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MODELING THE EFFECTS OF EARLY CHILDHOOD INTERVENTION VARIABLES ON PARENT AND FAMILY WELL-BEING[1]

Carl J. DUNST[2]

Ph.D., Research Scientist, Orelena Hawks Puckett Institute, Asheville, NC, USA

E-mail: dunst@puckett.org

Deborah W. HAMBY[3]

M.P.H., Statistical Analyst, Orelena Hawks Puckett Institute, Morganton, NC, USA

E-mail: dhamby@puckett.org

Jeffri BROOKFIELD[4]

Ed.D., Associate Director for Research and Training,
Child and Family Development Center, University of Illinois at Chicago, Chicago, IL, USA

E-mail: jeffrib@uic.edu

Abstract: *Structural equation modeling was used to evaluate the effects of family, child, and both early childhood intervention process and structural variables on parent and family well-being in a sample of 250 parents involved in birth to age three early childhood intervention programs. Family SES and income had direct positive effects, family-centered early intervention practices had direct and indirect positive effects, perceived program control appraisals had direct and indirect positive effects, and early intervention program service intensity had direct negative effects on either or both self-efficacy beliefs and parent and family well-being. Findings are discussed in terms of the benefits and limitations of different features of early childhood intervention and the use of SEM for program evaluation.*

Key words: *Early childhood intervention; program evaluation; structural equation modeling; effects decomposition*

1. Introduction

Multivariate, system theory perspectives of early childhood intervention research and practice place major emphasis on how intervention and nonintervention factors influence child and family development and functioning, and how intervention variables account for variation in child and family outcomes beyond those associated with nonintervention factors (Dunst, Snyder, and Mankinen 1988; Dunst and Trivette 1997; Guralnick 1997; Marfo and Cook 1991; Marfo and Dinero 1991; Marfo et al. 1992). As part of ecological system theory, early childhood intervention is considered an environmental

factor that would be expected to show complex relationships with other environmental variables, and together with different person variables, have either favorable or unfavorable consequences on human behavior and functioning (Bronfenbrenner 1979).

Research and evaluation on the characteristics and effectiveness of early childhood intervention having positive consequences on child, parent, and family functioning continues to expand (e.g., Guralnick 1997; Meisels and Shonkoff 2000). Most evaluation studies, however, have in the past and continue to be conducted using univariate, main effects data analysis procedures, despite the fact that more powerful statistical analysis techniques are available for investigating complex relationships among variables, one of which is structural equation modeling (Bentler 1995; Joreskog and Sorbon 1993). Previous research has found structural equation modeling especially useful for program evaluation purposes (e.g., Hennessy and Greenberg 1999; Lipsey and Cordray 2000; Reynolds 1998; Rosenheck et al. 2001; Turnbull 1999).

Structural equation modeling (SEM) has been used in only a few studies investigating the effects of early childhood intervention and nonintervention variables on child and parent outcomes (e.g., Dunst 1999; Sorbon 1982; Thompson et al. 1997). Thompson et al. (1997) used SEM to investigate the influences of early intervention program characteristics, social support, and program family-centeredness on both parent stress and empowerment and found that social support and family-centeredness had both direct and indirect positive effects on both aspects of parent functioning. Similarly, Dunst (1999) found that early intervention program family-centeredness had direct and indirect positive effects on parents' appraisals of different kinds of parenting supports, but that program characteristics (number of child services & frequency of child contacts) had negative effects on the same outcome measures.

The study described in this paper used SEM to evaluate the effects of a number of person and environmental (early childhood intervention) variables on parent and family well-being. Well-being is generally recognized as an important family-level outcome of early childhood intervention (Bailey et al. 1998; Krauss and Jacobs 1990), and a mediator of the kinds of parenting interactional styles (Dunst and Trivette 1988; Shonkoff and Phillips 2000) known to be related to positive child outcomes (e.g., Landry et al. 2001; Mahoney et al. 1998; NICHD Early Child Care Research Network 1999). The study differed from other investigations of early childhood intervention by integrating five heretofore separate conceptual and theoretical approaches into a broader-based multivariate framework for evaluating the determinants of parent and family psychological health. The first is based on research investigating the influences of family socioeconomic status on health and mastery outcomes (Turner, Lloyd, and Roszell 1999). The second is based on research investigating the sources and consequences of perceived control appraisals (Bandura 1997; Skinner 1995). The third is based on evidence demonstrating the effects that the birth and rearing of a child with a disability has on family adaptation and stress (Roberts and Wallander 1992). The fourth is based on research investigating the effects of family-centered help giving practices on different aspects of perceived control appraisals and family functioning (Dunst and Trivette 1996; Dunst, Trivette, and Hamby 2006; Dunst, Trivette, and Hamby 2007). The fifth is based on the hypothesized relationship between early intervention program structural features (service intensity, duration, age of onset, etc.) and both child and family outcomes (e.g., Bryant and Maxwell 1997; Guralnick 1998).

2. A Multivariate Model of Early Childhood Intervention

The manner in which the different person and environmental variables were expected to be related to parent and family psychological functioning is shown in Figure 1. The model evaluated the influence of different person and environmental variables on perceived control and well-being, where the direct and indirect relationships among the variables shown in Figure 1 and described below were based on prior research. The study itself included the measurement of the independent and dependent (well-being) measures, respectively, on two occasions, six months apart to eliminate statistical problems associated with temporal codependencies and to improve confirmatory inferences about direction of effects (Kenny 1979).
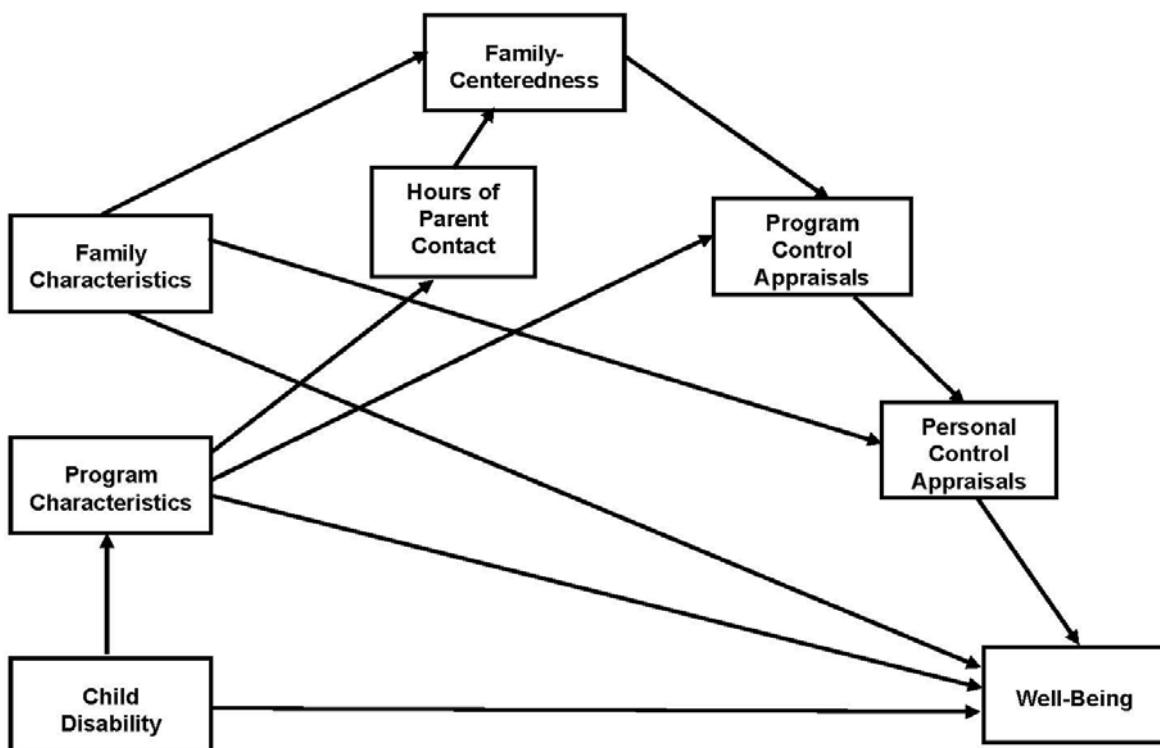
Figure 1. Hypothesized relationships among five sets of program and person variables and their direct and indirect influences on psychological well-being.

Socioeconomic Status

Socioeconomic status (SES) is a composite index typically ascertained by income, educational attainment, and occupational prestige (Dutton and Levine 1989; Entwisle and Astone 1994). Research indicates that the presence of more favorable socioeconomic factors is consistently related to a heightened sense of personal control (Turner, Lloyd, and Roszell 1999; Ziff, Conrad, and Lachman 1995) and better health status (Adler et al. 1994; Diener 2000; Diener and Oishi 2000; Ross and Van Willigen 1997), including psychological health (Bobak et al. 1998; Turner, Lloyd, and Roszell 1999). The influence of SES on health status

has been found to be both direct and indirect, mediated in part by personal control and mastery (Turner, Lloyd, and Roszell 1999).

Findings from studies of families of young children with or at risk for delays shows that SES is related to parent and family functioning in a manner identical to that found in other investigations (Dunst, Trivette, and Cross 1986), and that SES is related to personal control appraisals over general life events (Thompson et al. 1997) but is generally not associated with control appraisals that pertain to desired resources and supports from an early childhood intervention program or practitioner (Trivette et al. 1995; Trivette, Dunst, and Hamby 1996, 1996). Accordingly, we hypothesized that SES would be directly related to parent and family well-being, directly related to personal control (general life event) but not to early childhood intervention program control appraisals, and indirectly related to well-being through personal control appraisals.

Studies of the relationship between SES and parent judgments of the extent to which early childhood intervention program practices are family-centered indicate that families with higher SES backgrounds tend to assess program practices as less family-centered compared to families from lower SES backgrounds (Dunst, Brookfield, and Epstein 1998; King et al. 1999). A secondary hypothesis was that SES would be negatively related to parents' judgments about program family-centeredness.

Perceived Control

Research has shown that personal control belief systems are multidimensional (Bandura 1997; Skinner 1996), and that control appraisals over specific life events or domains of functioning contribute to a general sense of self-efficacy (Skinner 1995). Perceived control has been found to be an important component of self-efficacy (Bandura 1997), a positive contributor to better health status (Bandura 1997; DeVellis and DeVellis 2001; Taylor et al. 2000), including psychological well-being (Grob 2000), and a buffer against the deleterious effects of negative life events (Turner, Lloyd, and Roszell 1999). We hypothesized that perceived control would be directly related to parent and family well-being, and that the strength of the relationship would be greater for general life events compared to control appraisals over the provision of early childhood intervention program resources and supports (Dunst, Trivette, and Hamby 2006).

Child Disability

Unexpected and threatening life events are typically associated with negative reactions (e.g., Figley and McCubbin 1983). The birth and rearing of a child with a disability is a life event that is generally associated with higher levels of parent and family psychological distress (Crnic, Friedrich, and Greenberg 1983), where the degree of negative reaction is strongest in situations where a child's disability and associated behavior problems or difficulties necessitate considerable adaptation or adjustment (e.g., Patterson and McCubbin 1983). Research demonstrating that children with multiple and complex disabilities are sources of more family stress (Blacher 1984; Dunst, Trivette, and Cross 1986; Holroyd 1987; Wallander et al. 1989) was the basis of the hypothesis that the more pronounced and complex a child's disability, the more negative the relationship with parent and family well-being.

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Family-Centeredness

Family-centered practices involve family decision-making and action that honors and respects family choices, preferences, and desires (Dunst 1997; Roberts, Rule, and Innocenti 1998). The extent to which early childhood intervention program philosophy and practices are family-centered (Dunst 1997) has consistently been found to be associated with a heightened sense of self-efficacy regarding the ability to procure desired resources from an early childhood intervention program (Thompson et al. 1997; Trivette, Dunst, and Hamby 1996; Dunst, Trivette, and Hamby 2006). Furthermore, control appraisals pertaining to needed resources and supports from an early intervention program (program control appraisals) have been found to be related to a greater sense of control over general life events (Thompson et al. 1997). A greater sense of personal control, in turn, has been found to be associated with more positive psychological well-being and functioning (Dunst et al. 1988; Dunst et al. 1993). We hypothesized that family-centeredness would be directly related to early childhood intervention program control appraisals, and would be indirectly related to well-being mediated by personal control appraisals.

Research on the factors associated with variations in family-centered practices indicates that more frequent contact by early intervention program practitioners with parents is positively related (Dunst 1999; Trivette et al. 1995), and more services provided to a child is negatively related (Dunst, Brookfield, and Epstein 1998), to parents' appraisals of family-centeredness. Accordingly, we hypothesized that the amount of contact between practitioners and parents would be positively related to judgments about family-centered practices but negatively related to the provision of more child-related services.

Program Variables

The way in which social action programs are organized, and the manner in which interventions are provided (what, where, how much, etc.), matters in terms of observed outcomes (Crane 1998; Guralnick 1997; Schorr 1997). Early intervention program variables and features, including, but not limited to, service intensity, length of program involvement, and service delivery location, have been implicated as important factors having positive effects on family functioning and adaptation (see e.g., Krauss 1997). Results from studies examining intensity (cf., Innocenti and White 1993; Wolery 2000), length of program involvement (cf., Bryant and Graham 1993; Innocenti and White 1993), and service delivery location (cf., Harbin, McWilliam, and Gallagher 2000; White and Casto 1985) have produced mixed findings, with some studies yielding positive effects and other studies producing negative effects. For example, Havemen, van Berkum, Reijnders, and Heller (1997) reported positive effects of "more is better," whereas Dunst (1999) and Weller (1991) reported negative effects of greater numbers of services on parent and family functioning.

The following hypothesized set of relationships was posited between length of program involvement, service delivery location, and service intensity (number and frequency of child services). As the length of time a child was involved in early intervention increased, it would become more likely that services would be provided outside a child's home (Kochanek and Buka 1998; Dunst 2002) and that the intensity of child services provided by professionals would increase (Dunst 1999). Provision of early intervention outside a child's home was expected to be related to a greater number of child services and more frequent professional contact with a child (Dunst 1999; Kochanek and Buka 1998). In turn, as the number of child services increased, professional contact with a child would become more frequent (Dunst 1999; Dunst, Brookfield, and Epstein 1998). Additionally, we hypothesized that the more profound or complex a child's disability, the longer the child would be involved in early intervention, and the more child services he or she would receive (Shonkoff et al. 1992).

Both primary (Dunst 1999; Shonkoff et al. 1992; Taylor, White, and Kusmierek 1993) and corroborating (Dunst, Trivette, and Jodry 1997) evidence was the basis for the hypothesis that the more intense early childhood intervention (i.e., the greater the number of professionals working with a child, and the more frequently they provided services), the more negative would be the influences on parent and family functioning. The expectation that more services provided more frequently by more professionals would have negative effects on parent and family functioning can be explained in terms of a "pile-up" effect of stressors (McCubbin, Cauble, and Patterson 1982). The birth and rearing of a child with a disability brings the child and his/her parents into frequent contact with many different helping professionals (e.g., Berry and Hardman 1998; Marshak, Seligman, and Prezant 1999), the consequences of which are not always positive (e.g., Dunst and Trivette 1988; Newson and Schultz 1998; Affleck et al. 1989). Evidence from a number of sources indicate that well meaning (but often conflicting) advice from different helpgivers can sometimes be confusing and increase caregiver burden and stress (Haveman et al. 1997).

The approach to combining theory building and SEM for evaluating intervention and nonintervention factors influencing parent and family-well-being was considered an especially appropriate strategy for testing the multivariate model of early childhood intervention. According to Hennessy and Greenberg (1999), "An explicit program theory highlights the distinctions between the role of background or exogenous variables versus those that reflect program processes and produce the program's effects. The identical distinction among background, mediators, and outcome variables is the central [feature] of SES because it is used to model sequential systems of variables and to estimate the relationships between them" (p. 472).

3. Method

Participants

The participants were 250 parents and caregivers and their children who were involved in 59 early childhood intervention programs in a northeastern State. They were first surveyed when their children were receiving early childhood intervention, and subsequently completed a number of self-report scales 6 months later (hereafter referred to as Follow-Up). The sample included those children and their parents who had "graduated" from early childhood intervention at the time the follow-up measures were administered and constituted a subsample of more than 1200 early intervention program participants in a larger study.

Table 1 shows the characteristics of the participants and their families and children at entry into the study. The largest majority (94%) of the participants were the biological mothers of the children involved in the early intervention programs. Nearly all the participants (89%) had at least a high school education. Three-quarters of the participants were married or living with a partner, and half (54%) were employed outside the home either part- or full-time. The socioeconomic backgrounds of the families were quite varied, with at least 16% of the sample constituting each of five different socioeconomic classes (Hollingshead 1975). Approximately 25% of the families' incomes placed them below the poverty level.

The children, on average, were 26 months of age (SD = 8.63) at the time data collection first occurred, and had been involved in early intervention an average of 13 months (SD = 9.37). The children's diagnoses were quite varied, with approximately half of the group having identifiable disabilities or etiologies for their developmental delays or conditions.

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Table 1. Characteristics of the Participants, Families, and Children in the Study

Participants	N	%	Family/ Child	N	%
Relationship to Child			Family Socioeconomic Status		
Biological Parent	232	94			
Foster Parent	11	4	Low	40	16
Grandparent	2	1	Low-Middle	42	17
Other	2	1	Middle	67	27
			Middle-Upper	58	23
Gender			Upper	43	17
Female	233	95			
Male	13	5	Family Income (Yearly)		
Age (Years)			<$3,000 - $5,000	16	6
18-29	86	34	$5,000 - $10,000	33	13
30-39	129	52	$10,000 - $20,000	72	29
40-49	27	11	$20,000 - $30,000	60	24
50+	8	3	$30,000 - $40,000	28	11
			$40,000 - $50,000	12	5
Education			$50,000+	29	12
Less than High School	27	11			
High School Graduate	95	38	Child Age (Months)		
Some College	53	21			
College Graduate	75	30	0-12	28	11
			12-24	58	24
Marital Status			24-36	14	60
Married/Living with Partner	189	76	36+	11	5
Single	37	15			
Divorced	17	7	Child Diagnosis		
Widowed	4	2			
			At Risk	68	27
Employment Status			Physical Disability	46	19
Employed	135	54	General Delay	41	16
Not Employed	115	46	Mental Retardation	36	14
			Language Delay	14	6
			Multiple Disability	13	5
			Behavioral Disability	9	4
			Sensory Impairment	7	3
			Other	16	6

Procedure

Survey. The survey completed at the beginning of the study asked for background information about the respondent (age, education, marital status, etc.), his/her spouse or partner and family (occupation, income, etc.), and the child receiving early intervention (age, reason for participation in early intervention, disability or kind of delay, etc.). Additionally, the survey asked the respondent for information about the types of services his or her child was receiving, where the services were being provided, and how often the respondent and his/her child received family-level and child-level services, respectively. The respondents were also asked to rate the extent to which: (a) the early intervention program had adopted a family-centered philosophy, employed family-focused and family-centered program practices, and program practitioners used family-centered helpgiving practices and (b) he/she had control over the kind of help and services provided by the early childhood intervention program.

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Follow-up. The participants completed personal control appraisal (Boyd and Dunst 1996), psychological well-being (Radloff 1977), and family well-being (McCubbin and Comeau 1987) scales at follow-up. The control appraisal scale included items that asked respondents to indicate the extent to which they had control over a number of aspects of early childhood intervention program practices and other life events and experiences. Respondents assessed both their personal well-being and family psychological health by indicating the extent to which different behavior states were experienced by the respondent and his or her and family.

Measures

Family socioeconomic status. Socioeconomic status (SES) was determined from yearly family income, years of formal education, and the occupation of the respondent (if employed outside the home) and/or his or her spouse or partner using the Hollingshead (1975) scoring system. Family income was scored on a 10-point scale ranging from less than $US3,000 per year (1) to more than $US50,000 per year (10).

Child severity of disability. Orthogonal contrast coding (Cohen and Cohen 1983) was used to place the children on an ordered continuum from at-risk (-3) to multiply disabled (3). The ordering of children according to diagnostic group was: at-risk, language delay, general developmental delay, identified disability (sensory impaired, physical disability, mental retardation, or behavioral disability), and multiple disabilities.

Length of program involvement. The child's age in months at the time the survey was completed minus the child's age in months at entry into the early intervention program was used as the measure of length of program involvement.

Intensity of child services. Intensity of child services was determined by the combination of number of child services and the frequency of provision of the services. Number of child services received was the sum of eight different types of child services being provided at the time the survey was completed. The kinds of services included physical therapy, occupational therapy, speech/language therapy, audiology, special instruction/special education, developmental services, nutrition, and nursing/medical services. Child contact was rated on a 5-point scale varying from one time or less a month (1) to 5 days or times per week (5). Intensity was calculated as the product of the number and frequency of child services.

Frequency of parent contact. Respondents rated the hours of parent (respondent) contact with the early intervention program staff on a 6-point scale ranging from less than one hour per month (1) to 5 or more hours per month (6).

Service delivery location. Orthogonal contrast coding (Cohen and Cohen 1983) was used to ascertain the extent to which child services were provided mostly or entirely in the respondent's homes (home-based) or were provided outside the home (e.g., center-based or preschool program). Initial inspection of the service delivery location data indicated that where services were provided varied as a function of the types of services provided. We therefore computed three service delivery measures, one for physical and occupational therapy, one for speech/language therapy and audiology, and one for special education and special instruction. For each service combination, a score of –2 was assigned if the child received both services outside the child's home, a score of –1 was assigned if the child received only one of the services and it was provided outside his/her home, a score of +1 was assigned if both services were provided and one was provided in the child's home, and a score of +2 was assigned if either or both services were provided in the child's home and no services were provided outside the home.

Family-centeredness. The extent to which respondents indicated that the early intervention program adopted and adhered to 12 guiding family support principles ($\propto = .89$)

was used as the measure of family-centered program philosophy (Dunst et al. 1991). The principles included value statements about strengths-based practices, parent/professional partnerships, family empowerment, promotion of parent competence, healthy family functioning, etc. Each value statement was rated on a 5-point scale ranging from not at all true (1) to almost always true (5) that the program adhered to the principles.

Family-centered program practices ($\propto$ = .92) were ascertained using the 10 family-focused and 10 family-centered practices items on the *Family-Oriented Program Practices Scale* (Dunst and Trivette 1995). The practices rated by the respondents included parent participation and decisions involving Individualized Family Service Plans; practitioner flexibility and responsiveness to family concerns and priorities; family choice involving the sources, location, and focus of early interventions; etc. Respondents indicated on a 7-point scale the extent to which they strongly disagreed (1) to strongly agreed (7) that the program used each practice.

Family-centered helpgiving ($\propto$ = .85) was assessed using five items on the *Helpgiving Practices Scale* (Dunst, Trivette, and Hamby 1996). The helpgiving practices rated by the respondents included practitioner active and reflective listening, empathy, and responsiveness to parent requests. The extent to which each practice was experienced by a respondent was ascertained using 5-point rating scales with markers that varied depending upon the item being rated.

Program and personal control appraisals. The survey included a single program control appraisal item that asked a respondent to indicate on a 10-point scale the extent to which he/she had control over the help and services received from the early intervention program staff (Affleck, Tennen, and Rowe 1991). The measure was constructed so that it captured the respondents' perceived self-efficacy in terms of his/her ability to procure desired resources and help from the early childhood intervention program.

