conducting a employee satisfaction and organizational environment survey during a power struggle between formal and informal sectors within the company, leading meters to participate in either side of the dispute, potentially affecting measurement results;
- **influence of organizational culture –** influences by the cultures, beliefs, traditions, customs, practices, popular trends, etc., occurring directly or indirectly within the organization, examples are: the influence of Eastern culture in the company; influence of religious cultures in companies the leaders of which are also religious leaders; influence of organizational traditions considered outdated for the present moment, such as excessive strictness towards employees, a tradition of low payments, family traditions of some companies, etc.;
- **economic influence –** influence that could allow for financial benefits, advantages, or even blackmail to some of the individuals involved in the measurements, providing intentional changes in the results, benefiting in some way other individuals involved in this kind of influence;
- **social influence –** similar to the item above, replacing the financial benefits, advantages, or blackmail by social benefits, advantages, or blackmail (humiliation, threats, promises, fears, etc.);

- **influence of the work environment** – an item that can also influence and provide trends to measurements results; for example, a good work environment may facilitate any kind of subjective measurement, providing results closer to the reality of the measurand; however, an poor work environment may produce the opposite effect, making the measurements difficult and producing results that diverge from that reality;
- **influence of norms –** fear or apprehension with respect to the consequences of breaching any rule, regulation, or order when evaluating an organizational element, providing undesirable changes in the results, such as, for example, currently, with strategies, policies and, targets aimed at increasing quality in all organizational items during internal subjective measurements carried out with the employees, some of these may believe that a measurement that does not portray the high level of quality improvement could be violating some rule, norm, or order. In this case, subjective measurements would not necessarily be portraying the reality of the attribute(s) being measured;
- **other –** the influences to which people are subject are not limited to the items above. Modern society is often giving rise to new ways of influencing people to obtain desired results, not necessarily those that portray the reality of the attribute(s) of the measurand.

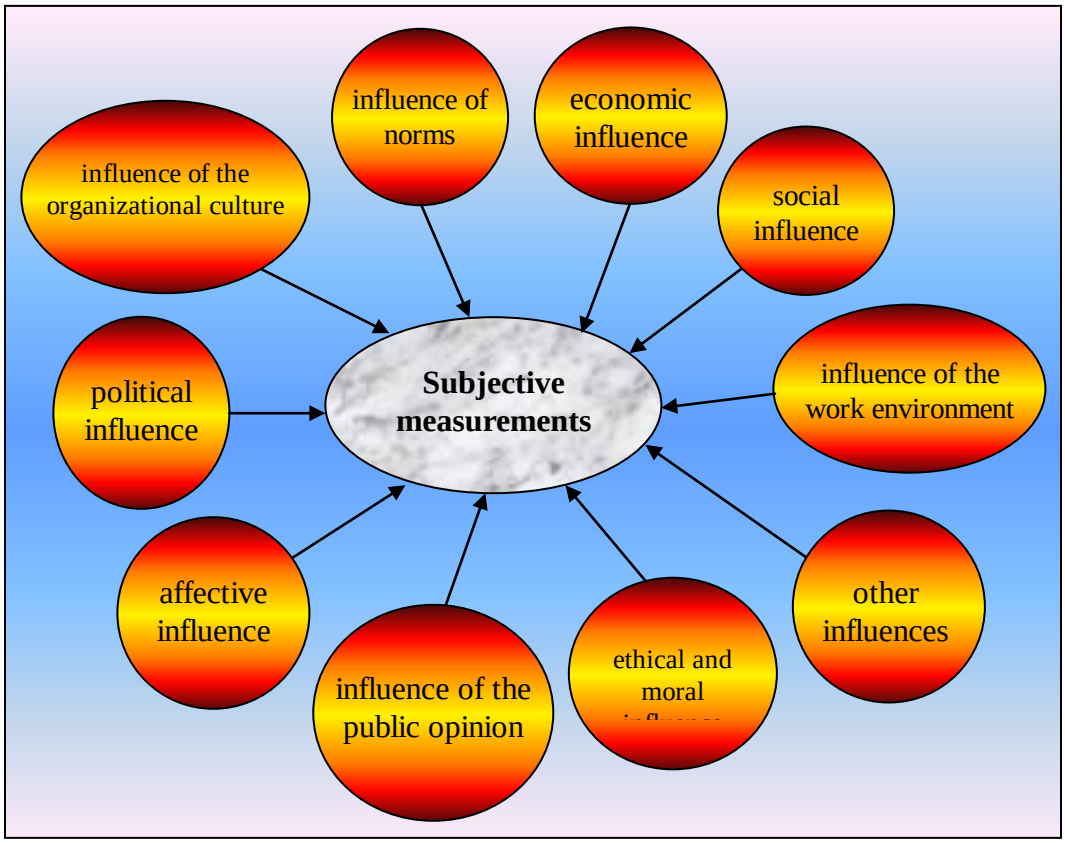

Figure 4 – Influencing factors that act on individuals during subjective measurements