The measure completed by the respondents at follow-up was the *Personal Assessment of Control Scale* (Boyd and Dunst 1996). This scale includes five statements about respondent control over different aspects of early childhood intervention program services and practices ($\propto$ = .81), and four statements about personal control involving general life events ($\propto$ = .73). Respondents rated the extent to which each control appraisal statement was true on a 5-point scale varying from rarely true (1) to almost always true (5).

Parent and family well-being. The respondents completed at follow-up both the *Center for Epidemiologic Studies Depression Scale* (CES-D, Radloff 1977) and the Health and Mastery subscale of the *Family Inventory of Resources and Management* (FIRM, McCubbin and Comeau 1987). The CES-D includes 20 statements about different psychological states ($\propto$ = .94), with each rated on a 4-point scale ranging from experienced less than 1 day per week (1) to experienced 5-7 days per week (4) for the most recent seven-day period of time. The FIRM Health and Mastery subscale includes 20 statements about family well-being and competence ($\propto$ = .94), which were rated in terms of how well the respondents' families were functioning on a 4-point scale ranging from not at all well (1) to very well (4). The CES-D and FIRM were both scored so that higher scores indicated better functioning.

Data Analysis

EQS (Bentler 1995) was used for the SEM. The model that was evaluated assessed the effects of family characteristics, child disability, family-centeredness, and the early intervention program variables on both perceived control appraisals and parent and family well-being, where the explicit hypothesized relationships among variables between sets were based on theory and corroborating research evidence described in the introduction.

The extent to which the model fit the data was ascertained by a series of structural equations simultaneously analyzed by EQS, with the variance of one measure of each of

three latent variables (family characteristics, family centeredness, and program location) initially fixed to 1.0. Three sets of statistics were the focus of substantive interpretation in each analysis: (1) the fit indices of the models (Hu and Bentler 1995), (2) the standardized parameter estimates (Hoyle 1995), and (3) the percentage of variance accounted for by the independent variables in each regression model included in the analysis (Bentler 1995).

The three fit indices produced by EQS (Bentler-Bonett Normal Fit Index [NFI], Bentler-Bonett Nonnormal Fit Index [NNFI], & Comparative Fit Index [CFI]) were used to determine how well model specification was achieved. According to Bentler (1990), CFI is the index of choice as the measure of model fit, and therefore was used as the primary index for assessing whether an adequate fit was achieved. (The χ^2 goodness-of-fit test was not considered because of its susceptibility to influence by small and large sample sizes and other statistical problems; Hu and Bentler 1995.) The magnitude and direction of the standardized parameter estimates were used to discern the nature of the relationships between variables in the models. "Standardized parameter estimates correspond to effect size estimates" (Hoyle 1995, p. 9). Percentage of variance accounted for in the mediated (perceived control appraisals) and dependent (well-being) variables by the independent variables for each equation in the structural model was used to ascertain the strength of the relationships among different sets of predictor measures and both perceived control and well-being.

The indirect effects of the four primary predictor variables (family characteristics, program characteristics, family-centeredness, and child disability) on personal control and parent and family well-being were discerned by effects decomposition (Kline 2005). The direct, indirect, and total effects of the predictor variables mediated by perceived control appraisals were computed to isolate the sources and paths of influence on parent and family well-being.

Post hoc model respecifications were tested to confirm or disconfirm other possible linkages among measures. Both the direct and indirect effects of new paths on personal control and parent and family well being were discerned by effects decomposition.

4. Results

Confirmatory Model Fit

Figure 2 shows the results of the confirmatory analysis. Two of the three fit indices were .92 or greater, indicating an acceptable fit of the model to the data. The comparative fit index (CFI) was .94, providing the best evidence that the model was supported by the relationships among the latent and measured variables. The standardized parameter estimates shown in Figure 2 show both the magnitude and direction of relationships among variables.

Family-centeredness. Both family characteristics and hours of parent contact were both related to family-centeredness in an expectant manner, $R^2 = .12$, $p < .01$. Families from higher SES backgrounds and those with larger incomes tended to assess practitioner and program practices as less family-centered ($\beta = -.12$, $p < .05$), whereas the more frequently practitioners had contact with the parents, the more likely the respondents indicated that the practitioners and their programs used family-centered practices ($\beta = .31$, $p < .001$). Child service intensity was unrelated to the family-centered practices measures.

Service intensity. The early childhood intervention program variables were related to one another as expected. The longer a child received early intervention, the more likely he or she received the services outside the home ($\beta = -.25$, $p < .001$) and the greater the intensity of service provision ($\beta = .46$, $p < .001$). Additionally, the more severe or complex a child's disability, the longer a child was involved in early intervention and the more intense

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the services the child received (β = .12, *p* < .05). The three variables together were strongly related to service intensity, R^2 = .37, *p* < .001.
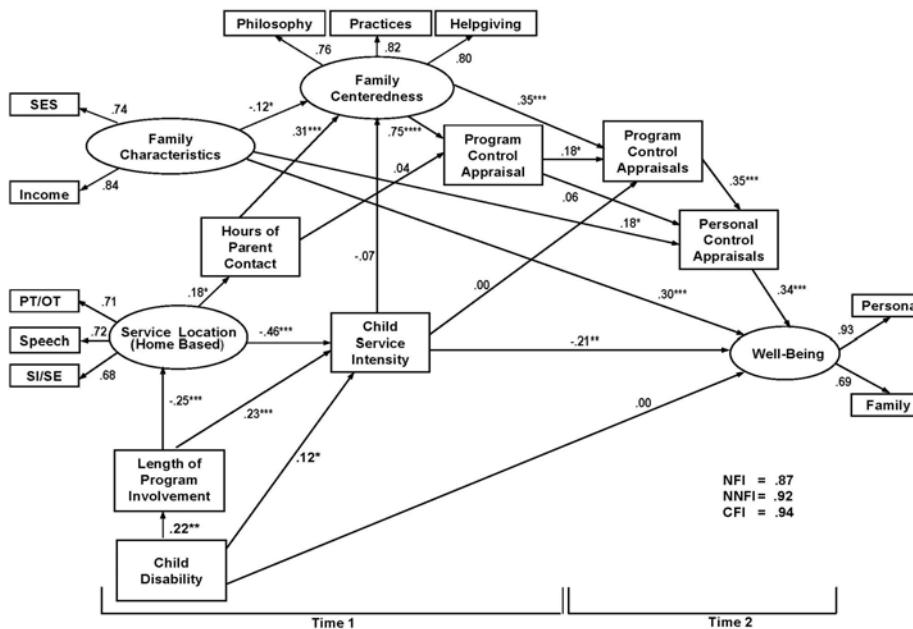
Figure 2. Relations between child and family variables, family-centeredness, early intervention program variables, and both control appraisals and personal and family well-being.
Notes: (NFI = Normed fit index, NNFI = Nonnormed fit index, and CFI = Comparative fit index. PT = Physical Therapy, OT = Occupational Therapy, Speech = Speech and language therapy and audiology, SI = Special instruction, and SE = Special education).
*p < .05, **p < .01, ***p < .001, ****p < .0001.

Perceived control. Family-centeredness was related to the program control appraisal at Time 1, R^2 = .59, *p* < .0001, and both the family-centeredness and Time 1 program control appraisal measures were related to Time 2 program control appraisals, R^2 = .26, *p* < .001. The strength of the relationship between the family-centered measure and Time 2 program control appraisals (β = .35, *p* < .001) was twice as strong as that between Time 1 and Time 2 program control appraisals (β = .18, *p* < .05).

Family characteristics were directly related to personal control appraisals (β = .18, *p* < .05). The structural equation predicting personal control appraisals at Time 2 produced an R^2 = .16, *p* < .001, with Time 2 program control appraisals (β = .34, *p* < .001) and family characteristics (β = .18, *p* < .05) both contributing to the amount of variance accounted for in the dependent measure. The three predictor measures taken together were significantly related to personal control, R^2 = .16, *p* < .001.

Well-being. Family characteristics (β = .30, *p* < .001) and personal control (β = .34, *p* < .001) were both related to parent and family well-being as expected. In both cases, the presence of more favorable personal and family characteristics was associated with more positive parent and family well-being.

The relationship between the early intervention program variables and well-being was as expected. The intensity of child services was negatively related to parent and family well-being where intensity was influenced by length of program involvement and service

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delivery setting. Contrary to expectation, child disability had no direct effect on personal and family well-being.

The structural equation predicting parent and family well-being from the family, service intensity, child disability, and personal control measures yielded an $R^2 = .29$, $p < .0001$, with Time 2 personal control appraisals ($\beta = .34$, $p < .001$), and family characteristics ($\beta = .30$, $p < .001$) showing positive relationships with the dependent measure, and the intensity of child services ($\beta = -.21$, $p < .01$) showing a negative relationship with the well-being measure.

Effects Decomposition

Table 2 shows the findings from the seven sets of effects decomposition analyses. The pattern of results makes clear the importance of family characteristics, family-centeredness, and program control appraisals as determinant of both self-efficacy beliefs (personal control appraisals) and parent and family well-being.

Table 2. Standardized Direct, Indirect, and Total Effects of the Person and Intervention Variables on Perceived Control and Parent and Family Well-Being

Measures		Effects Decomposition		
Predictor	Criterion	Direct	Indirect	Total
Child Disability	Program Control (T1)	-	-.01	-.01
	Program Control (T2)	-	-.01	-.01
	Personal Control	-	.00	.00
	Well-Being	.00	-.04	-.04
Service Intensity	Program Control (T1)	-	-.05	-.05
	Program Control (T2)	.00	-.03	-.03
	Personal Control	-	-.02	-.02
	Well-Being	-.21**	-.02	-.23**
Family Characteristics	Program Control (T1)	-	-.09	-.09
	Program Control (T2)	-	-.06	-.06
	Personal Control	.18*	-.03	.15*
	Well-Being	.30**	.05	.35***
Family-Centeredness	Program Control (T1)	.75****	-	.75****
	Program Control (T2)	.35***	.14*	.49***
	Personal Control	-	.21**	.21**
	Well-Being	-	.07	.07
Program Control (T1)	Program Control (T2)	.18*	-	.18*
	Personal Control	.06	.06	.12*
	Well-Being	-	.04	.04
Program Control (T2)	Personal Control	.35***	-	.35***
	Well-Being	-	.12*	.12*
Personal Control	Well-Being	.34***	-	.34***

Note: T1 = Time 1 and T2 = Time 2.
*p < .05. **p < .01. ***p < .001. ****p < .0001.

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Child disability had neither direct nor indirect effects on any criterion measure. Service intensity had almost entirely direct negative effects on parent and family well-being.

The influence of family SES and income on both personal control and parent and family well-being was almost entirely direct. In contrast, the influence of family-centeredness on program control was both direct and indirect, and the influence of family-centeredness on personal control appraisals was indirect mediated by program control appraisals.

The influence of program control appraisals on self-efficacy beliefs (personal control appraisals) was both direct and indirect, and the influence of program control and personal control appraisals on parent and family well-being had a combination of direct and indirect effects.

Family-centeredness and program control appraisals were the only two predictor variables that had indirect effects on the criterion measures. In both analyses, the indirect effects of family-centered practices on parent and family well-being were mediated by program control appraisals.

Model Respecifications

Model respecifications were done by adding different paths to the model and rerunning the EQS analyses. This included paths between service location, length of program involved, and child disability and family-centeredness, and paths between service location and length of program involvement and program and personal control appraisals. None of the analyses changed the fit indices or structural coefficients for the already included or new paths. For example, it was reasonable to postulate that the birth and rearing of a child with a disability would have negative effects on perceived control, based on evidence that parenting efficacy appraisals are often taxed by such life circumstances (see especially, Bandura 1997, pp. 190-196). Post hoc model respecifications were made, and new models tested with paths linking child disability to both program control measures (Model II), personal control appraisals (Model III), and all three control measures simultaneously (Model IV). None of the fit indices changed in any analysis, and none of the added structural coefficients were statistically different from zero. Thus, the plausibility of an explanatory relationship between child disability and parent perceived control appraisals is not warranted *in the context of the model we tested*.

5. Discussion

Five conceptual and theoretical frameworks were used to build and evaluate a multivariate model of early childhood intervention. The SEM analyses produced findings that were consistent with the conceptual framework used to guide model specification. Both family socioeconomic factors and the family-centeredness of early intervention program philosophy and practices were directly related to perceived control appraisals in the manner expected, and the predicted direct and indirect influences of family-centeredness on well-being were for the most part substantiated by the results. The manner in which the early intervention program variables were interrelated was as predicted and showed negative influences on well-being. The influences that severity of child disability had on both the

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length of program involvement and the number of services provided to a child by professionals was also as expected. Results add to the knowledge base regarding the relationships among intervention, nonintervention, and person variables (Bronfenbrenner 1992; Marfo and Dinero 1991; Marfo et al. 1992; Guralnick 1993), and how these various factors both individually and in combination contribute to variations in perceived control and personal and family well-being (Dunst 1999; King et al. 1999; Thompson et al. 1997).

Previous research has demonstrated that frequent contact by professionals with parents is related to variations in parents' judgments about family-centeredness (Dunst 1999), and that the family-centeredness of program practices and practitioner helpgiving is related to a heightened sense of control over early intervention program supports and resources (Judge 1997; Trivette, Dunst, and Hamby 1996, 1996). The present study helps explain the mechanisms through which these relationships operate to produce observed effects. The path linking hours of contact between parents and professionals to parents' program control appraisals produced results indicating that it is not contact per se that influenced perceived control, but rather *how* practitioners interacted with parents that accounts for a greater sense of control (Dunst 1997; Dunst and Trivette 1996). This was discernable by the nonsignificant structural coefficient between hours of contact and program control appraisals ($\beta = .04$), and the significant structural coefficients between hours of contact and family-centeredness ($\beta = .31$), and between family-centeredness and perceived control ($\beta = .75$).

The manner in which early intervention program variables were related to well-being is made clear by closely examining and analyzing the nature of the relationships among measures. Consider, for example, the result showing that the intensity of services provided to a child attenuated parents' judgments of parent and family well-being. This finding was expected based on theory and research about pile-up effects (McCubbin, Cauble, and Patterson 1982), where we predicted that the more frequently more professionals worked with a child, the more stressful it would be to the parents. Corroborating evidence indicating that heightened stress attenuates judgments about family-centered practices (King et al. 1999), and evidence showing that fewer rather than more professionals interacting with parents is related to positive parent and family functioning (Shonkoff et al. 1992), supports this interpretation.

The fact that severity of child disability was not directly related to parent and family well-being deserves comment inasmuch as our findings run counter to results reported by others (e.g., Holroyd 1987; Shonkoff et al. 1992). In the present study, children having different diagnoses or disabilities were ordered along a continuum from at-risk to multiply disabled, and orthogonal contrast coding (Cohen and Cohen 1983) was used to code severity of delay or disability. The extent to which this coding scheme may have masked differences between groups was assessed by running two one-way ANOVAs with child diagnosis as a grouping variable and the two well-being measures as dependent variables. This is the way most investigators have typically evaluated the influence of type of disability or severity of delay on parent and family functioning (e.g., Dunst, Trivette, and Cross 1988; Holroyd 1987). Neither of the ANOVAs produced significant results.

The value of SEM as an analytic tool for program evaluation purposes is offset by several interrelated, cautionary notes (see e.g., Mulaik and James 1995). One is the fact that confirmatory or causal inferences must be made carefully, and only after adequately ruling

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out alternative explanations so that substantive meaning can be attributed to observed relationships between variables. The example above with regard to the differences between contact per se and the family-centeredness of the contacts, and their relationship to perceived control over early intervention program supports and resources, represents one way in which this kind of interpretive process proceeds, and adds to our understanding of the relationships between intervention and nonintervention variables and child and family outcomes.

A second, related issue has to do with the fact that we constructed and tested a single model, and that there are many other models that could be specified to account for the relations among variables. However, our SEM evaluation was strictly confirmatory based on prior research and theory that formed the foundation of model specification (Hennessy and Greenberg 1999). According to MacCallum (1995), "In the strictly confirmatory [SEM] strategy, the researcher constructs one model of interest and evaluates that model by fitting it to appropriate data. If the model yields interpretable parameter estimates and fits the data well, it is supported and considered a *plausible model*" (p. 31, emphasis added). The multivariate model that constituted the focus of this program evaluation study is not only plausible, but more importantly, contributes to our understanding of the interrelationships among variables of practical significance that inform "recipes for action" (Cook and Campbell 1979, p. 31). Moreover, the approach to model building and the use of SEM for evaluating the model serves as both theoretical and analytic tools for applied purposes (Hennessy and Greenberg 1999; Hopwood 2007).

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[2] Carl J. Dunst, Research Scientist, Orelena Hawks Puckett Institute, 18A Regent Park Blvd., Asheville, NC 28806, received his doctorate degree in Developmental Psychology from George Peabody College, Vanderbilt University, Nashville, TN. He has published more than 100 journal articles and more than 10 books and monographs, many of which have focused on program evaluation. His research interests include the study of the ecology of early childhood learning and development.

[3] Deborah W. Hamby, Research Analyst, Orelena Hawks Puckett Institute, Morganton, NC 28865, received her masters degree in Biostatistics from the University of North Carolina, Chapel Hill, NC. She has coauthored more than 20 journal articles and monographs on program evaluation, research methodology, and statistical analysis procedures. Her research interests include the use of multivariate data analysis procedures for program evaluation.

[4] Jeffri Brookfield, Associate Director for Research and Training, Child and Family Development Center, University of Illinois at Chicago, 1640 W. Roosevelt Blvd., Chicago, IL 60608, received her doctorate degree in Early Childhood Special Education from the University of Kentucky, Lexington, KY. She has focused her research and practice on the evaluation of early childhood intervention programs and the adult learning strategies for promoting adoption and use of evidence-based early childhood intervention practices. She is currently Principal Investigator of the *Increasing the Use of Family-Centered Practices in Early Intervention Through Participatory Program Evaluation, Training and Technical Assistance Project*.

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WEB SITE PROJECTS EVALUATION – A CASE STUDY OF ROMANIAN FACULTIES OF ECONOMICS WEB SITES

Sidonia Otilia VULTUR

PhD Candidate, University Assistant, Department of Computer Science
Bogdan Voda University, Cluj Napoca, Romania
Main published books: Baze de date şi programare, (co-author) Risoprint, Cluj Napoca,
2007, Elemente de programare în Visual FoxPro, (co-author) Risoprint, Cluj Napoca, 2006
E-mail: sidonia.vultur@ubv.ro

Delia Adriana MARINCAS[1]

PhD Candidate, Information Management in Economics Department,
Babes-Bolyai University, Cluj Napoca, Romania

E-mail: marincasdelia@gmail.com

Abstract: *In this paper, an evaluation of web sites regarded like projects is discussed. We give an overview of the Web Assessment Index (WAI), by presenting a web sites of Romanian Faculties of Economics case study. The WAI contains five categories: accessibility, access speed, navigability, content and reliability. We analyzed and presented a detailed report of the results coming out from this study. This study is important to understand the issues on which the faculties web sites are confronting.*

Key words: *web site; project; evaluation; Web Assessment Index (WAI)*

1. Introduction

Projects are temporary endeavors undertaken to create unique products or services. A project has settled start date, end date, milestones, scope and objectives; produces unique results and is characterized by a certain approach and a progressive elaboration

Nowadays, educational Web sites are considered as projects developed by Universities or other entities for their presentation, recruiting students and supplying different educational services. This is the reason why we have decided to evaluate the academic web sites of the most important Romanian Universities. For this assessment we need a flexible, engineering-based methodology that allows us to measure the degree of goal achievement of educational projects through the academic web sites.

In order to evaluate this kind of projects it is necessary to analyze them from different aspects, such as: the way they are managed, the costs/benefits report, the upgrade possibility, the potential risks, but most of all, in our opinion, we should pay a special attention to the quality feature.

Along with the web technology development, the education institutes have chosen for their presence on the Internet, by means of web sites. These ones are developed to offer general information about the universities, to support the education process or to carry on the distance education process over the Internet, exclusively.

Information technology has been successfully combined with the learning process, resulting the e-learning technology, which provides new learning opportunities with less restriction on time and space. Academic e-learning initiatives aim at designing, implementing and introducing an e-learning system in a higher education institution [Mendling, 2004].

The purpose of this paper is to develop a web site assessment index that can be employed to estimate the current usage of the Internet by the most famous Romanian universities for their educational process support and at the same time the satisfaction of specific requirements from user's viewpoint. Web sites, as essential component in modern academic educational projects, necessitate continuous evaluation for supervising the fulfillment of learning objectives stipulated in these projects.

The web site quality assessment is necessary because the web is an increasingly important source of information and there is no way to control the quality of published content.

2. Web sites assessment methods

In order to achieve our goals, we have established the main necessary indicators for the web sites quality evaluation in education domain.

A review of the recent literature on web site reveals a lot of criteria for the web sites assessment. These elements are used in a quantitative evaluation, comparison, and ranking process [Pöllä, 2007; Shahin, 2004].

One of the most common method was proposed by Olsina et al. 1999 and can be considered as one of the main approaches. This method is the web site Quality Evaluation Method (QEM). There are four main factors analyzed in Olsina's study: functionality, usability, efficiency and site reliability [Olsina et al., 1999]. Currently, the results of the web sites evaluation are very subjective; thus, site evaluators should be given precise guidelines to rate every factor. In order to avoid this subjectivity problem, a Web Assessment Index (WAI) can be used. According to Evans and King, this index represents a web assessment tool and must have five main components: categories, factors, weights, ratings and total score [Evans and King, 1999].

In this paper, we have employed this assessment tool to compare the Internet usage from the five largest Romanian universities of the most famous

university centers of the province: Iaşi, Cluj-Napoca, Timişoara, Constanța, Braşov. Because of paper limited space, we have been reported only on Faculties of Economic Sciences of these universities (we mention that the Academy of Economic Sciences of Bucharest is constituted of 11 faculties and colleges, so we have not been reported on this one). The list below presents the faculties web sites of the first five Romanian universities.

Table 1. Classification of Romanian universities based on stuff's scientific results with international relevance in 2006

University Centre	Faculty of Economic Sciences web site
"Al. I. Cuza" University of Iassy	http://www.feaa.uaic.ro
"Babes-Bolyai" University of Cluj-Napoca	http://www.econ.ubbcluj.ro
"West" University of Timisoara	http://www.fse.uvt.ro
"Ovidius" University of Constanța	http://www.univ-ovidius.ro/stec
"Transilvania" University of Brasov	http://econ.unitbv.ro/ed/default.aspx

Source: Ad Astra Association, Topul universitatilor din Romania - Clasamentul general – 2006 (http://www.ad-astra.ro/universitati/universities.php?year=2006)

The WAI proposed by Miranda et al. (2006) employs four categories that are critical to web site effectiveness. These four categories are: accessibility, speed, navigability, and site content [Miranda, Cortés and Barriuso, 2006].

In order to complete our empirical study, we have extended Miranda's proposed index at five categories: accessibility, speed, navigability, content, reliability. In our opinion, these five categories are essential for web sites assessment. For each category, we have chosen some factors which reflect the most important components and features of web sites from the user's viewpoint.

The first category in the WAI is *accessibility*. This criterion is an influence factor of the site quality; that is, the identification and access facility (from user's viewpoint) is in direct proportion with the quality. The web accessibility can be evaluated analyzing two factors: link popularity and search engines presence.

The accessibility of a web site is increased by the search engines ranking. In order to establish the search engines ranking of the five web sites, we have chosen Google search engine, this one being the most frequently used in our country and considered the best in the world. The higher search engine ranking is, the higher degree of accessibility is.

Link popularity is the number of external links to the assessed web site. This has been measured using Google for counting the link occurrences of the reviewed sites in other different sites.

A significant issue for sites visitors is access time. In our paper, we analyzed the *access speed* from time viewpoint. The access speed was measured using a chronometer [Miranda, Cortés and Barriuso, 2006]. In order to eliminate any disagreements in access speeds measuring of the five web sites, we carried the access speed tests at the same hour with the same computer (Intel PIV 2,66 GHz, 512MB of RAM, 64MB graphic card) which has a 1MB optic fiber connectivity. We

used Internet Explorer 6.0, Opera and Mozilla Firefox 2.0 browsers. The access speed was calculated as the average between the three time values, reported at the number of pages for each web site. This procedure was repeated on consecutive days so that the averaged speed of access to be more representative.

The *navigability* is a very important factor from user's viewpoint because it refers to user's ability to reach the desired location in very short time. In this category, we analyzed: the presence of a permanent menu which allows a fast access to the different sections (at least the presence of a Home button) and the presence of a site map button which allows us to see the structure of the web site. Also, a search function is a very important factor.

The *content* is the most important category, in our opinion, because the presented information is the attraction key factor. That is why we have focused on the assessment of this category. In order to evaluate the content of the five web sites, we decomposed the content in attributes, in lower levels of abstraction, so as to be able to effectuate the measurement. Thus, we considered the following levels of content: informational level, services level, scientific research level, communicational level and miscellaneous level.

The first level – information – has a general descriptive character therefore we have followed the decomposition for assessment process. We were interested in the presence of: general faculty information (departments, management); entrance, educational forms; university degree; syllabus, timetable; announcements; financial information.

The second level takes into account the services available on the web, especially in student's self-interest: digital library (download courses, on-line reading and other on-line resources); on-line support services (view of the results centralization, using a login form); scholarship; symposiums, magazines.

The scientific research level addresses to anyone who wants to participate at conferences, to publish scientific articles or to gain scholarships. Generally, the academic personnel are the target of this level.

The communicational level refers especially to contact information, such as: headquarters address; telephone/fax; e-mail/web; form-based feedback.

Reliability is an important category both for visitors and for faculties because it highly affects their site assessment. This category is evaluated using two factors: link errors and miscellaneous errors. Link errors can be hyperlinks which do not work from different reasons, invalid links that are not correctly implemented and unimplemented links that are not implemented at all (they are measured through the number of links that are invalid, respective unimplemented reported to the total number of links).

Miscellaneous errors consist of three factors: deficiencies or absent features due to different browsers, deficiencies or unexpected results (e.g. non-trapped search errors, frame problems, etc.) independent of browsers and inactive nodes (unexpectedly under construction or dead-end Web nodes).

3. Data analysis

In order to evaluate these web sites, for each category was assigned a weight, established on according to importance degree (from a total of 100 points). Every factor in every category has been rated (from the total of category).

Table 2. Web Assessment Index with the five category and their weights

CATEGORIES	Weights	CATEGORIES	Weights
Accessibility	**10**	**Navigability**	**10**
Presence in search engine	5	Permanent menu	4
Link popularity	5	Site map	3
		Search function	3
Speed	**10**	**Reliability**	**10**
Access speed	10	Link errors	6
		Miscellaneous errors	4
Content	**60**		
Informational level	15	Services level	15
General faculty information	3	Digital library	6
Entrance, educational forms	3	Marks centralization	4
University degree	3	Scholarship	3
Syllabus, timetable	3	Symposium	1
Financial information	3	Magazines	1
Scientific research level	15	Communicational level	15
Conferences, symposiums	6	Address, telephone	4
Journals, magazines	6	E-mail	4
Scholarship	3	Form-based feedback	7
		TOTAL	**100**

For the first category, we have considered the *Position* attribute, which denotes the range number of the main site of the faculty (index) within results of Google *expression* search. The expression represents the faculty of each University, followed by the city name, such as: "facultatea de ştiinţe economice cluj-napoca" or "faculty of economic sciences cluj-napoca". The criterion function for determining the rating of the presence in search engine factor, is [Olsina, Rossi, 2000]:

case Position of
0: Rt = 0;   1: Rt = 5;
2: Rt = 4;   3: Rt = 3;
otherwise if (Position < =10) then Rt = 2 else Rt = 1.

For the evaluation of link popularity, we have employed an advanced search option of Google search engine. For every web site we have counted sites that contain links to the faculty web site, Lk_i ($1 \leq i \leq 6$), and we have calculated an average variable, Av. In order to establish the link popularity for each faculty site, we compared the Lk with the Av variable.

$$Av = (Lk_1 + Lk_2 + Lk_3 + Lk_4 + Lk_5 + Lk_6) / 6;$$
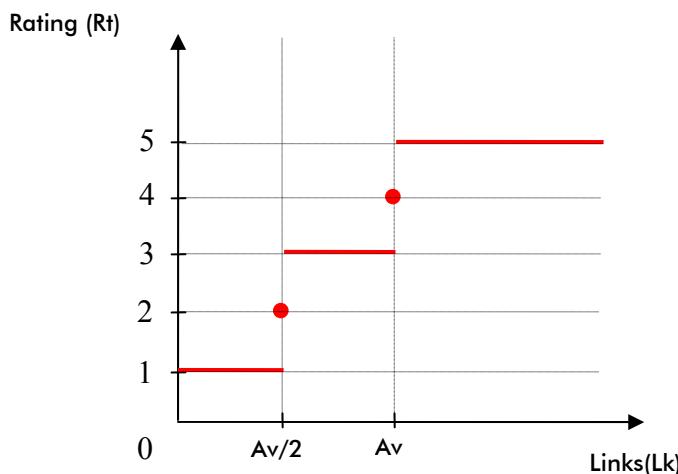
Figure 1. Popularity link assessment

If the web site structure includes a functional permanent menu available in every location which allows us to navigate in the whole web site, the permanent menu factor gets 4 points rating (by permanent menu we understand the principal menu, which is present by his buttons in every section of the web site, in top of the page). Otherwise, it gets 0 points rating (if the menu doesn't exist) or 2 points rating (if it exists but is not functional).

If there is a tree permanent menu, the factor gets only 3 points if it is functional, 1 point if it is not functional or 0 points if it is not permanent.

If there is no permanent menu, but there is a permanent Home button, the points are 3, 1 and 0, corresponding the three cases (exists and is functional, exists but is not functional, doesn't exist). In the same manner, we have rated the site map and intern search function with 3 points, 1 point or 0 points (corresponding the three cases presented above).

The content's factors ponderability has been made depending on some aspects, as follows:

- for the first level – we have considered some aspects, regarding information, such as: quality, amount, enframming within page, last update;
- for the second level – we have focused on student services offer, especially on digital library service. We have rated these factors depending on the service complexity and functionality;
- for the scientific research level – we have analyzed the possibility of research activity development for the faculty's personnel and for others academics. We have rated this factor depending on amount of conferences symposiums, journals, magazines (like Acta Universitatis). We also consider very important (maybe more important than the amount characteristic) their bench mark (if there are international or national rated, if they are recognized by CNCSIS etc.).
- the feedback level (or the communicational level) implies the existence of contact information, such as address, telephone, e-mail. We have also

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looked for the feed-back availability, meaning the presence of a form which allows the user to ask any questions about the faculty.

Link errors (El) have been measured through the number of links that are invalid, respective unimplemented (Li) reported to the total number of links (Tl). In order to establish the points for this factor (Epi), we have multiplied this coefficient El by 100 and we have truncated it to obtain natural numbers, named link errors index (Eli), which have been compare using a scale from 0 to 10 (we have chosen the upper limit at 10, because the bigger natural number was 9).

$$El = Li / Tl;$$
$$Eli = Trunc (El * 100);$$
$$if \ Eli = 0 \ then \ Epi = 6$$
$$else \ if \ Eli <= 2 \ then \ Epi = 5$$
$$else \ if \ Eli <= 4 \ then \ Epi = 4$$
$$else \ if \ Eli <= 6 \ then \ Epi = 3$$
$$else \ if \ Eli <= 8 \ then \ Epi = 2$$
$$else \ if \ Eli <= 10 \ then \ Epi = 1.$$

Miscellaneous errors (Em) have been measured through the number of specified attributes (Sa) considering a scale. In order to find out miscellaneous errors, we tested the five web sites using two browsers: Internet Explorer and Opera. Then we have calculated an average variable, Avm (the average of the Sa variables). The factor was rated with points (Mp) from 0 to 4, comparing with the 0, $Avm/2$ and Avm values.
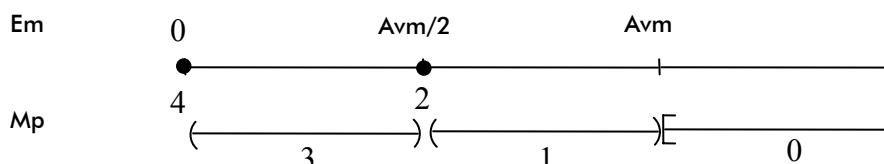
Figure 2. Miscellaneous errors assessment

After the settlement of these assessment criteria, we have started the evaluation of the five web sites – projects based on empirical case study. Using the above criteria, we calculated for each factor and each category, the rating and the weight, respectively. We present a table containing the five categories and their weights:

Table 3. Romanian Faculties of Economics Web Sites Assessment Index

Categories / Universities	Al.I.Cuza Iasi	Babes-Bolyai Cluj-Napoca	West University Timisoara	Ovidius Constanta	Transilvania Brasov
Accessibility	6	10	6	2	6
Presence in search engines	5	5	5	1	5
Popularity	1	5	1	1	1
Speed	10	10	10	10	10
Access speed	10	10	10	10	10

Categories / Universities	Al.I.Cuza Iasi	Babes-Bolyai Cluj-Napoca	West University Timisoara	Ovidius Constanta	Transilvania Brasov
Navigability	**10**	**4**	**7**	**7**	**3**
Permanent menu	4	4	4	4	3
Site map	3	0	0	0	0
Search function	3	0	3	3	0
Content	**51**	**36**	**32**	**28**	**32**
Informational level	14	13	9	11	12
Services level	9	6	3	8	7
Scientific level	13	9	12	3	9
Feedback level	15	8	8	6	4
Reliability	**4**	**9**	**1**	**10**	**9**
Link errors	4	5	1	6	6
Miscellaneous errors	0	4	0	4	3
TOTAL	**81**	**69**	**56**	**57**	**60**

4. Results analysis

Although we have synthesized the results of our work in a graphic which presents the best web sites according to the WAI, we are not interested on identifying the best web sites, but on analyze how each faculty web site is compared to related sites and how can they be improved for their educational goals achievement.

According to the WAI, the best web sites correspond to the Faculties of Economic Sciences of "Al. I. Cuza" University of Iasi and "Babes-Bolyai" University of Cluj-Napoca.
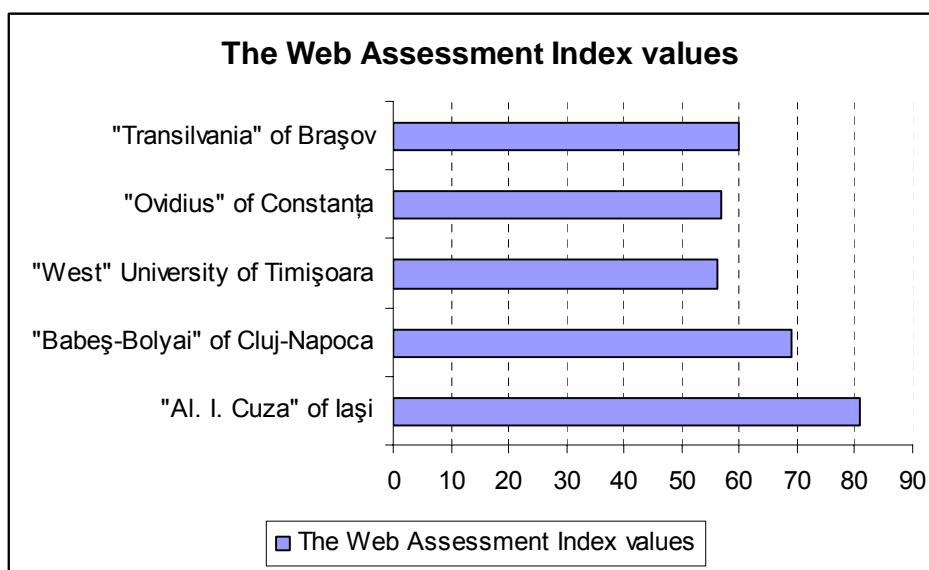

Figure 3. The WAI values for the five Romanian Faculties of Economic Sciences

From the accessibility viewpoint, it's obvious that the faculties of Iasi, Cluj-Napoca, Timisoara and Brasov hold the best presence in search engines, meaning their web sites are the first outputs of Google search engine. Related to the popularity, things are changed, meaning only the faculty of Cluj-Napoca has a popularity of 606 results for its web site (www.econ.ubbcluj.ro) while the others have a popularity of 2 results for their web sites.
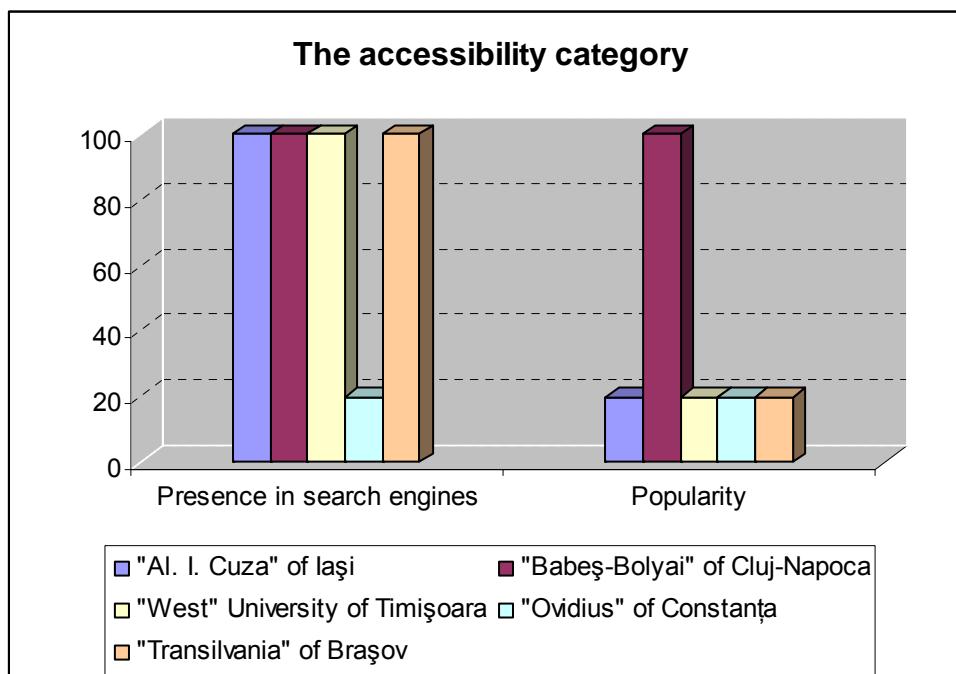
Figure 4. The two factors of the accessibility category

Regarding the five web sites access speed, we consider that all the web sites have an optimum access time reported to their number of pages and there are no lags in their access. So they all get a 100% percent, meaning they all get 10 points in the web assessment index.

Excepting the Faculty of Economic Sciences of Brasov which has a tree menu, difficult to use, the other faculties web sites hold a permanent menu tree, in top of pages, which is easy to use, permitting the navigability in every section of the web site. Only one of the five reviewed web sites has a site map, and this is Faculty of "Al. I. Cuza" University of Iasi. The site map is a very important element of the web structure, because it allows us to take a look at the entire site, simplifying the localization of the sections we are interested in. The search function is very important for the site, because it performs an intern search, within the web site. Only three of the five web site analyzed, own a keyword search function.

If we appertain to the entire category, we can notice that, considering the navigability, on the first place is the Faculty of Economic Sciences of Iasi, with a 100% percent, followed by the faculties of Timisoara and Constanta with a 70% percent, faculty of Cluj-Napoca with a 40% percent and the faculty of Brasov with a 30% percent. Even if the faculty of Cluj-Napoca is the second best web site of the

five sites analyzed, it has a lot of failings from navigability viewpoint and navigability elements could improve a lot this web site.
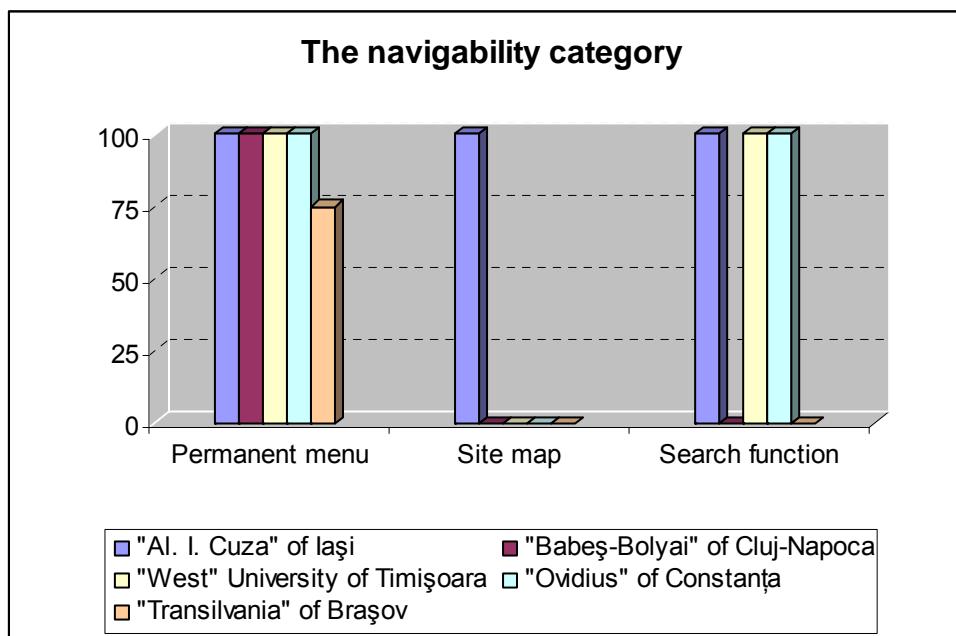
Figure 5. The factors of navigability category

The content category is the most important aspect in our study. As we can see, there is a various graphic for content category, meaning the five web sites are very different from this point of view. That is, their services are still deficient. At this category, the Faculty of Iasi offers the best services for their students and personnel with a 78,46% percent, followed by Cluj-Napoca with a 55,38% percent, Timisoara and Brasov with a 49,23% percent and Constanta with a 43,07% percent. The informational level is the only level where the all five web sites have a percent bigger then 50%, while the services level (services for students) is the level where the higher percent, 60%, is attained by Iasi and the lowest percent, 20%, is attained by Timisoara.

After this category study, we consider that this five web sites are designed for presentation, more than for education support. In our opinion, these web sites should be improved, so that they can be a real support for the students, namely it should be implemented a digital library and they should offer the students the possibility to find out information about their results centralization, based on an account with user and password for login on their personal page.

At scientific research level, the faculty of Iasi holds a 86% percent, followed by Timisoara with a 80% percent of scientific research information.

It is very important for a web site structure to contain a feedback establishment. Generally, the web sites hold a Contact button which allows to find out the address information, telephone (general information contact), but also there is a form that enables the feedback establishment by asking questions via the form. From the five web sites analyzed, only the faculty of Iasi settles a feedback with their users, the other faculties offering only general information contact.
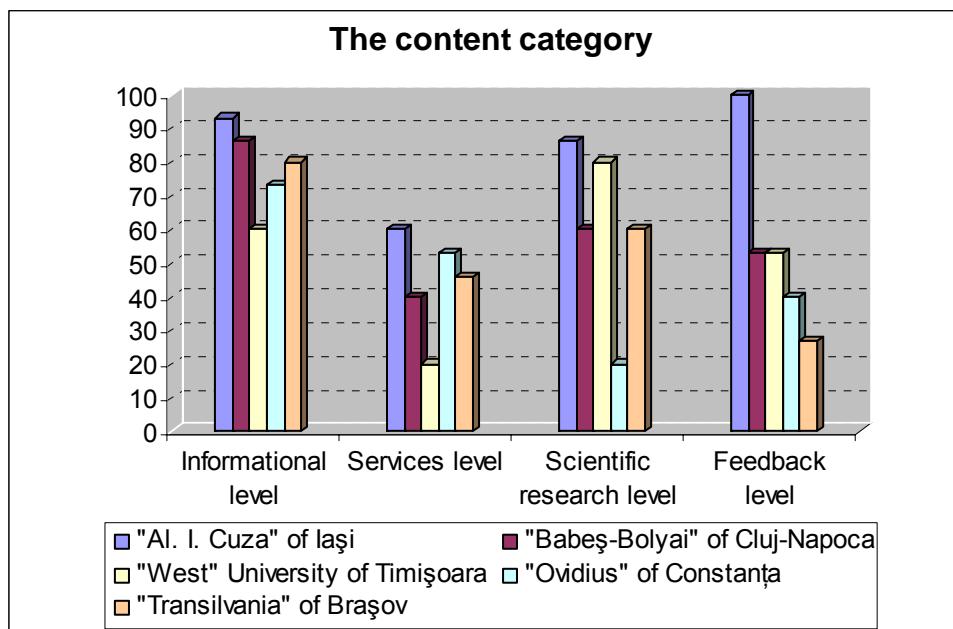
Figure 6. The levels of the content category

Regarding reliability, the most reliable web sites are the sites of the faculties of Constanța with a 100% percent, Cluj-Napoca and Brasov with a 90% percent compared with the site of Iasi with an only 40% percent and Timisoara with a 10% percent. The reliability is a very important aspect of a web site, meaning that no matter how complex the site is, it should not contain any link errors or any miscellaneous errors.
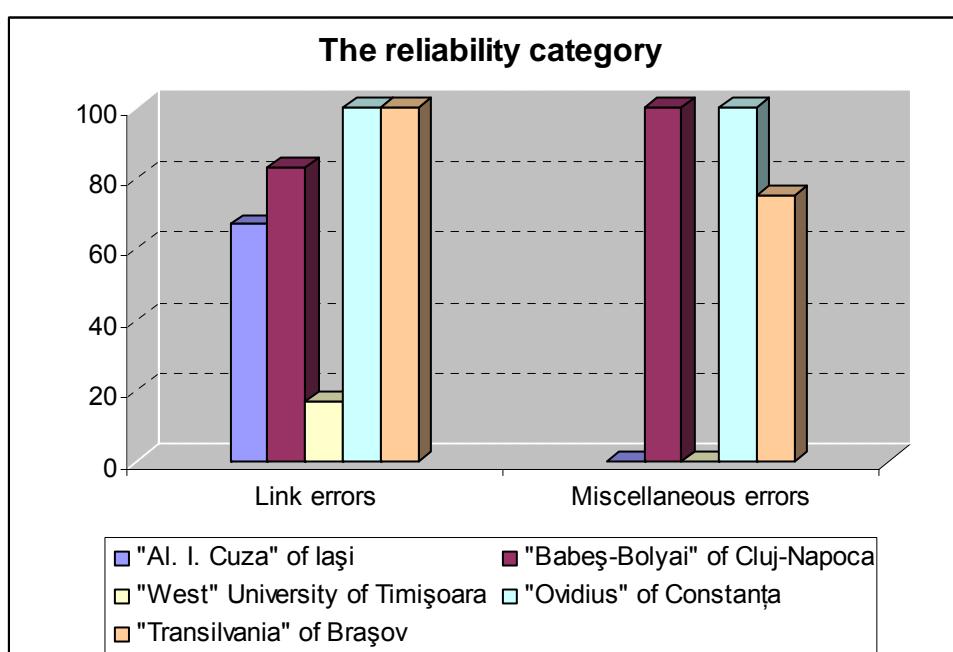
Figure 7. The analyzed factors of the reliability category

5. Conclusions and discussions

Although the Faculty of Economic Sciences from Iassy city has a best web sites (according to the WAI), its web site can be much improved regarding the reliability and the popularity of the web site. From the five web sites analyzed it offers the best students services and the higher possibility for scientific research.