Another possible source of systematic errors provided by environmental failures occurs with the limitations, restrictions, or manipulations of organizational resources available: material, human, financial, informational, time, and working conditions. They may be intentional, especially when it comes to manipulations, being related to the postulate 2 – personal goals, or provided by the organizational situation in which the company is in that period, allowing for failures in procedures that could affect the results. In this case, because it is an organizational failure, it is not related to any postulate of the subjective measurements.

5.2.4 Main sources of random errors in subjective measurements

The main sources of random errors are those that "produce" some of the systematic errors. If these sources could be managed in advance in order to minimize measurement errors, then systematic errors would be produced.

However, if measurements failures provided by these sources appear at the moment of measurement, on a temporary, unpredictable, and unavoidable basis, then the errors are random. The main sources of random errors for subjective measurements, previously described as systematic errors, are: level of demand, level of perception, level of influence, public opinion, affection, organizational culture, ethics and morality, a different (unintentional) behavior, (unintentional) selective perception, (unintentional) intrusive measurement, previous memories, and automated responses.

6. Conclusions

During the initial stage of the theoretical foundation, we observed almost no publications on some of the foundations of subjective measurements. Thus, it was necessary to focus on studies that allowed for the development of its main postulates. Such foundations were complemented with the literature review regarding the subjective measurements instruments used in the area of organizational management, and other related areas.
Based on newly developed postulates of subjective measurements and subjective measurement instruments mentioned in the previous paragraph, we carried out a study on the main types and sources of errors in subjective measurements, another item with few available publications.

With the assumptions and sources of errors outlined in this article, it was possible to formulate a theoretical framework that allowed us to better understand why subjective measurements are more subject to measurement errors in relation to objective measurements.

References

Bazerman, M. H. (2006). Judgment in managerial decision making. 6th ed. New York: Wiley.

Bazerman, M. H. (2007). Processo decisório para cursos de Administração, Economia e MBAs. Rio de Janeiro: Elsevier.

JCGM 200: 2008. (2008). International vocabulary of metrology – basic and general concepts and associated terms. Geneva: Working Group 2 of the Joint Committee for Guides in Metrology (JCGM/WG 2).

Bispo, C. A. F. (2006). Um novo modelo de pesquisa de clima organizacional. Revista Produção, Vol. 16, No. 2, pp. 258-273.

Bispo, C. A. F. and Cazarini, E. W. (2007). Paraconsistent Qualitative Evaluation: a Practical test. In: XIII ICIEOM - International Conference on Industrial Engineering and Operations Management, Foz do Iguaçu. *Proceedings in CD*. Rio de Janeiro: Associação Brasileira de Engenharia de Produção. CD, ENEGEP2007_TI620465_9244.pdf.

Bispo, C. A. F. and Cazarini, E. W. (2008). Uma proposta de gestão de erros em medições subjetivas utilizadas na gestão organizacional. In: XV SIMPEP – Simpósio de Engenharia de Produção, Bauru, Universidade Estadual Paulista, Faculdade de Engenharia de Bauru. Anais on-line. Available (for search): http://www.simpep.feb.unesp.br/anais_simpep.php?e=2. Accessed: 27th march, 2010.

Bunge, M. (1976). Tratado de filosofia básica. São Paulo: Edusp, Vol. 2: Semântica II – Interpretação e verdade, pp. 93- 141.

Bussab, W. O. and Morettin, P. A. (2002). Estatística básica. 5th ed. São Paulo: Saraiva.

Csányi, V. (1995). The biological bases of cognitive maps. In: Laszlo et al. (Eds.). The evolution of cognitive maps: new paradigms for the twenty-first century. Amsterdam: Gordon and Breach, Chapter 1, pp. 23-28.

Droguett, E. L. and Menezes, R. C. S. (2007). Análise da confiabilidade humana via redes bayesianas: uma aplicação à manutenção de linhas de transmissão. Revista Produção, Vol. 17, No. 1, pp. 162-185.

Ensslin L. and Montbeller, Neto G. and Noronha, S. M. (2001). Apoio à decisão: metodologias para estruturação de problemas e avaliação multicritério de alternativas. Florianópolis: Insular.