The web site of the Faculty of Economic Sciences from Cluj-Napoca city, could be improved by adding a site map and a search function and by diversifying the services offered to the students.

The web site of the Faculty of Economic Sciences of Timisoara, has many link errors, which means that it is not functional enough. It could be improved by working at the reliability, at popularity and also diversifying the set of the services.

The Web site of the Faculty of Economic Sciences from Constanta city has a very bad presence in the search engines and popularity, although it has highest reliability of the five sites reviewed. It necessitates diversifying of the services offered and could be improved by adding a site map.

The last site analyzed is the web site of the Faculty of Economic Sciences from Brasov city. In our opinion, the tree menu should be changed by another easier to use (a menu containing submenus and options), it could be added a site map and a search function, but also it is recommended to diversify the services for the students.

We conclude that Romanian universities have partly accomplished the objectives of supporting their educational project by means of the academic web sites reviewed in this paper and they need improvement where the WAI indicator has recorded poor results or absent characteristics.

Although many firms and institutes have a web site which is intended to be their image, in many cases this web sites does not complete all the characteristics of the web site assessment. Many times, the only concern is the web design aspect, which is not enough for a site. There are more aspects on a web site than web design, aspects on which we have debated above.

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[1] Delia Adriana Marincas is from 2006 to present PhD student at Information Management in Economics Department, Faculty of Economics, "Babes-Bolyai" University. The doctoral thesis title is "Conception, Design and Development of a Collaborative Decision Support System for Management", Research field: collaborative decision support system for management, e-commerce, supply chain management. She is also from 2004 to present economist in a small company having the principal activity manufacture and commerce of electrical and thermal equipments. Main activities and responsabilities are accounting management and sales, participation in company managment. Company name is SC Soreva Impex SRL in Cluj Napoca, Romania.

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IT PROJECT METRICS

Ion IVAN[1]

PhD, University Professor, Department of Economic Informatics
University of Economics, Bucharest, Romania
Author of more than 25 books and over 75 journal articles in the field of software quality management, software metrics and informatics audit. His work focuses on the analysis of quality of software applications.
E-mail: ionivan@ase.ro , **Web page:** http://www.ionivan.ro

Adrian VISOIU[2]

PhD Candidate, Assistant Lecturer, Economic Informatics Department,
University of Economics, Bucharest, Romania

E-mail: adrian.visoiu@csie.ase.ro

Dragos PALAGHITA[3]

4th year student, University of Economics, Bucharest, Romania

E-mail: dpalaghita@gmail.com

Abstract: *The objectives of IT projects are presented. The quality requirements that these projects must fulfill are established. Quality and evaluation indicators for running IT projects are built and verified. Project quality characteristics are presented and discussed. Model refinement for IT project metrics is treated and a software structure is proposed. For an IT project which is designed for software development, quality evaluation and project implementation mode metrics are used.*

Key words: *IT metrics; IT projects; quality; quality characteristics*

1. IT projects

They represent an important category of projects and their management implies specific particularities because:

- Their unique character; informatics systems and software are developed only one time to bring in new solutions;
- The reproduction of the resulted products is defined by costs nearing zero, determined by the possibility to make copies on modern storage devices;
- The work force used to develop the IT project is highly qualified and represents, in most cases, over 85% of the projects value;
- The development cycle of an IT project must include without question solution improvement stages to bring in the latest technologies in the field; neglecting these new technologies will lead to an old solution which may be rejected by the beneficiaries and the informatics market;

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- The structure of the development cycle is adapted the pursued objective, the allocated resources, which leads to decisions regarding the continuance or abandonment of the projects, when the reviewed efficiency criterion suggest one of the two choices; this explains the fact that of 100 projects, over 50 are abandoned in the development process, only 10 projects get in maintenance and only 2-3 go in to the reengineering process;
- In the context of an evolving information and knowledge based society, all IT projects must be oriented to be user friendly, in order to grant free access to broader categories of information to every citizen.

IT project imply vast amounts of money. For projects in constructions, the amount of money needed range between thousands and millions of euros, and the resulting product is tangible, it becomes functional and is directly perceived.

For IT projects the amount of money needed starts from ten thousands euros and finally the result can only be seen in computers and networks, which are no more than 15% of the projects value. The hidden part of 85% must prove its efficiency through functionality, in time. This is why it is necessary building IT project metrics, to measure:

- How are the resources used;
- Which are the products' performances;
- How efficient will the products be in exploitation;
- Which are the risks of not finishing the project or to compensate deviations from the project.

Currently there are numerous metrics for every software typology, for every quality characteristic and for cost estimation.

It is important these metrics are analyzed and a practical approach for using quantitative methods is developed such that in the IT field the grounds of decisions will change the structure of projects and make the number of projects that get reengineered to increase.

2. Quality characteristics of IT projects

The IT projects quality characteristics form a dynamical, complex and optimal system.

The systemic character is given by the interdependences between characteristics. At a given time *t*, a quality characteristic of a project positively influences the level of another characteristic at time *t+1*. Also, that characteristic has a negative influence on the level of another quality characteristic.

The dynamic character is linked to the fact that interdependence intensity between characteristics varies in time. More, the importance of quality characteristics changes from one IT project to another, from user to user or even inside the project, the modification occurs from one stage of the project to another.

The complex character resides in the large number of quality characteristics, in the number of interdependencies, and mostly in the directions in which they manifest. The accumulated experience in elaborating and implementing projects shows that the characteristics system becomes more complex as the objectives are better pursued and the level of performance is higher.

The optimality of the quality characteristics system oversees the quantitative side of costs that the tendency to plan and complete projects with a higher quality level generates.

There is a solution of the quality optimization model that shows the moment in which the improvement of quality is no longer sustained through costs, which are far grater than the costs needed to fix the corresponding defects of a lower quality level of the IT project.

If M is considered the number of the quality characteristics C_1, C_2, ..., C_M of the projects, for each characteristic must be stated:

- the content ;
- the factors of influence;
- the associated models
- the use of indicators in taking decisions;
- the indicators aggregation.

Complexity is the characteristic used in differentiating projects. A project A_i is more complex than a project A_j if:

- the type number of resources used is grater;
- the number of stages through which the project is finished is grater;
- the number of machines used is grater;
- the number of different operations done by each machine is grater;
- the qualification needed by workers to operate the machines is higher;
- the number of links between stages is grater;
- the execution time is grater;
- the organizational effort is grater;
- the density of execution procedures is higher.

A graph is associated to the project A_i in which the nodes are either stages or activities, and the arcs are the ones that set the precedence. If:

- n^i_1 – the number of nodes of the graph $G(A_i)$ for the project A_i
- n^i_2 – the number of arcs which link the nodes of the graph $G(A_i)$

the complexity CP of the project A_i in a Halstead way is given by:

$$CP(A_i) = n^i_1 \, log_2 \, n^i_1 + n^i_1 \, log_2 \, n^i_2$$

A project A_i is more complex than a project A_j if and only if:

$CP(A_i) > CP(A_j)$

Meaning

$$\frac{(n_1^i)^{n_1^i}}{(n_1^j)^{n_1^{ji}}} \cdot \frac{(n_2^i)^{n_2^i}}{(n_2^j)^{n_2^{ji}}} > 1$$

If in time in an organization projects are implemented of which a project A_k is considered a model, the relative complexities of the projects $CR(A_1)$, $CR(A_2)$, ..., $CR(A_M)$ are obtained from:

$$CR(Ai) = \frac{(Ai)}{C(Ak)}$$

The project model has the relative complexity $CR(A_k) = 1$.

The K completeness of project K is a quality characteristic which refers to two aspects:

K_o – the completeness of the offer regarding the content of the document which is under evaluation

K_i – the completeness of the implementation regarding the stages developing process and the completeness of the process

If p_1 is the percentage of the elaboration stage of the offer and p_2 is the percentage of the developing of the project $p_1 + p_2 = 1$ and $p_1, p_2 \in (0,1)$ it results that the level of completeness KP of project A_i is given by:

$$KP = p_1 * Ko + p_2 * Ki.$$

The level of completeness K of any construction regards:

np – the number of parts imposed to consider the construction accepted

nr – the number of parts effectively realized

and the relation is obtained:

$$K = \frac{\min\{np, nr\}}{\max\{np, nr\}}$$

A project contains:

- eligibility criterion to which variables that belong to $\{0,1\}$ are associated to; if in the project the imposed requirements are respected the value 1 is given to a criterion Cr_i; if a project must fulfill L eligibility criterions the indicator IL = $\displaystyle\prod_{i=1}^{L} \alpha_i$ is calculated where α_i is the level of the Cr_i criterion, $\alpha_i \in \{0,1\}$;

- the technical side definition, in which definitions are given, processes are described, models are built; the completeness refers to the degree in which these descriptions include all the components known by specialists; the descriptions must offer a suggestive picture in connection with what is going on in the actual choused domain; there must not be a lack of elements which by their absence:
    o prove that the authors do not have a grasp on the domain;
    o show that the authors of the project do not have knowledge of materials, equipment, processes, operations, effects and models.

The specialists that analyze a new project have a clear image about the structure that includes mandatory parts, minimum requirements and by comparison see what is missing or what has been treated shallow.

Clarity is a very important characteristic not only for the offer made for a project but also to the development process.

The offer is a text. The implemented project is a product, a service, an action.

The clarity of text T_i associated with project A_i is analyzed in the following manner:

- the text T_i is decomposed in parts $a_{i1}, a_{i1}, ..., a_{ir}$;
- each part a_{ij}, $j = 1, 2, ..., r$, is connected with resources, actions and equipments;
- the logic content of a_{ij} with the logic of the process development;
- parts of the text are connected with resources building up pairs (a_{ij}, r_p)

If the pairs parts of text – resources are completely defined then the text *T* is clear. If parts of text or resources are not paired, the project does not have a good clarity level. The clarity is influenced in a negative way by pairs in which for different parts of text the same resources come up.

The necessity of defining probabilities which are associated with the pairs (a_{ij}, r_p) also has a negative influence on clarity.

Correctness is quality characteristic of a project, through which the ones that make the offer ant participate in the development of the project ensure:

- the concordance between theory and practice
- the use of results obtained by other specialists, results that were verified in practice;
- the use of concepts as they were defined, maintaining the context unaltered;
- respecting the defined procedures for executing operations;
- through all the means used, that the requirements imposed by obtaining a high level of quality for the product or service in its final form, are respected.

The correctness of a project offer is demonstrated, and the correctness of a product or the execution of a service is pointed out either by analysis, or by establishing the effects the product or service will generate. A product or a service is correctly or incorrectly realized.

If it is accepted that the product or service is partially correct, the correctness measuring indicator moves from the values 0 or 1 to the interval [0,1].

The problem of correctness in calculating costs and efficiency regards:

- the hypothesis on the basis of which the efficiency calculations are made;
- establishing the expenses levels for each chapter by pointing out quantities, unitary price, and interval limitation;
- using the calculation models as they were defined;
- bounding the variables regarding specific consumes through comparative analysis with projects already implemented;
- respecting the control keys;
- respecting the inequalities regarding the expense structure in conditions of the impossibility of not transmitting from one capital to another of the expenses.

For the definition of IT projects the following are defined:

- the criterions $Cr_1, Cr_2, ..., Cr_h$;
- the domains of variation measured for each criterion $[a_1, b_1], [a_2, b_2], ..., [a_h, b_h]$.

If for criterion Cr_i the level *xi* is measured, then the correctness of the project is given by:

$$CG = \prod_{i=1}^{h} x_i$$

$$\prod_{i=1}^{h} a_i \leq CG \leq \prod_{i=1}^{h} b_i.$$

The correctness norm is realized by defining the relation:

$$\prod_{i=1}^{h} \frac{a_i}{b_i} \leq CGN = \prod_{i=1}^{h} \frac{x_i}{b_i} \leq 1$$

There are numerous cases in which the relative correctness of a criterion Cr_i is obtained using a report like:

$$CRi = \frac{A_i}{h_i}$$

Where:

A – the number o fulfilled sub criterions

h – the total number of subcriterions

In this case the global correctness is

$$CG = \left(\prod_{i=1}^{h} CR_i\right)^{\frac{1}{h}}$$

Consistency is a quality characteristic which is used to point out to what extent an IT project is built respecting precise rules, without including components which have the role of annihilating what was prior executed.

The text of the project includes stages, chapters developed in ascendant order with the next components being constructed based on the ones before.

A project is under defined if the text or the product doesn't contain those elements that insure its functionality.

The project is over defined if it includes a lot more components than necessary. The numerous details make it hard to accomplish, and the function for which it is constructed is lost among many other functions, some having nothing in common with the initial objective.

Only a defined project, in which every component has its role well established, is a consistent project.

A project structure, *SP*, is considered, having the complexity C *(SP)*, structure which corresponds to projects, products or IT services considered to be functional, which exist and have a degree of satisfaction at user level grater than 0.8, the degree of satisfaction is given by:

GS=NF/NT

Where

NF – the number of users that have successfully finished the problem for which they used the resources of the project;

NT – the total number of users that accessed the resources belonging to the project.

The consistency CO for the project A_i is given by:

$$CO = \frac{\min\{C(SP), C(A_i)\}}{\max\{C(SP), C(A_i)\}}$$

Ability to complete is another characteristic that all evaluators take in consideration and it is influenced by:

- the experience of the team which proposes a solution for an IT problem;
- the estimation of resources used for implementing the solution;
- the estimated duration of the project;
- identified resources and procedures used to attenuate the effects.

The practice of elaborating an offer and implementing it presume:
- knowledge of technologies;
- rigorous knowledge of duration and minimal and maximal consumptions necessary to complete activities;
- the correct defining of precedence;
- identifying the operations needed to prepare;
- building a timeline for activities;
- regrouping the activities such that the equipment and highly qualified workforce are efficiently used.

If in a project are identified:

NA – number of activities;

D_i – time to complete activity i;

K_i – number of resources necessary for completing activity i;

x_{ij} – resource consumption j for completing activity i;

t_{si} – start time for activity i;

t_{fi} – end time for activity i;

The planned and effective levels are established.

For the planned levels mark p will be used; the planned level for activity xxx will be xxx^p.

For the effective level the mark e will be used, such that variable xxx will have the effective level xxx^e.

The indicator IUR regarding the use of resources is built using the relation:

$$IUR = \frac{\sum_{i=1}^{NA}\sum_{j=1}^{ki}\alpha_{ij}}{\sum_{i=1}^{NA}k_i}$$

where

$$\alpha_{ij} = \begin{cases} 1, x_{ij}^p = x_{ij}^e \\ 0, \text{ for the rest} \end{cases}$$

The ability to complete is seen also compared to optimistic or pessimistic attitude manifested by those who make an offer or implement a project.

If the planned level for a resource is x_{ij}^p, the minimal consumption for completing operation x_{ij}^{min}, and the maximal consumption for a resource is x_{ij}^{max} the level realistic approach is built as the indicator IR given by:

$$IR = \frac{\sum_{i=1}^{NA}\sum_{j=1}^{ki}\beta_{ij}}{\sum_{i=1}^{NA}k_i}$$

Where

$$\beta_{ij} = \begin{cases} 0, x_{ij}^{p} = x_{ij}^{\min} \ sau \ x_{ij}^{p} = x_{ij}^{\max} \\ 1, for \ the \ rest \end{cases}$$

Reliability is quality characteristic of IT projects which states the degree in which the stages in the life cycle of the project are developing successfully

The life cycle of an IT project includes:

E1- the offer elaboration stage

E2- project implementation stage

E3- the current use of the product resulted after… through the project

E4- the maintenance process

E5- using the product post maintenance

E6- taking the product out of use

Each of these stages has associated an importance coefficient p_i, $i=\{1,2,3,4,5,6\}$.

Each stage *Ei* is characterized by a duration *D(Ei)*.

The physical duration norm of the life cycle of the project is given by:

$$DFN = \sum_{i=1}^{6} D(Ei)$$

The corrected duration norm of the project is given by:

$$DFNC = \sum_{i=1}^{6} p_i D(Ei)$$

$DFNC < DFN$ because $pi \in (0,1)$ $\sum_{i=1}^{6} pi = 1$ resulting that $D(Ei) > piD(Ei)$ for

i=1,2,3,4,5,6.

In the background of every stage processes are running. If a process θj is stopped because of various causes, the duration of the process $DP(\theta j)$ increases with $\Delta(\theta j')$ which increase depends on:

- the complexity of the cause that determined the interruption;
- the ability of the team to eliminate the cause;
- the resources that are redirected to eliminate the cause;
- the place where the cause was spotted; as a cause is spotted later, the resources used and durations are increasing;

The physical running cycle norm of the project is identical with the effective duration if and only if $\Delta(\theta j)=0$ $\forall j \in N$. In reality, throughout the lifetime there are recorded interruptions of specific stages $\Delta(Ei)$, such that the effective duration of the cycle:

$$DFE = \sum_{i=1}^{n} (D(E_i) + \Delta(E_i))$$

The norm reliability of the project *P,f(P)* is given by:

$$f(P) = \frac{DFN}{DFE}$$

The corrected reliability *fc(p)* is given by the relation:

$$fc(P) = \frac{DFNC}{DFEC}$$

where $DFEC = \sum_{i=1}^{n} [p_i D(E_i) + h_i \Delta(E_i)]$ where h_i $i=1,2,3,4,5,6$ are the fractions associated

to the importance which is given to the duration of process delaying from the stages E_i, $i=1,2,..6$.

Compared to other products or services in which reliability is characterized by quality in use, at the beneficiary, giving the degree in which the product or service accomplishes the set objective, in case of the IT projects, the reliability of a project is mistaken with the reliability of the life cycle because:

- in all the stages the workforce plays an important role, representing more then 85% of the production costs;
- the successful functioning of the finite product strictly depends on the operating of each subsystem; the offer lays down the conceptual foundation and resource allocation; the elaboration of the offer is a stage of the life cycle of the IT project; the offer elaboration process reliability is essential to the entire product;
- the eventual deploying of an reengineering process is meant to redefine basic elements of the offer, and the multiple mobilization effect of the new structure of an IT project is limited to all the other stages that follow.

It is important to identify in the existing projects in the databases those variables with the help of which the levels of difference $\Delta(Ei)$ are calculated to help compute the effective reliabilities of these projects in the norm version and most of all in the corrected version.

Given the Project P in the table 1 below,

Table 1. Data for P project

Name	Norm duration	Effective duration	Interruption duration	Total
E1	6	12	8	20
E2	24	38	12	50
E3	50	60	40	100
E4	10	15	5	20
E5	5	10	10	20
E6	5	10	10	20
Total	100	145	85	230

The reliability of project P = $\frac{145}{230}$.

There are other quality characteristics of an IT project like:

- comparability
- reusability
- orthogonality
- reproduction ability

For these characteristics the research must be continued such that the results will be operational in daily practice.

3. IT project model quality refinement

Models are built starting from a model of hypothesis. It is necessary to go on to the stage of refining the models. The refinement process consists of:
- Reducing the number of variables;
- Decreasing as much as possible the degree of incorporated nonlinearity ;
- Guaranteeing minimal loss of information by using simplified models.

The refinement of IT projects assumes:
- Taking in consideration only the data that is collected usually for elaborating the offer and running the projects;
- Retaining in the indicator stricture the variables that decisively influence the evolution of the project from a practical point of view;

Refinement is made on two levels:
- At the first level, from the set of indicators I_1, I_2, ..., I_M a subset is retained formed by the indicators I_i, I_{i+1}, ..., I_{i+K}, $K << M$.
- At the second level, the retained indicators operate with the variables X_i, X_{i+1}, ..., X_{i+H}, $H << L$ instead of using the variables X_1, X_2, ..., X_L.

It means that instead of analyzing M characteristics, a number of K characteristics is analyzed.

Instead of L variables, the refined indicators operate with H variables.

The effort must be reduced without significant loss of information obtained from using the metrics. The decisions taken based on the refined metrics of the IT projects must lead to maintaining the process of implementation in the limits recognized acceptability.

IT projects metrics refinement must allow the use of existent data bases, and the implementation of simplified indicators must not be affected by the defined data structures, without requiring new data structures or data reorganization.

The IT project metrics refinement process is carried on like in figure 1.
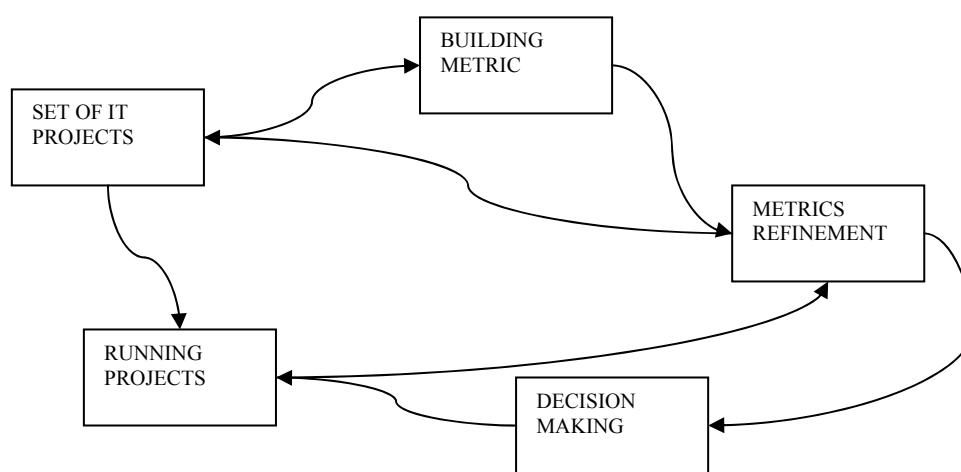
Figure 1. Usage of refined models

The refinement process is customizable by defining limits referring to:
- the minimum list of variables that defines the indicators;
- the accepted loss of in formation level.

Under the conditions the indicators I_1, I_2, ..., I_K are considered in which the variables X_1, X_2, ..., X_L are used, through refinement it is imposed:
- the maximum number of indicators to be M_{max};
- the maximum number of variables to be H_{max};
- the error level must not be higher than E.

Refinement presumes:

P1- definition of the initial solution for the refinement process which includes all the K indicators, all the L variables and the criterion through the measurements are made;

P2- taking the data bases that regard IT projects that have frequent definition classes and best implementation, known as successful projects.

P3- evaluation of indicators $I_1, I_2, ... I_k$ with the data taken from the data bases for the L variables

P4- calculating the aggregated error criterion

P5- elimination of the x_i variable from the indicators

P6- evaluation of the indicators

P7- calculation of the criterion

P8- building the Er_i array

P9- repeating the steps P_5 - P_8 to eliminate the variable x_{i+1} from the list

P10- after building the array $Er_1, Er_2, ... Er_L$ it is sorted in descending order and the variables for which the error has the smallest value are eliminated

P11- the steps P_5 - P_{10} are repeated until the given error level is obtained; it is possible this level is reached in the first iteration and the refinement process stops;

Once the variable list is refined, the refinement of indicators starts.

P12- the list $I_1, I_2, ... I_K$ of indicators and the list of refined variables $X_1, X_2, ... X_H$ are considered;

P13- the indicators are calculated using the relation and are considered an initial solution for the aggregate performance indicator

$$IP^0 = \sum_{j=1}^{H} p_j I_j \quad \text{where } p_j \text{ - weight}$$

and a certain level is obtained

P14- the indicator I_k , $k=1....$ is eliminated

P15- *IP* is calculated and a vector $\alpha_1, \alpha_1, ...$ is built

P16- steps P_{14} - P_{15} are repeated until the indicators are eliminated one by one

P17- $\alpha_1, \alpha_2, ...$ are ordered decreasing

P18- the indicator which has the smallest error difference with IP^0 is eliminated

P19- the steps P_{14} - P_{18} are repeated until the maximum admitted number for indicators is reached

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The refinement activity is a repeating process convergent to a stabile process. To complete the refinement simulation methods and genetic algorithms and neuronal networks are built.

4. Software for implementing IT metrics

The software product for evaluating IT projects assumes:
- building a list with *K* quality characteristics *KAL 1, KAL 2, ..., KAL k*
- building a list of indicators *I 1,I 2,...I k*
- building a list with *M* variables
- making the connection between the *M* variables and fields in the data base
- launching the refinement process
- obtaining a sublist of characteristics with a sublist of indicators which are obtained with a sublist of variables
- validating the sublist of indicators as a metric of IT projects

The software product designed to implement IT metrics is a complex construction which:
- must be accessed off the internet;
- has user authentication ;
- accepts definitions of data bases;
- takes fields from the data base and constitutes the series that make estimations;
- allows the selection of structures of initial indicators *I1,I2,...Ik;*
- offers a list of performance criterion for selecting indicators and variables;
- generate indicator structures for the refinement process;
- calculates the level of refined indicators on request or periodically to fundament decisions.

The software product has the functions:
- user authentication;
- the management of data sets that correspond to the problems to solve;
- estimation of model coefficients;
- model refinement;
- model structure generation;
- aggregation level calculation to fundament decisions;
- options, parameters and solutions are saved if the data sets are valid;
- adding of information and identification data.
 The software structure is given in figure 2.
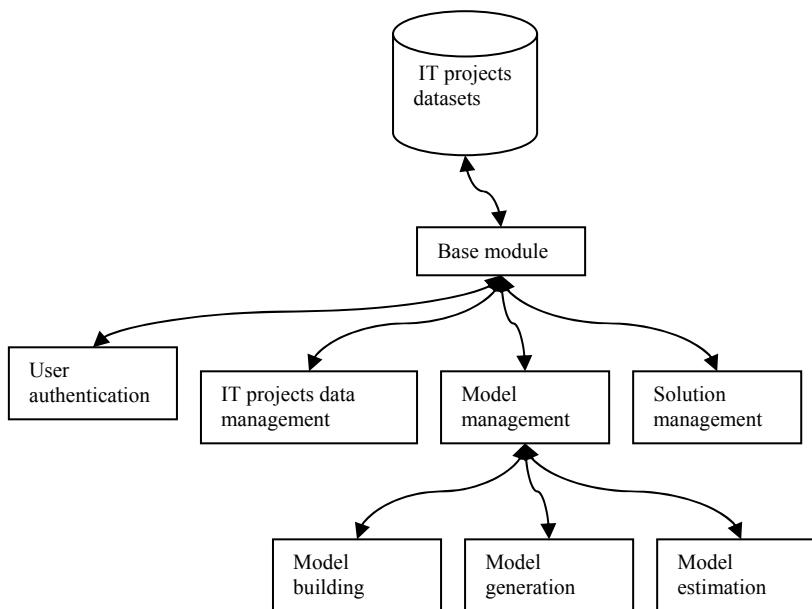
Figure 2. Software structure for IT project metrics implementation

The software product is taking numerous elements that constitute a modelbase.

The modelbase is a complex construction in which lists are included with:

- dependent variables and independent variables;
- linear and nonlinear models structures;
- registered data sets and generated data sets;
- implementation of the coefficients estimation algorithms;
- procedures for the hypothesis verification;
- procedures for the estimated values calculation;
- models hierarchizing procedures.

These very important components are elements with which the modelbase is populated. For the modelbase to become operational, an administration system has to exist.

First of all, the administration system has to operate distinctly with data sets, with the procedures and with the models structures.

Second of all, the administration system functions have to effectuate the fast finding of the data sets, of the models structures and of the procedures in order to secure the processes development in concordance with the demands of the analyst economist.

Third of all, the administration system has to be equipped with functions which permit the data sets adding, the models adding and the procedures adding. The perspective has to be changed, through which the modelbase bringing up to date implied data / models / procedures deleting or changing of some parts of these with new sequences.

The acceptance of the bringing up to date function exclusive through adding comes to bring a concordance between the natural way of understanding the evolution with the corresponding reflection of it on informatics level.

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The modelbase administration system operates with non homogenous entities, important aspect in securing the flows consistency.

Fourth of all, an open character is secured, the users having at their disposal the possibility of defining personal algorithms for interpolation and extrapolation, for pseudoaleatory numbers generation, for the coefficients estimation, for implementing personal models selection criteria.

Fifth of all the, defining of the specific concepts regarding the finding, selection, extraction, targets the triplets (data, models structures, procedures), which group complex proceedings.

Sixth of all, a growth of the generalization degree for the transaction concept is produced, which in case of the modelbase implies the traversing of some flows in which it is operated simultaneously with data sets, with data structures and with procedures.

The new conglomerate, more complex than the object structure that includes the operands and operators, develops a new projection on the philosophy of designing an administration system, the administration system of the modelbase, in which new typologies specific to the implemented processes in the field of artificial intelligence are included besides the already usual proceedings.

Utilizations of the modelbase imply activations of some sequences of procedures from the modelbase.

The administration system of the modelbase is a construction with a very high complexity degree. The users must have the possibility of starting a small diversity of economic analysis projects.

For example, the coefficients estimation of a model on the basis of a data set consists of:
- the specification of the exogenous variables number and of the endogenous variables number;
- the specification of the data series terms number;
- the insertion of the data table;
- the delimitation of the variables list corresponding to the data series position.

Also, some results regarding the estimations quality are displayed.

This procedure is specific to the situation in which the user has a clear image on the phenomenon and this one's analysis is already a routine activity.

Model generators are software applications taking as input datasets and information regarding model nature, structure and complexity and produce different models from a certain model class.

Linear model generators take as input a dataset containing a number of independent variables and a dependent variable and produce linear models combining influence factors.

Linear model generators with lagged arguments allow the elaboration of constructions which permit the modeling of the cases when a variation in an influence factor has a delayed effect on the dependent variable. The generator produces combinations of both influence factors and lags, identifying best models.

Standard nonlinear model generators use predefined analytical forms for generating models. General nonlinear model generators build automatically analytical expressions containing influence factors.

All generators order their results according to performance indicators.

Model complexity is assessed by measures based on Halstead metrics, taking into account the number of operators and operands. Complexity measures help comparing models and building performance indicators.

The quantitative study of phenomena is encouraged by the volume of historically recoded information. Its purpose is to take decisions leading to continuous improving of performance indicators for subsequent projects.

Modelbases are complex software constructions offering functions for:

- defining, retrieving and updating models;
- modeling applications management;
- estimation and validation of coefficients;
- automated model generation from existing datasets;
- dataset management.

Model generators are modelbase instruments that build model structures from a given class using variables found in the dataset given as input. Model classes group models with the same structure, e.g. linear models, linear models with lagged variables, nonlinear models. For each class a model generator is developed. Each dataset contains data series for the recorded variables. The endogenous variable is specified and the generator builds analytical expressions using influence factors. For each model structure, coefficients are estimated and a performance indicator is computed. The resulting model list is ordered by the performance indicator. The analyst chooses between the best models an appropriate form that later will be used in estimating the studied characteristic.

In the context of model generation, the refinement process is described as follows.

Consider the dataset S and a model generator G. The set of models generated by G to fit the dataset S is L_M. The model set L_M is characterized by the following:

- the number of models is large;
- models have a variety of values for the performance criterion ranging from the worst fitting model to the best fitting model;
- models have a variety of values for the complexity, ranging from the most simple expressions to very complex ones;
- the best fitting models are not compulsory the most complex ones, and also, the simplest models are not the worst in explaining the studied phenomenon.

The refinement process using model generators is described by the following diagram shown in figure 3.

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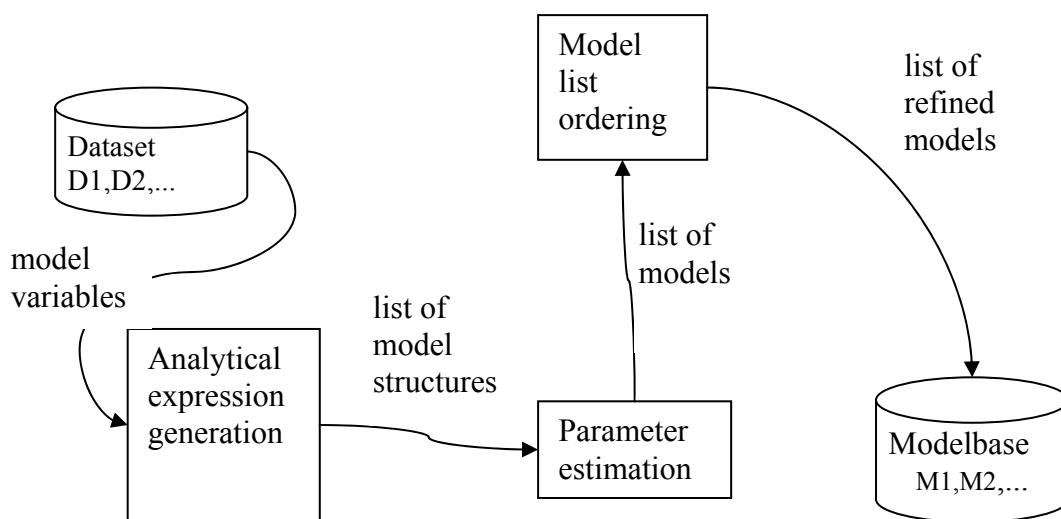
Figure 3. The model refinement process

The refinement process takes the following steps:

- the dataset is built; it contains data series for the dependent variable and independent variables;
- using variable names found in the dataset, model structures are generated; the list of generated model structures is denoted by L_G and contains a large number of models, also depending on the constrains or type of the generation algorithm;
- for each model structure in L_G, coefficients are estimated, along with statistical performance indicators, obtaining the list of estimated models, L_E;
- for each model found in L_E, an aggregated performance indicator is computed; the L_E list is ordered by this performance indicator and an arbitrary number of models is chosen, forming L_R list, the refined list of models;
- the refined list of models is saved into a modelbase and then used by the human analyst to choose one or more models to be used in estimating the studied phenomenon.

5. Conclusions

Taking into consideration the importance of IT projects the continuance of the study is mandatory:

– Quality characteristics;
– Identifying new indicators;
– Making the data collection and metrics calculation an automatic process;
– Recording reaction to the decision quality to see what are the indicators which need perfecting.

In current time there are instruments used to assist elaboration processes of IT projects. These instruments are meant to ensure the completeness of IT projects.
If the following are built:

- activity lists;

- resource lists;
- job lists.

and for each the number of elements is established from the list, as an instrument is meant to impose:

- the complete description of the elements in each list;
- the correlation of elements between lists;
- the aggregation of data from the generated matrices by the combination of lists.

If a series of relations are imposed regarding:

- the structure of the offer text;
- the expense structure;
- the activity precedence ;
- the rates of financing.

the instruments are meant to:

- verify if the structure is respected;
- generate the parts of structure;
- reduce the number of repeats from one component to the other;
- control the levels of complexity;
- include aggregated levels;
- eliminate abbreviations introducing the elements clearly;
- ensures the qualitative level of the criterions;
- evaluate the level of allocated resources;
- use correct words from a specialty vocabulary.

For a data base in which the records regarding the evolution of a project are saved, the dates must be complete and correct.

If data is taken from several projects the following are calculated:

- differences between the consumption or normed duration;
- The interval belonging frequencies and consumption variation;
- The probability that a variable will follow a certain repartition law.

The complete image over an IT project is obtained only through the implementation of a correctly constructed metric, refined and completely validated.

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[1] Ion IVAN has graduated the Faculty of Economic Computation and Economic Cybernetics in 1970, he holds a PhD diploma in Economics from 1978 and he had gone through all didactic positions since 1970 when he joined the staff of the Bucharest University of Economics, teaching assistant in 1970, senior lecturer in 1978, assistant professor in 1991 and full professor in 1993. Currently he is full Professor of Economic Informatics within the Department of Economic Informatics at Faculty of Cybernetics, Statistics and Economic Informatics from the University of Economics. He is the author of more than 25 books and over 75 journal articles in the field of software quality management, software metrics and informatics audit. His work focuses on the analysis of quality of software applications.   He is currently studying software quality management and audit, project management of IT&C projects. He received numerous diplomas for his research activity achievements. For his entire activity, the National University Research Council granted him in 2005 with the national diploma, Opera Omnia.
He has received multiple grants for research, documentation and exchange of experience at numerous universities from Greece, Ireland, Germany, France, Italy, Sweden, Norway, United States, Holland and Japan.
He is distinguished member of the scientific board for the magazines and journals like:
- Economic Informatics; - Economic Computation and Economic Cybernetics Studies and Research; - Romanian Journal of Statistics
He has participated in the scientific committee of more than 20 Conferences on Informatics and he has coordinated the appearance of 3 proceedings volumes for International Conferences.
From 1994 he is PhD coordinator in the field of Economic Informatics.
He has coordinated as a director more than 15 research projects that have been financed from national and international research programs. He was member in a TEMPUS project as local coordinator and also as contractor in an EPROM project.

[2] Adrian Visoiu graduated the Bucharest University of Economics, the Faculty of Cybernetics, Statistics and Economic Informatics. He has a master degree in Project Management. He is a PhD student at Doctoral School of Bucharest University of Economics in the field of Economic Informatics.
He is an assistant lecturer in the Economic Informatics Department of the Bucharest University of Economics.
He published 7 articles and he is coauthor of "Baza de modele economice" book.

[3] Dragos Palaghita is a 4th year student in the University of Economics, Bucharest, Cybernetics Statistics and Economic Informatics faculty, Economic Informatics section. He is programming in C++ and C# and his main areas of interest are Informatics Security and Software Quality Management.

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CONTROL OF PROJECTS - A CYBERNETIC CONTROL

Elena DOBRE

PhD, Senior Lecturer, Finance and Accounts Department,
Ovidius University, Constanta, Romania

E-mail: Elenadobre2006@gmail.com

Abstract: *Control is the last element in the implementation cycle planning-monitoring-controlling. Information is collected about system performance, compared with the desired (or planned) level, and action taken if actual and desired performance differ enough that the controller (manager) wishes to decrease the difference. Note that reporting performance, comparing the differences between desired and actual performance levels, and accounting for why such differences exist are all parts of the control process. In essence control is the act of reducing the difference between plan and reality. Control is focused of the three elements of project-performance, cost and time. The project manager is constantly concerned with these three aspects of the project. Is the project delivering what it promised to deliver or more? Is it making delivery at or below the promised cost? Is it making delivery at or before the promised time? It is strangely easy to lose sight of these fundamental targets, especially in large projects with a wealth of detail and a great number of subprojects. Large projects develop their own momentum and tend to get out of hand, going their own way independent of the wishes of the project manager and the intent of the proposal.*

Key words: cybernetic control; negative feedback loop; first order control system; second-order control system; third-order control system

In project management field, there are few things that can cause a project to require the control performance, costs or time.

Performance:
- Unexpected technical problems arise.
- Insufficient resources are available when needed.
- Insurmountable technical difficulties are present.
- Quality or reliability problems occur.
- Client requires changes in system specifications.
- Inter functional complications arise.
- Technological breakthroughs affect the project.

Cost:
- Technical difficulties require more resources.
- The scope of the work increases.
- Initial bids or estimates were too low.
- Reporting was poor or untimely.
- Budgeting was inadequate.
- Corrective control was not exercised in time.
- Input price changes occurred.

Time:
- Technical difficulties took longer than planned to solve.
- Initial time estimates were optimistic.

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- Task sequencing was incorrect.
- Required inputs of material, personnel, or equipment were unavailable when needed.
- Necessary preceding tasks were incomplete.
- Customer-generated change orders required rework.
- Governmental regulations were altered.

And these are only a few of the relatively "mechanistic" problems that project control can occur. Actually, there are no purely mechanistic problems on projects. All problems have a human element, too. For example, humans, by action or inaction, set in motion a chain of events that leads to a failure to budget adequately, creates a quality problem, leads the project down to a technically difficult path, or fails to note a change in government regulations. If, by chance, some of these or other things happen (as a result of human action or not), humans are affected by them. Frustration, pleasure, determination, hopelessness, anger and may other emotions arise during the course of a project. They affect the work of the individuals who feel them – for better or worse. It is over this welter of confusion, emotion, fallibility, and general cussedness that the PM tries to exert control.

All of these problems, always combinations of the human and mechanistic, call for intervention and control by the project manager. There are infinite "slips" especially in projects where the technology or deliverables are new and unfamiliar, and project managers, like most managers, find control is a difficult function to perform. There are several reasons why this is so. One of the main reasons is that project managers, again like most managers, do not discover problems. In systems as complex as projects, the task of defining the problems is formidable, and thus knowing what to control is not a simple task. Another reason control is difficult is because, in spite of an almost universal need to blame some   person for any trouble, it is often almost impossible to know if a problem resulted from human error or from the random application of Murphy's Law.

Project managers also find it tough to exercise control because the project team, even on large projects, is an "in-group". It is "we" while outsiders are "they". It is usually hard to criticize friends, to subject them to control. Further, many project managers see control as an ad-hoc process. Each need to exercise control is seen as a unique event, rather than as one instance of an ongoing and recurring process. Whitten offers the observation that projects are drifting out of control if the achievement of milestones is threatened. He also offers some guidelines on how to resolve this problem and bring the project back in control.

Because control of projects is such a mixture of feeling and fact of human and mechanism, of causation and random chance, we must approach the subject in an extremely orderly way. This why we start by examining the general purposes of control. Then we consider the basic structure of the process of control. We do this by describing control theory in the form of a cybernetic control loop. While most projects offer little opportunity for the actual application of automatic feedback loops, the system provides us with a comprehensive but reasonably simple illustration of all the elements necessary to control any system. From this model, we then turn to the types of control that are most often applied to projects. The design of control systems is discussed as are the impacts that various types of controls tend to have on the humans being controlled. The specific requirement of "balance" in a control system is also covered, as are two special control problems: control of creative activities, and control of change.

The process of controlling a project (or any system) is far more complex than simply waiting for something to go wrong and the, if possible, fixing it. We must decide at what points in the project we will try to exert control, what is to be controlled, how it will be measured, how much deviation from plan will be tolerated before we act, what kinds of interventions should be used, and how to spot and correct potential deviations before they occur. In order to keep these and other such issues sorted out, it is helpful to begin a consideration of control with a brief exposition on the theory of control,

No matter what our purpose in controlling a project, there are three basic types of control mechanisms we can use: cybernetic control, go/no-go control and post-control. We will describe the first type and briefly discuss the information requirements of each. While few cybernetic control systems are used for project control, we will describe them here because they clearly delineate the elements that must be present in any control system, as well as the information requirements of control systems.

Cybernetic control

Cybernetic or steering control is by far the most common type of control system. The key feature of cybernetic control is its automatic operation. Consider the diagrammatic model of a cybernetic control system shown in figure 1. As Figure 1 shows, a system is operating with inputs being subjected to a process that transforms them into outputs. It is this system that we wish to control. In order to do so, we must monitor the system output. This function is performed by sensors that measure one or more aspects of the output, presumably those aspects one wishes to control. Measurements taken by a sensor are transmitted to the comparator, which compares them with a set of predetermined standards. The difference between actual and standard is sent to the decision maker, which determines whether or not the difference is of sufficient size to deserve correction. If the difference is large enough to warrant action, a signal is sent to the effectors, which acts on the process or on the inputs to produce outputs that conform more closely to the standard.

A cybernetic control system that acts to reduce deviations from standard is called a *negative feedback loop*. If the system output moves away from the standard in one direction, the control mechanism acts to move it in the opposite direction. The speed or force with which the control operates is, in general, proportional to the size of the deviation from the standard. The precise way in which the deviation is corrected depends on the nature of the operating system and the design of the controller. Figure 2 illustrates three different response patterns. Response path A is direct and rapid, while path B is more gradual. Path C shows oscillations of decreasing amplitude. An aircraft suddenly deflected from a stable flight path would tend to recover by following pattern C.