Feldt, L. S. (1980). A test of the hypothesis that Cronbach's alpha reliability coefficient is the same for two tests administered to the same sample. Psychometrika, Vol. 45, No. 1, pp. 99-105.

Gilmer, J. S. and Feldt, L. S. (1983). Reliability estimation for a test with parts of unknown lengths. Psychometrika, Vol. 48, No. 1, pp. 99-111.

Gilovich, T. and Griffin, D. and Kaneman, D. (2002). Heuristics and biases: the psychology of intuitive judgment. Cambridge: Cambridge University Press.

Godoy, A. S. (1995a). Introdução à pesquisa qualitativa e suas possibilidades. São Paulo, Revista de Administração de Empresas, Vol. 35, No. 2, pp. 57-63.

Godoy, A. S. (1995b). Pesquisa qualitativa: tipos fundamentais. São Paulo, Revista de Administração de Empresas, Vol. 35, No. 3, pp. 20-29.

Hammond, J. S. and Keeney, R. L. and Raiffa, H. (2004). Decisões inteligentes: como avaliar alternativas e tomar a melhor decisão. Rio de Janeiro: Campus.

Kahneman, D. (2003). A perspective on judgment and choice: mapping bounded rationality. American Psychologist, Vol. 58, No. 9, pp. 697–720.

Kuhn, T. S. (2006). A estrutura das revoluções científicas. 9th ed. São Paulo: Perspectiva.

Lacey, H. (1998). Valores e atividade científica. São Paulo: Discurso Editorial.

Laszlo, E. and Masulli, I. and Artigiani, R. and Csányi, V. (1995). The evolution of cognitive maps: new paradigms for the twenty-first century. Amsterdam: Gordon and Breachv.

Levine, D. M. and Berenson, M. L. and Stephan, D. (2000). Estatística: teoria e prática. Rio de Janeiro: LTC.

Minayo, M. C. S. (1994). Ciência, técnica e arte: o desafio da pesquisa social. In: Minayo MCS (org.). Pesquisa social: teoria, método e criatividade. Petrópolis – RJ: Vozes, Chapter 1, pp. 9-30.

Minayo, M. C. S. (2004). O desafio do conhecimento: pesquisa qualitativa em saúde. 8th ed. Sao Paulo: Hucitec.

Neves, J. L. (1996). Pesquisa qualitativa: características, usos e possibilidades. Cadernos de pesquisas em administração, Vol. 1, No. 3, pp. 103-113.

Patton, M. Q. (2002). Qualitative Evaluation and Research Methods. 3rd. ed. California/EUA: Sage Publication.

Pereira, J. C. R. (2004). *Análise de dados qualitativos: estratégias metodológicas para as ciências da saúde, humanas e sociais*. 3rd ed. São Paulo: Editora da Universidade de São Paulo – EDUSP.

Pidd, M. (1998). Modelagem empresarial: ferramentas para tomada de decisão. Porto Alegre: Bookman.

Richardson, R. J. (1999). Pesquisa Social: métodos e técnicas. 3rd ed. São Paulo: Atlas.

Salmon, P. (2001). Psychology of Medicine and Surgery: A Guide for Psychologists, Counsellors, Nurses and Doctors. Wiley Series in Clinical Psychology. Chichester – England: John Wiley & Sons.

Schmitz, E. B. and Alentar, A. J. and Villar, C. B. (2006). Modelos qualitativos de análise de risco para projetos de tecnologia da informação. Rio de Janeiro: Brasport.

Serapioni, M. (2000). Métodos qualitativos e quantitativos na pesquisa social em saúde: algumas estratégias para a integração. Ciência & Saúde Coletiva, Vol. 5, No. 1, pp. 187-192.

Swan, J. (1997). Using cognitive mapping in management research: decisions about technical innovation. British Journal of Management, Vol. 8, No. 2, pp. 183-198.

Triviños, A. N. S. (1994). Introdução à pesquisa em ciências sociais: a pesquisa qualitativa em educação. São Paulo: Atlas.

Tversky, A. and Kahneman, D. (1974). Judgment under uncertainty: heuristics and biases. *Science*, 185 (4157), 1124–1131.

Vuolo, J. H. (1996). Fundamentos da Teoria de Erros. 2nd ed. São Paulo, Edgard Blücher.

Woodruff, D. J. and Feldt, L. S. (1986). Tests for equality of several alpha coefficient when their sample estimates are independent. Psychometrika, Vol. 51, No. 3, pp. 393-413.