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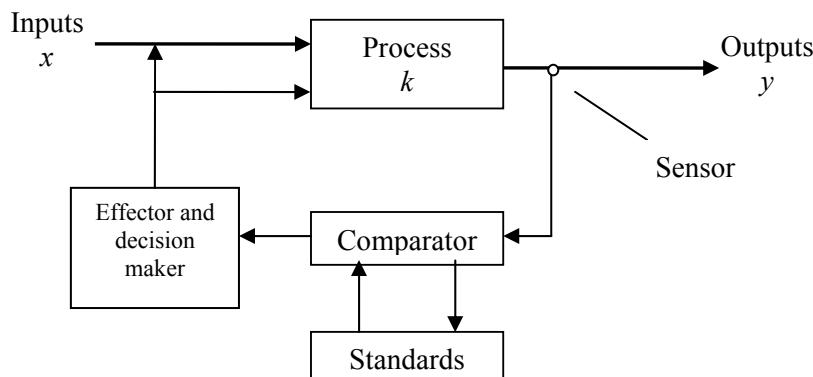
Figure 1. A cybernetic control system

Types of cybernetic control systems

Cybernetic controls come in three varieties, or *orders*, differing in the sophistication with which standards are set. Figure 1 show a simple, *first order control system*, a goal seeking device. The standard is set and there is no provision made for altering it except by intervention from the outside. The common thermostat is a time-worn example of a first-order controller. One sets the standard temperature and the heating and air-conditioning systems operate to maintain it.
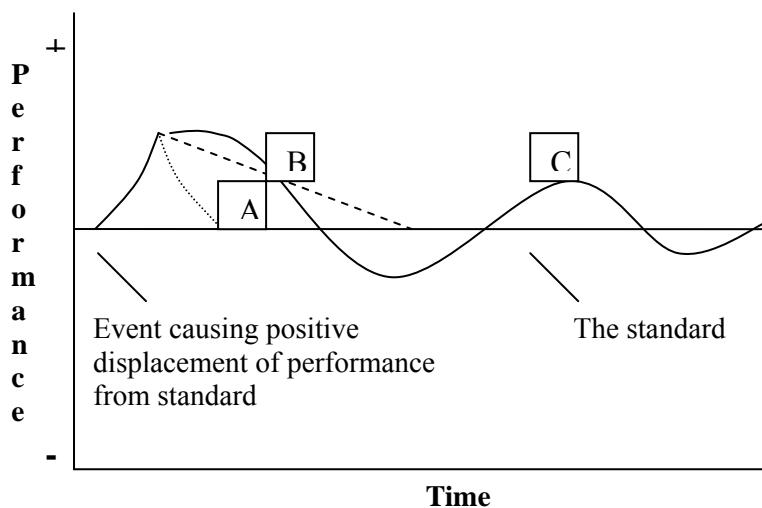
Figure 2. Typical paths for correction or deviation of performance from standard

Figure 3 show a *second-order* control system. This device can alter the system standards according to some predetermined set of rules or program. The complexity of second-order systems can vary widely. The addition of a clock to a thermostat to allow it to maintain different standards during day and night makes the thermostat a second-order controller. Am interactive computer program may alter its responses according to a complex set of pre-programmed rules, but it is still only a second-order system. Many industrial projects involve second-order controllers – for example, robot installations, flexible manufacturing systems, and automated record keeping or inventory systems.
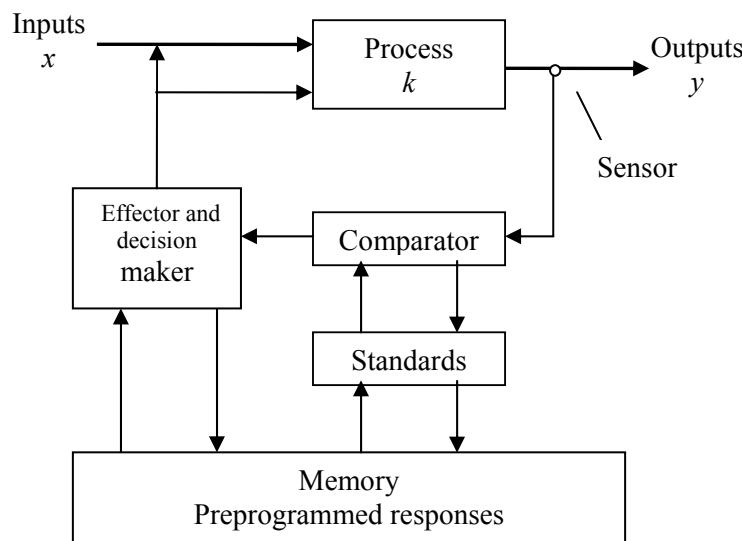
Figure 3. A second-order feedback system- preprogrammed goal changer

A *third-order* control system (Figure 4) can change its goals without specific preprogramming. It can reflect on system performance and decide to act in ways that are not contained in its instructions. Third-order systems have reflective consciousness and, thus, must contain humans. Note that a second-order controller can be programmed to recognize patterns and to react to patterns in specific ways. Such systems are said to "learn". Third-order systems can learn without explicit preprogramming and therefore can alter their actions on the basis of thought or whim. An advantage of third-order controllers is that they can deal with the unforeseen and unexpected. A disadvantage is that, because they contain human elements, they may lack predictability and reliability. Third order systems are of great interest to the PM for reasons we now discuss.
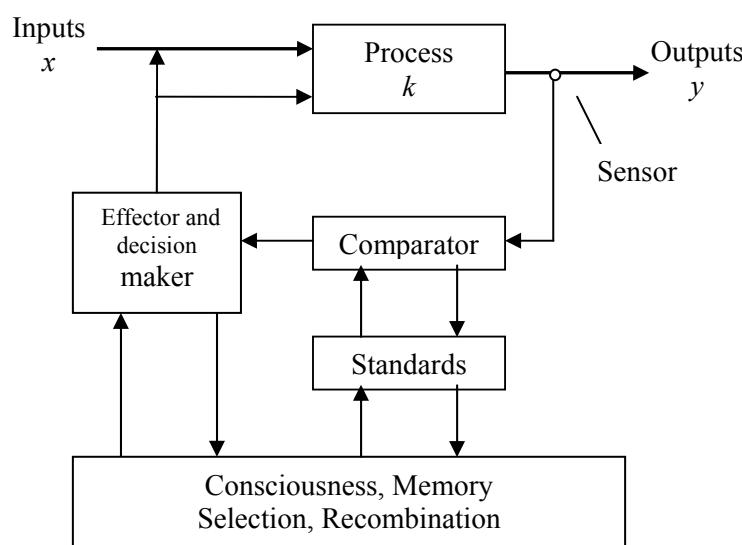
Figure 4. A third-order feedback system – reflective goal changer

Information requirements for cybernetic controllers

In order to establish total control over a system, a controller must be able to take a counter-action for every action the system can take. This statement is a rough paraphrase of Ashby's Law of Requisite Variety. This implies that the PM\ controller is aware of the system's full capabilities. For complex systems, particularly those containing a human element, this is simply not possible. Thus we need a strategy to aid the PM in developing a control system. One such strategy is to use a cost\benefit approach to control – to control those aspects of the system for which the expected benefits of control are greater than the expected costs. We are reminded of a firm that manufactured saw blades. It set up a project to reduce scrap losses for the high-cost steel from which the blades were made. At the end of the one year project, the firm had completed the project – cost $ 9700, savings $4240. (Of course, if the savings were to be repeated for several years, the rate of return on the project would be acceptable. The president of the firm, however, thought that the savings would decline and disappear when the project ended.)

Relatively few elements of a project (as opposed to the elements of a system that operates more or less continuously) are subject to automatic control. An examination of the details of an action plan will reveal which of the project's tasks are largely mechanistic and represent continuous types of systems. If such systems exist, and if they operate across a sufficient time period to justify the initial expense of creating an automatic control, then a cybernetic controller is useful.

Given the decisions about what to control, the information requirements of a cybernetic controller are easy to describe, if not to meet. First, the PM must decide precisely what characteristics of an output (interim output or final output) are to be controlled. Second, standards must be set for each characteristic. Third, sensors must be acquired that will measure those characteristics at the desired level of precision. Fourth, these measurements must be transformed into a signal that can be compared to a standard signal. Fifth, the difference between the two is sent to the decision maker, which detects it, if it is sufficiently large, and sixth, transmits a signal to the effectors that causes the operating system to react in a way that will counteract the deviation from standard. If the control system is designed to allow the effectors to take one or more of several actions, an additional piece of information is needed. There must be built-in criteria that instruct the effectors on which action(s) to take.

Knowledge of cybernetic control is important because all control systems are merely variants, extensions or non-automatic modifications of such controls. Because most projects have relatively few mechanistic elements that can be subjected to classic cybernetic controls, this concept of control is best applied to tracking the system and automatically notifying the project manager when things threaten to get out of control.

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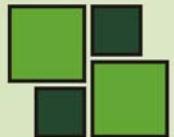
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THE ELASTICITY OF THE PRICE OF A STOCK AND ITS BETA

Cyriac ANTONY

MPh, Lecturer (Selection Grade) in Statistics,
Sacred Heart College Thevara, Kochi, India

E-mail: cyriacantony2003@yahoo.co.in

E.S. JEEVANAND

PhD, Reader in Statistics, Union Christian College, Aluva, Kerala, India

E-mail: radhajeevanand@sancharnet.in, radhajeevanand@yahoo.co.in

Abstract: *Systematic risk in an investment in a security is measured by the security's beta. The beta of a stock is considered as a very important parameter in asset pricing. It is used to estimate the expected return of a stock with respect to its market return. Beta is estimated by the regression method. In this paper, we consider some problems associated with the concept of beta and its estimation. We also advocate for the use of elasticity as an alternative to beta.*

Key words: *Beta; CAPM; characteristic line; price index; risk; least squares; elasticity*

1. Introduction

        Estimating the expected return on investments to be made in the stock market is a challenging job before an ordinary investor. Different market models and techniques are being used for taking suitable investment decisions. The past behaviour of the price of a security and the share price index plays a very important role in security analysis. The straight line showing the relationship between the rate of return of a security and the rate of market return is known as the security's characteristic line. The slope of the characteristic line is called the security's beta. The concept of beta introduced by Markowitz(1959) is being widely used to measure the systematic risk involved in an investment. Ordinary least square (OLS) method is used by researchers and practitioners for estimating the characteristic line.

        The measure beta is an inevitable tool in portfolio management. Asset pricing without beta is unimaginable. The Capital Asset Pricing Model (CAPM) is used to determine a theoretically appropriate required rate of return of an asset that is added to a portfolio. See Sharpe (1964), Linter (1965) and Mossin (1966). Beta plays a prominent role in CAPM. Therefore, the usefulness of CAPM mainly depends on the authenticity of beta.

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In this paper, we explore the meaning of beta and its incapability to measure the sensitivity of return of a security to market returns. We also strongly recommend the use of the concept of elasticity of the price of a stock as an alternative to measure the sensitivity of its price corresponding to the market movements. Using the term elasticity, we modify the CAPM introduced by William Sharpe (1964), John Linter (1965) and Jan Mossin (1966).

This paper is organized as follows. Section 2 discusses the characteristic line of a stock and its limitations in measuring the relationship between the return of a security and the market return. In Section 3 we introduce the concept of the elasticity of a stock and the advantages of elasticity over beta in measuring the sensitivity of the price of a stock with respect to market movements. Section 4 is devoted to a discussion of the idea of modifying the CAPM by replacing beta by elasticity. In section 5 we give an illustration and a comparison of calculated values of beta and elasticity. Section 6 concludes the paper with the main advantages of our results.

2. Characteristic line and beta

The price 'Y' of a stock depends on a number of factors some of which are internal to the company and others external. Empirical studies show that there is a linear relation between the share price index 'X' and Y. Let (X_1, Y_1), (X_2, Y_2), … (X_n, Y_n) be 'n' observations relating to X and Y made at 'n' consecutive periods of time. If 'x' denotes the percentage rate of return of the price index and 'y' denotes that of the security, then the values of x and y are given by

$$x_i = 100 (X_{i+1} - X_i) / X_i \quad \text{and} \quad y_i = 100 (Y_{i+1} - Y_i) / Y_i \text{ for } i = 1,2,3,\ldots,n-1$$

The characteristic line representing the relationship between x and y is given in Figure(1).
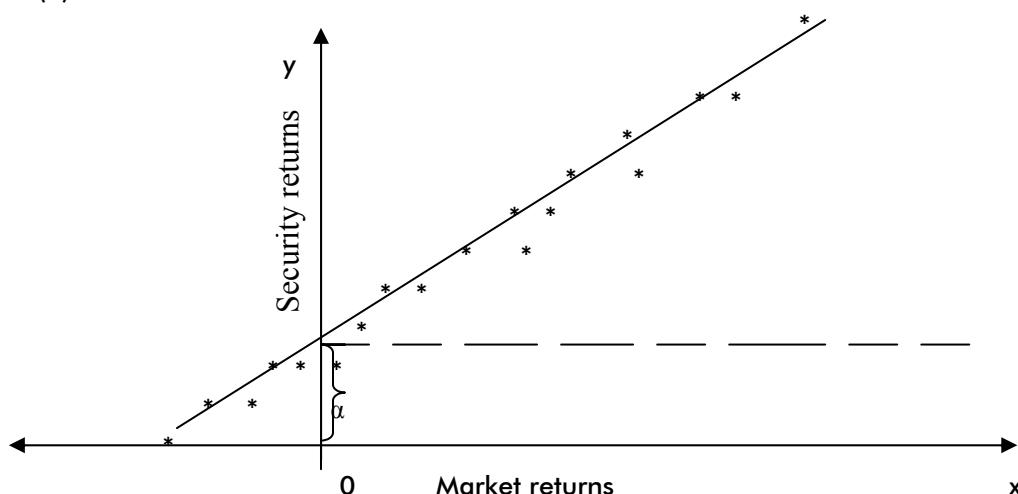

Figure 1. The characteristic line of a stock

The equation of the characteristic line can be written as

$$y = \alpha + \beta x \tag{1}$$

where α and β are constants. The slope of characteristic line β is the security's beta. The characteristic line is estimated by the least squares method. At present, beta is taken as the

measure of the sensitivity of the security's price Y with respect to market changes. Beta shows how the price of a security responds to market forces. It is an indispensable tool in asset pricing.

2.1. Problems of the characteristic line and beta

As beta is the slope of a straight line, it is always a constant. Blume (1971), Hamada (1972) and Alexander & Chervani (1980) challenged the stability of beta. They argued that beta is time varying. Black (1976) linked beta to leverage which changes owing to changes in the stock price. Mandelker & Rhee (1984) related beta to decisions by the firm and thus a varying measure. The relationship between macro-economic variables and the firm's beta, as illustrated in the work of Rosenberg & Guy (1976) points to the varying character of beta. Since beta is evaluated as the covariance between the stock returns and index returns, scaled down by the variance of the index returns and the index volatility is time-varying (Bollerslev et al. 1992), beta is not constant over a period of time. Roll et al (1994) point out the inefficiency of the CAPM for estimating the expected returns using beta.

The constancy nature of beta raises doubts about the suitability of using it as a measure of the sensitivity of the security's return corresponding to market returns. This led us to think of a suitable measure that reflects instantaneous changes of the market.

Even if x and y are related by (1), beta alone cannot be used to measure the sensitivity of the price of the security. The parameter α also will play a major role unless its value is tested statistically insignificant. To measure the market sensitivity, the concept of elasticity is more useful. We discuss elasticity in the next section.

To understand and measure the response of the price of a security with respect to market changes, we need only the relationship between X and Y. Using regression method, the best linear equation can be estimated as

$$Y = a + b X \qquad\qquad (2)$$

where a and b are constants.

3. Elasticity of price of a stock

The term 'elasticity' is a technical term used mainly by economists to describe the degree of responsiveness of the endogenous variable in an economic model with respect to the changes in the exogenous variable of the model. It measures the percentage change in the endogenous variable when the exogenous variable is increased or decreased by 1 %. So the concept of elasticity will be useful to measure the sensitivity of the price of a stock corresponding to market movements. If Y = f (X) is the functional relationship between X and Y, then the elasticity of Y with respect to X is given by

$$\eta = \frac{X}{Y} \cdot \frac{dY}{dX}$$

Theorem 1.

The elasticity of price of a security with respect to price index is a constant 'k' if and only if the relationship between the price Y of the security and the price index X is of the form

$$Y = C X^k \qquad \text{where } C > 0, \ k > 0$$

By definition,

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$$\eta = \frac{X\, C\, kX^{k\text{-}l}}{CX^k} = k$$

Conversely, if the elasticity is a constant, then

$$\frac{X}{Y} \cdot \frac{dY}{dX} = k$$

which implies

$$\frac{dY}{Y} = k \cdot \frac{dX}{X}$$

On integration of both sides,

$$\log Y = k \log X + \log C = \log C X^k$$

which implies

$$Y = C X^k, \quad C > 0, \; k > 0$$

Where log C is the constant of integration. If k =1, then Y = C X which represents a straight line passing through the origin. For any other value of k, the relationship is a power curve. This indicates that the sensitivity of the price of a security is a varying measure unless the relationship between the price of the security and the price index is a power curve.

If X and Y are related by (2), then

$$\eta = \frac{b\, X}{a + b\, X}$$

Note that the value of η is not a constant. It depends on the value of X. So, η varies when X varies. This means that the sensitivity of the price of a stock is not the same at all levels of the index. Further, the value of η depends on both the parameters a and b.

Case (i). $\eta = 1$.

This is the case when the price return of a stock is the same as that of the market return. This means that the price of a security increases (decreases) by 1 % when the share price index increases (decreases) by 1 %. In this case, a = 0. Since the intercept is zero, the regression line passes through the origin. See Figure 2.
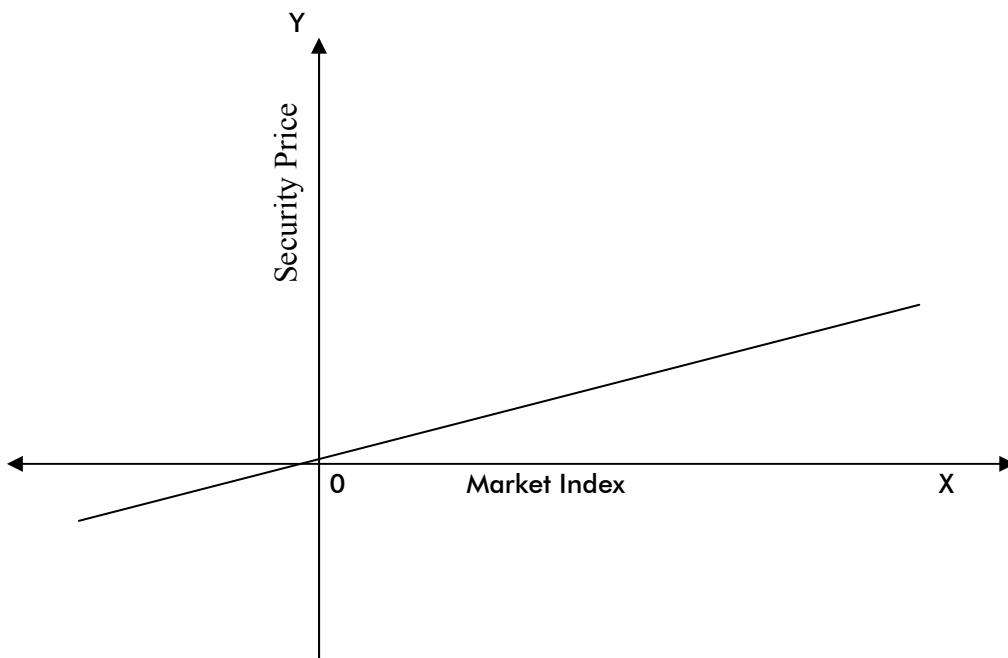
Figure 2. The regression of price of a stock on market index when $\eta = 1$.

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It is very interesting to see that the elasticity remains unity for any regression line passing through the origin irrespective of the slope of the line.

Case (2). $\eta > 1$.

This is the case when the price return of a stock is more than proportional to market return. Since the price of a stock and the market index are generally positively correlated, the slope of the regression line 'b' is positive. Therefore, $\eta > 1$ only if 'a' is negative. See Figure 3.
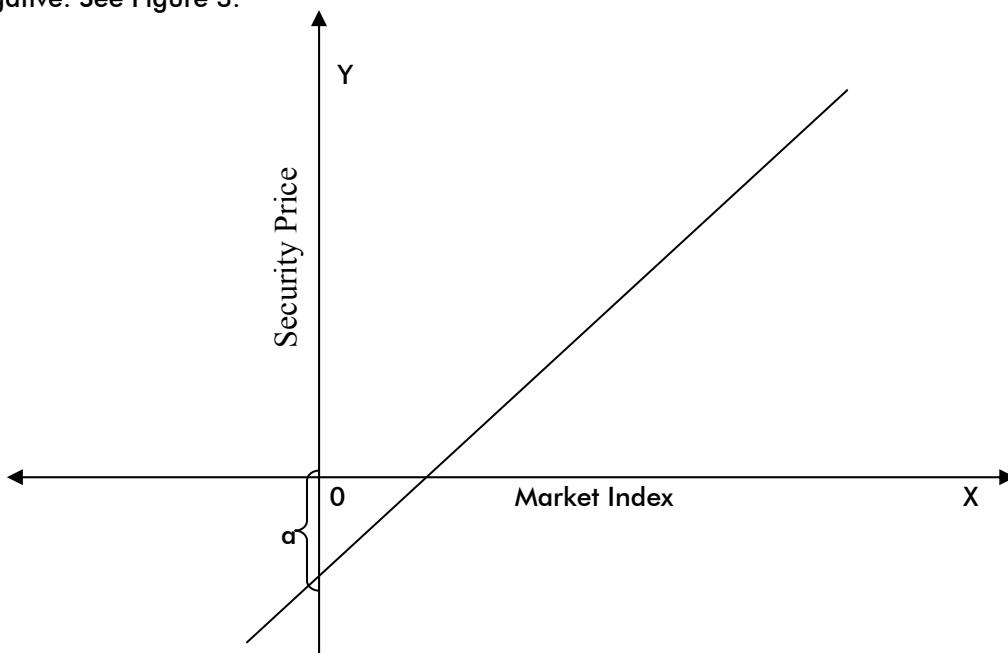
Figure 3. The regression of price of a stock on market index when $\eta > 1$.

Case (3). $\eta < 1$.

This is the case when the price return of a stock is less than proportional to market return. That is, the price of the security increases (decreases) by less than 1 % when the share price index increases (decreases) by 1%. Also, $\eta < 1$ only if 'a' is positive. See Figure 4.
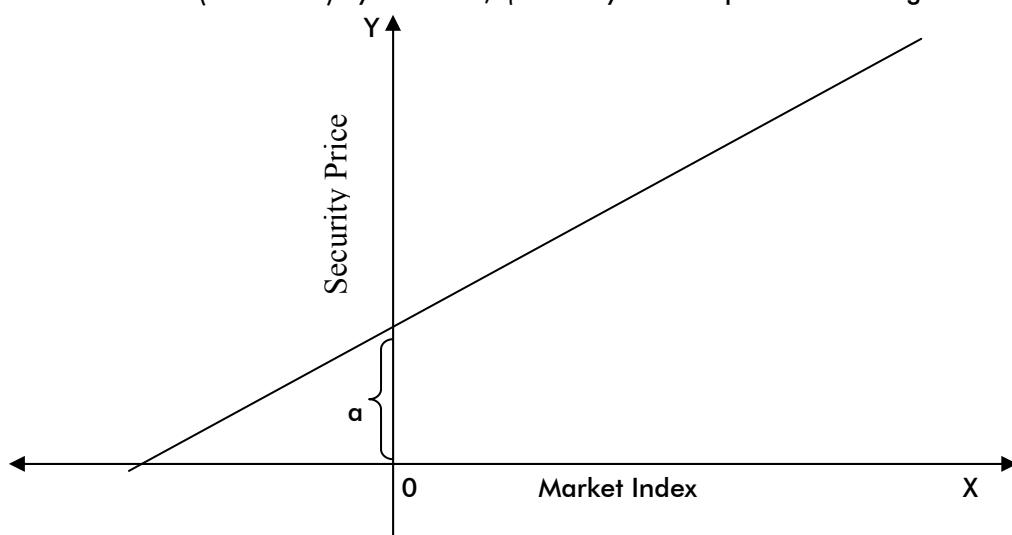
Figure 4. The regression of price of a stock on market index when $\eta < 1$.

4. Modified CAPM

Since elasticity measures the sensitivity of a security's price movement relative to the market movement, it will be more meaningful to replace the beta coefficient in the CAPM by the elasticity of the security. Then the modified CAPM takes the form

$$Rs = R_f + \eta (R_m - R_f) \tag{3}$$

Where

Rs = the return required on investment

R_f = the return that can be earned on a risk-free investment

R_m = the return on the market index for a given index

η = the security's sensitivity (elasticity) to market movement for a given index

In the present form of the CAPM, beta remains the same irrespective of the sensitivity of the security with respect to market index. It depends only on the return on market and not on the index level. But, in the modified form, importance is given to η that varies as index varies. This is the striking advantage of the modified CAPM over the present form.

5. Illustration

This study is based on prices of shares of Reliance Industries Listed (RIL) at Mumbai Stock Exchange (BSE) in India and the BSE's benchmark price index Sensex during the period March 1996 to March 2006.Data relating to the financial year closing prices (Y) of (RIL) Shares and the Sensex (X) are given in Table 1. The yearly returns of X and Yare denoted by x and y respectively.

The regression of Y on X is given by

$$Y = - 110.839 + 0.098918 X \tag{4}$$

Table 1. Yearly returns of RIL shares and Sensex (Price in Indian Rupees)

Period	X	Y	x	y
Mar-96	3367	104.97		
Mar-97	3361	154.45	-0.18	47.14
Mar-98	3893	177.20	15.83	14.73
Mar-99	3740	130.50	-3.93	- 26.35
Mar-00	5001	318.70	33.72	144.21
Mar-01	3604	391.20	-27.93	22.75
Mar-02	3469	398.40	-3.75	1.84
Mar-03	3158	278.50	-8.97	- 30.10
Mar-04	5613	538.20	77.74	93.25
Mar-05	6679	546.20	18.99	1.49
Mar-06	11603	1033.40	73.72	89.20

Source: Annual reports of Reliance Industries Limited and BSE publications

The elasticity of the price of the stock is

$$\eta = \frac{0.0989 \, X}{- 110.839 + 0.0989 \, X}$$

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When X = 9000, η = 1.14. This implies that when the price index is 9000, 1 % increase (decrease) in the index is followed by 1.14 % increase (decrease) and 10% increase (decrease) in the index is followed by 11.4 % increase (decrease) in the price of the share.

When X = 3500, η = 1.47. This shows that the sensitivity is varying at different levels of the index. It can also be seen that the sensitivity of the price of the RIL stock is very high for low values of the Sensex and comparatively low for higher values of the Sensex. Also, since the intercept is negative, η >1.

Now the characteristic equation based on the returns x and y is

$$y = 16.15 + 1.122 \, x \tag{5}$$

When the market return is x = 1 %, y = 17.37 % which is an exaggerated value. Also, when x = 10 %, y = 27.37 %. In this case, the proportionality is not maintained as in the case of η. This implies that relation (5) has no meaning. Therefore the beta value β = 1.122 has no role in measuring the market sensitivity. Further, the different points (x, y) in the scatter diagram exhibit no functional relationship. For example, the points corresponding to March-2000 (33.72,144.21) and March-2005 (18.99,1.49) are not comparable. In fact, the Sensex and the price of the stock registered 33.55 % and 71.38 % in 2005 compared to the values in 2000. Since the coordinates (x, y) of a period are based on the values of the previous period, there is no common origin of measurements for the different points. As the different points in the scatter diagram will have no relationship between themselves, the concept of regression cannot be used for estimation purposes. This problem will be more aggressive if beta is estimated on the basis of a random sample.

Table 2. gives the returns of RIL shares (x) and Sensex (y) on arbitrary selected periods. X_1 and Y_1 are the values of X and Y arranged in another order. The returns of X_1 and Y_1 are denoted by x_1 and y_1 respectively.

Table 2. Returns of RIL shares and Sensex on arbitrary periods

X	Y	x	y	X_1	Y_1	x_1	y_1
3367.00	104.97			3740.00	130.50		
3361.00	154.45	-0.18	47.14	5001.00	318.70	33.72	144.21
3893.00	177.20	15.83	14.73	3604.00	391.20	-27.93	22.75
3740.00	130.50	-3.93	-26.35	3367.00	104.97	-6.58	-73.17
5001.00	318.70	33.72	144.21	3361.00	154.45	-0.18	47.14
3604.00	391.20	-27.93	22.75	3893.00	177.20	15.83	14.73
3469.00	398.40	-3.75	1.84	6679.00	546.20	71.56	208.24
3158.00	278.50	-8.97	-30.10	5713.00	540.30	-14.46	-1.08
5613.00	538.20	77.74	93.25	5786.00	576.50	1.28	6.70
6679.00	546.20	18.99	1.49	5186.00	486.00	-10.37	-15.70
3469.00	293.90	-48.06	-46.19	4756.00	423.30	-8.29	-12.90
3554.00	334.30	2.45	13.75	5677.00	534.90	19.37	26.36
3238.00	271.50	-8.89	-18.79	3469.00	398.40	-38.89	-25.52
4311.00	410.50	33.14	51.20	3158.00	278.50	-8.97	-30.10
5186.00	486.00	20.30	18.39	5613.00	538.20	77.74	93.25
5713.00	540.30	10.16	11.17	6325.00	514.80	12.68	-4.35
5786.00	576.50	1.28	6.70	8649.00	829.30	36.74	61.09
5677.00	534.90	-1.88	-7.22	3469.00	293.90	-59.89	-64.56
6325.00	514.80	11.41	-3.76	3554.00	334.30	2.45	13.75
4756.00	423.30	-24.81	-17.77	3238.00	271.50	-8.89	-18.79
8649.00	829.30	81.85	95.91	4311.00	410.50	33.14	51.20

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The regression equation of y on x is

$$y = 8.20 + 1.167\,x \tag{6}$$

The regression equation of y_1 on x_1 is

$$y_1 = 12.45 + 1.617\,x_1 \tag{7}$$

The beta coefficients of (6) and (7) are considerably different. Further, the correlation coefficients between x and y is different from that between x_1 and y_1. This shows that beta cannot be estimated on the basis of a random sample. But, the regression equation of Y on X is the same as that of Y_1 on X_1. Similarly, the correlation coefficients between X and Y and that between X_1 and Y_1 are also the same. The elasticity also remains the same.

6. Conclusion

According to Nelson(2006), any asset pricing model should consider two areas of concern. The first concern is whether the model is well specified in random samples. The second concern is whether the model is powerful enough to explain stock returns. Our concept of elasticity and the modified CAPM address these two concerns. Also, this paper exposes the misconception of beta for measuring the sensitivity of the price of a security with respect to market movements. It also presents the mathematical logic against the fitting of a linear relation using regression method to a set of points that are not measured from an origin.

Our results show that the sensitivity of a stock is generally a varying aspect. Since beta is a constant as it is the slope of a straight line, it cannot be used to measure the sensitivity of a stock corresponding to market changes. The strong evidence in favour of time-varying betas (Bollerslev et al. 1992) highlights the limitations of ordinary least square betas. Further, the sensitivity of scrip's return depends largely on the elasticity of the price of the security. There are some securities that are more sensitive when the market index is at a peak level and less sensitive when the market index is at the moderate level. The expected rate of return varies from point to point. So, to estimate the expected rate of return corresponding to market returns, the use of the elasticity of price of the stock is advisable. Asset pricing based on elasticity will be more appealing than the one based on constant beta.

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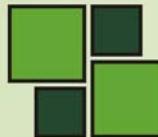
SOME ASPECTS ON SOLVING A LINEAR FRACTIONAL TRANSPORTATION PROBLEM

Dorina MOANTA[1]

PhD, Department of Mathematics,
University of Economics, Bucharest, Romania
Main published books: Three dimensional transport problems, Denbridge Press, New York
2006; Teorie si practica in probleme de transport, Cartea Universitara, Bucharest, 2006

E-mail: dorina.moanta@yahoo.com

Abstract: *This paper presents the three-dimensional transportation problem, a double sum model in which the objective function is the ratio of two positive linear functions. This paper objective is to present how to obtain optimum with simplex method. To illustrate the procedure, a numerical example is given.*

Key words: *the three dimensional transportation problem; programming with fractional linear objective function; simplex method*

Problem Description

I am proposing now to solve the 3-dimensional transport problem – a double sum model - with the fractional linear objective function and linear constraints:

$$\min f(x) = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} m_{ijk} x_{ijk}}{\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} n_{ijk} x_{ijk}} \tag{1}$$

$$\sum_{j=1}^{n}\sum_{k=1}^{p} x_{ijk} = a_i \qquad i = 1, m \tag{2}$$

$$\sum_{i=1}^{m}\sum_{k=1}^{p} x_{ijk} = b_j \qquad j = 1, n \tag{3}$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijk} = c_k \qquad k = 1, p \tag{4}$$

$$x_{ijk} \geq 0 \qquad i = 1, m \qquad j = 1, n \qquad k = 1, p \tag{5}$$

$$a_i, b_j, c_k > 0 \tag{6}$$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j = \sum_{k=1}^{p} c_k = T \tag{7}$$

Requiring the following specifications:

      m – the number of sources

      n – the number of destinations

      p – the number of means of conveyance

      ai – the available quantity in each source i = 1,m

      bj – the necessary quantity in each destination j = 1,n

      ck – the quantity with must be transported by means of conveyance k = 1,p

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} m_{ijk} x_{ijk} \geq 0 \quad , \quad \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} n_{ijk} x_{ijk} > 0$$

Matrix $X = \{x_{ijk} \setminus i = 1, m; j = 1, n; k = 1, p\}$,   which   satisfies constraints (2) (3) (4) (5), is called a transportation plan (feasible solution) and plan X is called optimum if it satisfies (1).

When the condition (7) is satisfied, the resulting formulation is called a balanced transportation problem. Relation (7) is the necessary and sufficient condition for the existence of the solution: the level of the matrix of the constraint system is m+n+p showing that a non-degenerated transportation plan of problem (1-7) contains at least m+n+p-2 non-null components;

The objective is to establish a transportation plan with minimum total expenses.

The function (1) is explicit quasi concave in S = { X / (2) (3) (4) (5) } i.e.:

If $x_1, x_2 \in S$, $x_1 \neq x_2$, $f(x_1) \neq f(x_2)$, $\lambda \in (0,1)$ and $x_0 = \lambda x_1 + (1- \lambda)x_2$ then $\min[f(x_1), f(x_2)] < f(x_0)$.

For such function, local minimum is not necessarily a global minimum. Every differentiable [3] explicit quasi concave function is pseudo concave as well. An optimality criterion for local minimum is given in [1]

In this paper is made to generalize the results given by [2],[6]. This paper objective is to present how to obtain optimum with the help of the simplex method.

Solving the problem

The considerations concerning the three-dimensional problem are valid.

An initial feasible solution can be obtained by using the known methods from the three-dimensional transport problem [4][5].

We denote $I_x = \{(i,j,k) / x_{ijk} > 0, x_{ijk} \in X\}$

Due to (7) each nondegenerate solution will contain m+n+p–2 positive components.

We consider the dual variables (simplex multipliers):

$$u_i^1, \ u_i^2, \ i = \overline{1,m} \ , \qquad\qquad v_j^1, \ v_j^2, \ j = \overline{1,n} \ , \qquad\qquad w_k^1, \ w_k^2, \ k = \overline{1,p}$$

defined such that:

$$m_{ijk} = u_i^1 + v_j^1 + w_k^1 \tag{8}$$

$$n_{ijk} = u_i^2 + v_j^2 + w_k^2 \tag{9}$$

for (i, j, k) ∈ I_x and

$$m'_{ijk} = m_{ijk} - (u_i^1 + v_j^1 + w_k^1) \qquad\qquad \forall(i,j,k) \tag{10}$$

$$n'_{ijk} = n_{ijk} - (u_i^2 + v_j^2 + w_k^2) \qquad \forall (i,j,k)$$

(11)

System (8) – (9) can be solved independently. So, system (8) – (9) has m+n+p-2 equations with m+n+p variables. We can arbitrarily set $u_1^1 = 0$, $v_1^1 = 0$ and solve for the other multipliers.

Having determined u_i^1, u_i^2, v_j^1, v_j^2, w_k^1, w_k^2 we shall use these values to determine m'_{ijk} and n'_{ijk} for the non-basic variables.

Let X* = (x*$_{ijk}$)$_{ijk}$ be a feasible solution of the problem (1) – (7).

To establish the optimal criterion we express f(x) in terms of the non-basic variables only.

$$\sum_i \sum_j \sum_k m_{ijk} x_{ijk} = \sum_i \sum_j \sum_k m_{ijk} x_{ijk} + \sum_i \left(a_i - \sum_j \sum_k x_{ijk} \right) u_i^1 + \sum_j \left(b_j - \sum_i \sum_k x_{ijk} \right) \cdot v_j^1 +$$

$$+ \sum_k \left(c_k - \sum_i \sum_j x_{ijk} \right) \cdot w_k^1 =$$

$$= \sum_i \sum_j \sum_k \left(m_{ijk} - u_i^1 - v_j^1 - w_k^1 \right) \cdot x_{ijk} + \sum_i a_i u_i^1 + \sum_j b_j v_j^1 + \sum_k c_k w_k^1 =$$

$$= \sum_i \sum_j \sum_k m'_{ijk} x_{ijk} + V_1$$

By means of a similar procedure we can also write :

$$\sum_i \sum_j \sum_k n_{ijk} x_{ijk} = \sum_i \sum_j \sum_k n'_{ijk} x_{ijk} + V_2$$

where   Vs = $\displaystyle\sum_{i=1}^{m} a_i u_i^s + \sum_{j=1}^{n} b_j v_j^s + \sum_{k=1}^{p} c_k w_k^s$,   s=1,2   (11)

Therefore the function f(x) becomes:

$$f(x) = \frac{\displaystyle\sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{p} m'_{ijk} x_{ijk} + V_1}{\displaystyle\sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{p} n'_{ijk} x_{ijk} + V_2}$$

For $\forall (i,j,k) \in I - I_x$ we have

$$\frac{\partial f}{\partial x_{ijk}} = \frac{m'_{ijk} \left(\displaystyle\sum_{I-I_x} n'_{ijk} x_{ijk} + V_2 \right) - n'_{ijk} \left(\displaystyle\sum_{I-I_x} m'_{ijk} x_{ijk} + V_1 \right)}{\left(\displaystyle\sum_{I-I_x} n'_{ijk} x_{ijk} + V_2 \right)^2}$$

The partial derivates of the function f(x) evaluated at the point $x_{ijk} = x_{ijk}^*$ are:

$$\left. \frac{\partial f}{\partial x_{ijk}} \right|_{x_{ijk} = x_{ijk}^*} = \frac{m'_{ijk} V_2 - n'_{ijk} V_1}{(V_2)^2}$$

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We note $\qquad \Delta_{ijk} = m'_{ijk} V_2 - n'_{ijk} V_1$

The dual variables u_i^1, u_i^2, v_j^1, v_j^2, w_k^1, w_k^2 $\qquad i = \overline{1, m}$ $\qquad j = \overline{1, n}$

$k = \overline{1, p}$ determined, it would be easy to calculate Δ_{ijk} for non-basic variables.

The solution X* can be improved if it exists at least a value $\Delta_{ijk} < 0$

Theorem A solution $X^* = (x^*_{ijk})_{ijk}$ is a local optimum if $\Delta_{ijk} \geq 0$ for all non-basic variables.

If one of this values is not positive, we choose

$$\Delta_{i_0 j_0 k_0} = \min\{\Delta_{ijk} | \Delta_{ijk} < 0\}$$

and we improve the value of f(x) by introducing $x_{i_0 j_0 k_0}$ in the set of basic variables.

The variable which leaves the basis and the value of the basic variable in the basis can be determined as usual.

Example

Consider the problem with $\qquad$ m=3, n=2, p=3, and

$a_1 = 24$, $b_1 = 40$, $c_1 = 16$

$a_2 = 8$, $\quad b_2 = 19$, $c_2 = 31$

$a_3 = 27$, $\qquad \qquad c_3 = 12$

The matrices of costs: m_{ijk} / n_{ijk}

k=1

i \ j	1	2
1	15/8	9/3
2	19/20	15/14
3	14/10	24/20

k=2

i \ j	1	2
1	18/15	14/10
2	20/15	21/15
3	11/10	23/20

k=3

i \ j	1	2
1	7/3	11/5
2	17/10	14/10
3	8/5	13/6

An initial feasible solution obtained as in [4],[5] is X_0:

k=1

i \ j	1	2
1	16	
2		
3		

k=2

i \ j	1	2
1		8
2	8	
3	15	

k=3

i \ j	1	2
1		
2		
3	1	11

for which the value of objective function is $\qquad f_0 = \dfrac{828}{549} \approx 1,5$

Optimality verification : we determine the quantities u_i^1, v_j^1, w_k^1, u_i^2, v_j^2, w_k^2

, $i = \overline{1,3}$ $j = \overline{1,2}$ $k = \overline{1,3}$

from systems:

$u_1^1 + v_1^1 + w_1^1 = 15$ $\qquad \qquad u_1^2 + v_1^2 + w_1^2 = 8$

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$$u_1^1 + v_2^1 + w_2^1 = 14 \qquad u_1^2 + v_2^2 + w_2^2 = 10$$

$$u_2^1 + v_1^1 + w_2^1 = 20 \qquad u_2^2 + v_1^2 + w_2^2 = 15$$

$$u_3^1 + v_1^1 + w_2^1 = 11 \qquad u_3^2 + v_1^2 + w_2^2 = 10$$

$$u_3^1 + v_1^1 + w_3^1 = 8 \qquad u_3^2 + v_1^2 + w_3^2 = 5$$

$$u_3^1 + v_2^1 + w_3^1 = 13 \qquad u_3^2 + v_2^2 + w_3^2 = 6$$

We obtain

$u_1^1 = 0$	$v_1^1 = 0$	$w_1^1 = 15$	$u_1^2 = 0$	$v_1^2 = 0$	$w_1^2 = 8$
$u_2^1 = 11$	$v_2^1 = 5$	$w_2^1 = 9$	$u_2^2 = 6$	$v_2^2 = 1$	$w_2^2 = 9$
$u_3^1 = 2$		$w_3^1 = 6$	$u_3^2 = 1$		$w_3^2 = 4$

The matrices: m'_{ijk} / n'_{ijk}

k=1

i \ j	1	2
1	0/0	-11/-6
2	-7/6	-16/-1
3	-3/-1	2/10

k=2

i \ j	1	2
1	9/6	0/0
2	0/0	-4/-1
3	0/0	7/9

k=3

i \ j	1	2
1	1/-1	0/0
2	0/0	-8/-1
3	0/0	0/0

For which $V_1 = 828$

$$V_2 = 549, \quad V_1 \approx 1,5 V_2$$

And matrix $\Delta_{ijk} = m'_{ijk} \cdot V_2 - n'_{ijk} \cdot V_1 \approx V_2(m'_{ijk} - 1,5 \cdot n'_{ijk}) = V_2 \cdot \Delta'_{ijk}$

($\Delta_{ijk} = 0$ for basic components).

Matrix Δ'_{ijk} :

k=1

i \ j	1	2
1	0	-2
2	-16	-14,5
3	-4,5	-13

k=2

i \ j	1	2
1	0	0
2	0	-2,5
3	0	-6,5

k=3

i \ j	1	2
1	2,5	0
2	0	-6,5
3	0	0

The solution is not optimum because there are components Δ_{ijk} < 0.
We improved solution:

Input criterion : $\Delta_{211} = -16 = \min\{\Delta_{ijk} | \Delta_{ijk} < 0\}$

Output criterion: as in [4],[5]: for basic components :

$$z_{111} = 1 \qquad z_{212} = 1 \qquad z_{313} = -1$$

$$z_{122} = -1 \qquad z_{322} = 0 \qquad z_{323} = 1$$

$$\theta = \min(x_{111}, x_{212}, x_{323}) = \min(16, 8, 11) = 8 \qquad\qquad x_{212} = \theta = 8$$

Solution actualization for basic components:

$$x'_{ijk} = x_{ijk} - \theta \cdot z_{ijk}$$

$$x_{212} = 0$$

$$x_{211} = 8$$

The new solution X_1 is:

k=1		
i \ j	1	2
1	8	
2	8	
3		

k=2		
i \ j	1	2
1		16
2		
3	15	

k=3		
i \ j	1	2
1		
2		
3	9	3

for which the value of objective function is $f_1 = \dfrac{772}{597} \approx 1,3$

Resume from optimality verification

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[1] Dorina Moanta has received a B.S. from Faculty of Mathematics, University of Bucharest. Also, she has received a degree in Informatics and has a Ph.D. in Economics - Economic Cybernetics field. She is the author of more than 16 articles in Operations Research, Economic Calculus and Informatics and attended at numerous specialty congresses. Recently published books:
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THE WEIGHTED POSSIBILISTIC MEAN VARIANCE AND COVARIANCE OF FUZZY NUMBERS

Supian SUDRADJAT[1]

PhD, Department of Mathematics, Faculty of Mathematics and Natural Sciences,
Padjadjaran University, Jl. Raya Bandung-Sumedang Jatinangor 40600, Bandung, Indonesia

E-mail: adjat03@yahoo.com

Abstract: *In the context of Markowitz portfolio selection problem (Markowitz,1959), this paper develops a "weighted" possibilistic mean-variance and covariance portfolio selection model. In the process of selecting a portfolio, this work is concerned with the choice of the portfolio (Markowitz,1952).*

Key words: Portfolio selection; VaR; Possibilistic mean value; Possibilistic theory; Weighted possibilistic mean; Fuzzy theory

1. Introduction

This article is organized in the following way: Section 2 propose an overview of proportional transaction costs model; in Section 3 we consider the possibilistic theory proposed by Zadeh [15][2] and we present the rate of return on security given by a trapezoidal fuzzy number; in Section 4, we stated the weighted possibilistic mean variance and covariance of fuzzy numbers. Thus are extended some recently results in this field [8,12,15].

2. The proportional transaction costs model

Transaction cost is one of the main sources of concern to managers see [1, 16].

Assume the rate of transaction cost of security j ($j=1,..,n$) and allocation of i ($i=1,...,k$) assets is c_{ji}, thus the transaction cost of security j and allocation of i assets is $c_{ji}x_j$. The transaction cost of portfolio $x=(x_1,...,x_n)$ is $\sum_{j=1}^{n}c_{ji}x_j$, $i=1,...,k$. Considering the proportional transaction cost and the shortfall probability constraints, we purpose the following mean *VaR* portfolio selection model with transaction costs [14]:

$$\underset{x \in R^n}{Max}\left[E(v_1) - \sum_{j=1}^{n}c_{j1}x_j, ..., E(v_k) - \sum_{j=1}^{n}c_{jk}x_j \right] \qquad (2.1)$$

Subject to $\Pr\{v_i < (VaR)_i\} \le \beta_i$, $i=1,...,k$, $\qquad (2.2)$

$$\sum_{j=1}^{n} x_j = 1, \tag{2.3}$$

$$M_{1j} \le x_j \le M_{2j}, \quad j = 1, \dots, n. \tag{2.4}$$

3. Triangular and trapezoidal fuzzy numbers

We consider the possibilistic theory proposed by Zadeh [15]. Let $\widetilde{a}$ and $\widetilde{b}$ be two fuzzy numbers with membership functions $\mu_{\widetilde{a}}$ and $\mu_{\widetilde{b}}$ respectively. The possibility operator (*Pos*) is defined in [12].

Let the rate of return on security given by a trapezoidal fuzzy number $\widetilde{r} = (r_1, r_2, r_3, r_4)$ where $r_1 < r_2 \le r_3 < r_4$. Then the membership function of the fuzzy number $\widetilde{r}$ can be denoted by:

$$\mu(x) = \begin{cases} \dfrac{x - r_1}{r_2 - r_1} & , r_1 \le x \le r_2, \\ 1 & , r_2 \le x \le r_3, \\ \dfrac{x - r_4}{r_3 - r_4} & , r_3 \le x \le r_4, \\ 0 & , otherwise. \end{cases} \tag{3.1}$$

We mention that trapezoidal fuzzy number is *triangular* fuzzy number if $r_2 = r_3$.

Let us consider two trapezoidal fuzzy numbers $\widetilde{r} = (r_1, r_2, r_3, r_4)$ and $\widetilde{b} = (b_1, b_2, b_3, b_4)$.

If $r_2 \le b_3$, then we have

$$Pos(\widetilde{r} \le \widetilde{b}) = \sup\{ \min\{\mu_{\widetilde{r}}(x), \mu_{\widetilde{b}}(y)\} \mid x \le y\}$$
$$\ge \min\{ \mu_{\widetilde{r}}(r_2), \mu_{\widetilde{b}}(b_3) \} = \min\{1,1\} = 1,$$

which implies that $Pos(\widetilde{r} \le \widetilde{b}) = 1$. If $r_2 \ge b_3$ and $r_1 \le b_4$ then the supremum is achieved at point of intersection δ_x of the two membership function $\mu_{\widetilde{r}}(x)$ and $\mu_{\widetilde{b}}(x)$. A simple computation shows that

$$Pos(\widetilde{r} \le \widetilde{b}) = \delta = \frac{b_4 - r_1}{(b_4 - b_3) + (r_2 - r_1)}$$

and

$$\delta_x = r_1 + (r_2 - r_1)\delta$$

If $r_1 > b_4$, then for any $x < y$, at least one of the equalities $\mu_{\widetilde{r}}(x) = 0$, $\mu_{\widetilde{b}}(y) = 0$ hold. Thus we have $Pos(\widetilde{r} \le \widetilde{b}) = 0$. Now we summarize the above results as

$$Pos(\widetilde{r} \le \widetilde{b}) = \begin{cases} 1, & r_2 \le b_3 \\ \delta, & r_2 \ge b_3, \ r_1 \le b_4 \\ 0, & r_1 \ge b_4 \end{cases} \tag{3.2}$$

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Especially, when $\widetilde{b}$ is the crisp number 0, then we have

$$Pos\left(\widetilde{r} \leq 0\right) = \begin{cases} 1, & r_2 \leq 0 \\ \delta, & r_1 \leq 0 \leq r_2 \\ 0, & r_1 \geq 0 \end{cases} \tag{3.3}$$

where

$$\delta = \frac{r_1}{r_1 - r_2} . \tag{3.4}$$

We now turn our attention the following lemma.

Lemma 3.1 [4] *Assume that trapezoidal fuzzy number* $\widetilde{r} = \left(r_1, r_2, r_3, r_4\right)$. *Then for any given confidence level* α *with* $0 \leq \alpha \leq 1$, $Pos\left(\widetilde{r} \leq 0\right) \geq \alpha$ *if and only if* $(1-\alpha)r_1 + \alpha r_2 \leq 0$.

The λ level set of a fuzzy number $\widetilde{r} = \left(r_1, r_2, r_3, r_4\right)$ is a crisp subset of R and denoted by $[\widetilde{r}]^\lambda = \{x | \mu(x) \geq \lambda, x \in R\}$, then according to Carlsson et al [3], we have

$$[\widetilde{r}]^\lambda = \{x | \mu(x) \geq \lambda, x \in R\} = [r_1 + \lambda(r_2 - r_1), r_4 - \lambda(r_4 - r_3)].$$

Given $[\widetilde{r}]^\lambda = [a_1(\lambda), a_2(\lambda)]$, the crisp possibilistic mean value of $\widetilde{r} = \left(r_1, r_2, r_3, r_4\right)$ is

$$\widetilde{E}(\widetilde{r}) = \int_0^1 \lambda(a_1(\lambda) + a_2(\lambda))d\lambda ,$$

where $\widetilde{E}$ denotes fuzzy mean operator.

We can see that if $\widetilde{r} = \left(r_1, r_2, r_3, r_4\right)$ is a trapezoidal fuzzy number then

$$\widetilde{E}(\widetilde{r}) = \int_0^1 \lambda(r_1 + \lambda(r_2 - r_1) + r_4 - \lambda(r_4 - r_3))d\lambda = \frac{r_2 + r_3}{3} + \frac{r_1 + r_4}{6} . \tag{3.5}$$

4. The weighted possibilistic mean variance and covariance of fuzzy numbers

The classical mean-variance portfolio selection problem uses the variance as the measure for risk, which puts the same weight on the down side and upside of the return. In this section, we study the "weighted" possibilistic mean-variance and covariance portfolio selection model.

Definition 4.2 [6]) *Let* $\widetilde{r} \in F$ *be a fuzzy number with* $[\widetilde{r}]^\lambda = [r_1(\lambda), r_2(\lambda)]$, $\lambda \in [0,1]$. *The* w-*weighted possibilistic variance of* $\widetilde{r}$ *is*

$$Var_w(\widetilde{r}) = \int_0^1 \left(\frac{r_2(\lambda) - r_1(\lambda)}{2}\right)^2 w(\lambda)d\lambda$$

$$= \int_0^1 \frac{1}{2}\left(\left[\frac{r_1(\lambda) + r_2(\lambda)}{2} - r_1(\lambda)\right]^2 + \left[r_2(\lambda) - \frac{r_1(\lambda) + r_2(\lambda)}{2}\right]^2\right)w(\lambda)\,d\lambda$$

where weighting function is non-decreasing and satisfies

$$\int_0^1 w(\lambda)d\lambda = 1.$$ (4.1)

The standard deviation of $\tilde{r}$ is defined by

$$\sigma_{\tilde{r}} = \sqrt{Var(\tilde{r})}$$ (4.2)

Let $\tilde{r}$ fuzzy number and w be a weighting function, we define the weighted possibilistic variance of $\tilde{r}$ by

$$Var_w(\tilde{r}) = \int_0^1 \left(\frac{r_2(\lambda) - r_1(\lambda)}{2}\right)^2 w(\lambda)d\lambda$$

and the weighted covariance of $\tilde{r}$ and $\tilde{b}$ is defined as

$$Cov_w(\tilde{r},b) = \int_0^1 \left(\frac{r_2(\lambda) - r_1(\lambda)}{2} \cdot \frac{b_2(\lambda) - b_1(\lambda)}{2}\right)w(\lambda)d\lambda \qquad .$$

If $w(\lambda) = 2\lambda, \lambda \in [0,1]$

$$Var_w(\tilde{r}) = \frac{1}{2}\int_0^1 (r_2(\lambda) - r_1(\lambda))\lambda d\lambda ,$$ (4.3)

and

$$Cov_w(\tilde{r},b) = \frac{1}{2}\int_0^1 (r_2(\lambda) - r_1(\lambda))(b_2(\lambda) - b_1(\lambda))2\lambda d\lambda .$$ (4.4)

Let $\tilde{r} = (r_1, r_2, r_3, r_4)$ and $\tilde{b} = (b_1, b_2, b_3, b_4)$ be fuzzy numbers of trapezoidal form.

Let $w(\lambda) = (2\gamma - 1)\left((1-\lambda)^{-\frac{1}{2\gamma}} - 1\right)$,

where $\gamma \geq 1$, be a weighting function then the power-weighted variance and covariance $\tilde{r}$ and $\tilde{b}$ are computed by

$$Var_w(\tilde{r}) = (2\gamma - 1)\int_0^1 \left(\frac{r_2(\lambda) - r_1(\lambda)}{2}\right)^2 \left((1-\lambda)^{-\frac{1}{2\gamma}} - 1\right)d\lambda$$

$$= \frac{(2\gamma-1)}{4}\left[\frac{(r_2 - r_1)^2}{2\gamma - 1} + 2(r_2 - r_1)(\alpha + \beta)\frac{2(r_2 - r_1)(r_3 + r_4)}{2(4\gamma - 1)} + (\alpha + \beta)^2 \frac{(r_3 + r_4)^2}{3(6\gamma - 1)}\right]$$ (4.5)

$$Cov_w(\tilde{r},\tilde{b}) = (2\gamma-1)\int_0^1 \frac{(r_2 - r_1)((1-\lambda)(r_3 + r_4)}{2} \cdot \frac{(b_2 - b_1) + (1-\lambda)(b_3 + b_4)}{2}\left((1-\lambda)^{\frac{1}{2\gamma}} - 1\right)d\lambda$$ (4.6)

$$= \frac{(2\gamma-1)}{4}\left[\frac{(r_2 - r_1)(b_2 - b_1)}{2\gamma - 1} + \frac{(r_2 - r_1)(b_3 + b_4)(r_3 + r_4)}{2(4\gamma - 1)} + \frac{(r_3 + r_4)(b_3 + b_4)}{3(6\gamma - 1)}\right].$$

Theorem 4.1 [12] *The mean-variance efficient portfolio model is*

$$\max_{x \in R^n} \sum_{i=1}^q \lambda_i \left[\tilde{\tilde{E}}_w\left(\sum_{j=1}^n \tilde{r}_{ji}x_j\right) - \sum_{j=1}^n c_{ji}x_j\right]$$ (4.7)

subject to $Pos\left(\sum_{j=1}^n \tilde{r}_{ji}x_j < \tilde{b}_i\right) \leq \beta_i, \quad i = \overline{1,q}$, (4.8)

$$\sum_{j=1}^{n} x_j = 1, \tag{4.9}$$

$$M_{1j} \leq x_j \leq M_{2j}, \quad j = \overline{1,n}. \tag{4.10}$$

In the next theorem we extend ([12], Theorem 4.2) to the case weighted possibility mean- variance approach with a special weighted $w(\lambda)$.

Theorem 4.2 Let $w(\lambda) = (2\gamma - 1)\left[(1-\lambda)^{-\frac{1}{2\gamma}} - 1\right]$, $\gamma \geq 1$ the weighted possibility mean variance (covariance) of the trapezoidal number $\tilde{r}_{ji} = \left(r_{(ji)1}, r_{(ji)2}, r_{(ji)3}, r_{(ji)4}\right)$ where $r_{(ji)1} < r_{(ji)2} \leq r_{(ji)3} < r_{(ji)4}$ and addition $\tilde{b}_i = (b_{i1}, b_{i2}, b_{i3}, b_{i4})$ is a trapezoidal number for $(VaR)_i$ level, $i = \overline{1,q}$. For $\lambda_i > 0, i = \overline{1,q}$, then the possibilistic mean variance (covariance) portfolio selection model is

$$\max_{x \in R^n} \sum_{i=1}^{q} \lambda_i \left[\frac{(2\gamma-1)\left(\sum_{j=1}^{n} r_{(ji)2} x_j - \sum_{j=1}^{n} r_{(ji)1} x_j\right)^2}{4(2\gamma-1)} + \frac{(2\gamma-1)\left(\sum_{j=1}^{n} r_{(ji)2} x_j - \sum_{j=1}^{n} r_{(ji)1} x_j\right)\left(\sum_{j=1}^{n} r_{(ji)3} x_j + \sum_{j=1}^{n} r_{(ji)4} x_j\right)}{4(4\gamma-1)} \right.$$

$$\left. + \frac{(2\gamma-1)\left(\sum_{j=1}^{n} r_{(ji)3} x_j + \sum_{j=1}^{n} r_{(ji)4} x_j\right)^2}{12(6\gamma-1)} - \sum_{j=1}^{n} c_{ji} x_j \right] \tag{4.11}$$

subject to

$$(1-\beta_i)\left(\sum_{j=1}^{n} r_{(ji)1} x_j - b_{i4}\right) + \beta_i\left(\sum_{j=1}^{n} r_{(ji)2} x_j - b_{i3}\right) \geq 0, i = \overline{1,q}, \tag{4.12}$$

$$\sum_{j=1}^{n} x_j = 1, \tag{4.13}$$

$$M_{1j} \leq x_j \leq M_{2j}, \quad j = \overline{1,n}. \tag{4.14}$$

Proof : From the equation (3.5), we have

$$\overline{\overline{E}}_w\left(\sum_{j=1}^n \widetilde{r}_{ji}x_j\right) = \left[\frac{(2\gamma-1)\left(\sum_{j=1}^n r_{(ji)2}x_j - \sum_{j=1}^n r_{(ji)1}x_j\right)^2}{4(2\gamma-1)} + \frac{(2\gamma-1)\left(\sum_{j=1}^n r_{(ji)2}x_j - \sum_{j=1}^n r_{(ji)1}x_j\right)\left(\sum_{j=1}^n r_{(ji)3}x_j + \sum_{j=1}^n r_{(ji)4}x_j\right)}{4(4\gamma-1)}\right.$$

$$\left. + \frac{(2\gamma-1)\left(\sum_{j=1}^n r_{(ji)3}x_j + \sum_{j=1}^n r_{(ji)4}x_j\right)^2}{12(6\gamma-1)}\right], \ i=\overline{1,q}, \ \gamma \geq 1.$$

From Lemma 3.1, we have that

$$Pos\left(\sum_{j=1}^n \widetilde{r}_{ji}x_j < \widetilde{b}_i\right) \leq \beta_i, \ i=\overline{1,q} \ \text{ is equivalent with}$$

$$\left(1-\beta_i\right)\left(\sum_{j=1}^n r_{(ji)1}x_j - b_{i4}\right) + \beta_i\left(\sum_{j=1}^n r_{(ji)2}x_j - b_{i3}\right) \geq 0, \ i=\overline{1,q}.$$

Furthermore, from (4.11)-(4.14) given by Theorem 4.1, we get the following form :

$$\max_{x \in R^n}\sum_{i=1}^q \lambda_i \left[\frac{(2\gamma-1)\left(\sum_{j=1}^n r_{(ji)2}x_j - \sum_{j=1}^n r_{(ji)1}x_j\right)^2}{4(2\gamma-1)} + \frac{(2\gamma-1)\left(\sum_{j=1}^n r_{(ji)2}x_j - \sum_{j=1}^n r_{(ji)1}x_j\right)\left(\sum_{j=1}^n r_{(ji)3}x_j + \sum_{j=1}^n r_{(ji)4}x_j\right)}{4(4\gamma-1)}\right.$$

$$\left. + \frac{(2\gamma-1)\left(\sum_{j=1}^n r_{(ji)3}x_j + \sum_{j=1}^n r_{(ji)4}x_j\right)^2}{12(6\gamma-1)} - \sum_{j=1}^n c_{ji}x_j\right] \qquad (4.15)$$

subject to

$$\left(1-\beta_i\right)\left(\sum_{j=1}^n r_{(ji)1}x_j - b_{i4}\right) + \beta_i\left(\sum_{j=1}^n r_{(ji)2}x_j - b_{i3}\right) \geq 0, \ i=\overline{1,q} \qquad (4.16)$$

$$\sum_{j=1}^n x_j = 1, \qquad (4.17)$$

$$M_{1j} \leq x_j \leq M_{2j}, \quad j=\overline{1,n}. \qquad (4.18)$$

This completes the proof.

Problem (4.15)-(4.18) is a standard multi-objective linear programming problem. Also we can obtain an optimal solution by using some algorithms of multi-objective programming [3, 11].

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For $\gamma \to \infty$ we see that $\lim_{\gamma \to \infty} \overline{\overline{E}}_w(\widetilde{r}) = \dfrac{(r_2 - r_1)^2}{4} + \dfrac{(r_2 - r_1)(r_3 + r_4)}{8} + \dfrac{(r_3 + r_4)^2}{36}$.

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[1] Supian Sudradjat was born in Tasikmalaya, Indonesia on May 19 1958. After completing secondary school at SMA St. Maria Bandung in 1977 he continued his study at the Departement of Mathematics, Universitas Padjadjaran Indonesia which he graduated in March 1983.

In 1986, he was accepted within the Departement of Mathematics, Universitas Padjadjaran Indonesia as a junior lecturer. In July 1986 he went on with his study at Department of Industrial Engineering and Management Institute of Technology of Bandung (ITB) Indonesia with the purpose of obtaining a master degree in Industrial Engineering and Management, which he succeeded in October 1989. In 1996 -2003 Vice Dean for Administration and Finance, Faculty of Mathematicas and Natural Sciences, Padjadjaran University, Bandung, Indonesia. In September 2003, he got the opportunity to pursue PhD degree at the University of Bucharest.

He started PhD in September 2004 at the Operations Research and Statistics Faculty of Mathematics and Informatics, University of Bucharest under supervision of Prof. dr. Vasile Preda, which he succeeded in June 22 2007. The subject of her research is portfolio optimization models and fuzzy stochastic models in financial modeling which led to thesis.

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TERRITORIAL DEVELOPMENT AND NETWORKING IN THE EUROPEAN UNION AND ROMANIA: THE PARTNERSHIP SIGNIFICANCE

Luiza Nicoleta RADU[1]

PhD Candidate
Ministry of Development, Public Works and Housing, Bucharest, Romania

Daniela Luminita CONSTANTIN[2]

PhD, University Professor
University of Economics, Bucharest, Romania

E-mail: danielaconstantin_2005@yahoo.com

Abstract: *In a complex and interdependent world, many of the problems to be solved - from reduction of unemployment and social exclusion to improving the economic competitiveness – the spatial, territorial dimension becomes more and more important. It has become the third dimension of the European Union cohesion policy, added to the economic and social ones. The territorial delineation of the economic issues leans toward an approach that reflects the necessity of involvement of all decisional levels and economic actors, both for identifying the problems and for implementing the optimal solutions. Starting from these overall considerations this paper explores the significance of the partnership setting up and development for the creation of sustainable territorial networks, able to support the implementation of regional policy in Romania, considering the overall European context.*

Key words: *territorial development; networks; partnerships; regional policy*

Introduction

Many of the regions of the EU are endowed with big potential for sustainable economic growth and job creation. It includes a mix of territorially organised tangible and other resources such as social capital, institutional settings, community development and local entrepreneurship capacities.

Mobilisation of diverse territorial potentials requires a new understanding of territorial authority and cooperation with the private sector. The territorial influence of European Union Cohesion Policy and other policies (example: rural, environmental and transport) must be recognised at all levels. This implies that EU policies should improve

consideration of local, regional and national policies and development potentials by having a more coherent approach to territorial development. On the other hand, regional and local development strategies should focus more on the European needs and make a better are able to provide a network for information exchange and the sharing of best practice, thus fostering greater efficiency in the implementation of the programmes. Partnership ensures more bottom-up participation, the introduction of innovative ideas and different perspectives and serves as a network across various policies and sectors. This paper proposes an inquiry into the network formed at the regional level under the influence of different conditions, pointing out the importance of partnership in establishing territorial relationships.

Background

The European Union Territorial Agenda is a strategic framework for the European territorial development, supporting the implementation of Lisbon and Gothenburg strategies through an integrated territorial development policy. The aim of this territorial agenda is the increase of global competitiveness and sustainable development of all European regions.

The Territorial Agenda demonstrates that, within the cohesion policy, geography matters. This involves a special attention that needs to be paid to the territorial cohesion, referring to the history, culture and institutional framework of each Member State. By taking into consideration these patterns can be better valorized the opportunities offered by the European territorial diversity and by the development opportunities of its territories.

Moreover, at the national level the regional policy must have a territorial dimension by directing the investments not only within developed areas, but also within areas with severe social and economic problems that tend to decouple from the economic development and that need urgent solutions for not becoming an obstacle in achieving the European objective of territorial cohesion.

The analysis within the *Territorial State and Perspectives of the EU* document shows that Europe will have to face some significant challenges in the coming years. The most important territorial tendencies and driving forces will influence differently the European cities and regions. Among the most important challenges identified within *Territorial State and Perspectives of the EU Document – Towards a stronger European Territorial Cohesion in the Light of the Lisbon and Gothenburg Ambitions* are (E.C., 2006):

- geographical concentration of activities supported by market forces and development of society;
- accelerating integration of the EU in the global economic competition;
- growing interdependency between the EU territory and neighbouring countries as well as the other parts of the world;
- impacts of the enlargement of the EU on the economic, social and territorial cohesion of the EU;
- aspects of unsustainable development leading to the overexploitation of the ecological capacity of the regions.

According to the Territorial Agenda the territorial cohesion should focus on regional and national territorial development policies able to ensure better exploiting of regional potentials and territorial capital, better positioning of regions by strengthening their potentials and cooperation, promoting the coherence of policies with territorial impact, both horizontally and vertically, so that they support sustainable development at national and

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regional level. This requirement highlights the contribution that can be brought about by the creation and development of territorial networks.

Regional networks – specific features and typology

The *regional networks* are defined as cooperation between the business environment, governmental bodies, research institutes and universities, intermediary organisations, as well as other groups. (Cappellin, 2000) The business networks, as well as the public or other institutions ones are components of the integrated system of "regional network".

The set-up of a regional network can be influenced by the partners' origin and number, by the aim of the initiative that should be implemented, as well as by the objectives to be achieved within a network.

The regional networks are characterized by the following features (Sprenger, 2001):

- participants are part of different fields of activity (business, chambers of commerce and industry, governmental organisms and public institutions, research institutes, universities, social groups);
- participation is on a voluntary basis;
- participation is based on equal rights, dialogue, consensus and compromise, as well as self-governing;
- by taking into consideration the different interests a network leads to coordination and organisation;
- participants within a network do not have the authority and power to penalise the others or the authority to give directives the other regional partners;
- premises of success are the mutual trust and learning from each other.

Figure 1 depicts various types of networks and corresponding relations between participants
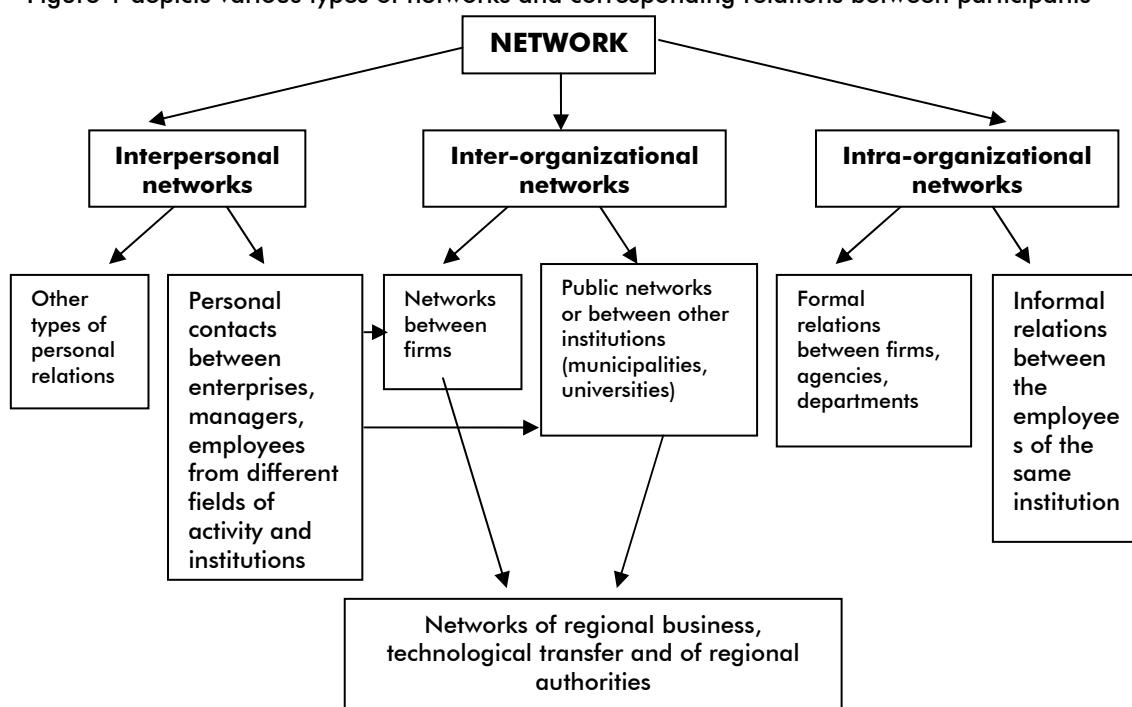

Figure 1. Types of networks and relations among participants
Source: Institute for Structural Policy and Economic Development, www.isw-online.org

At European level, the literature devoted to this subject reveals the changes produced by the implementation of the regional policy. The set-up of a network is no longer the creation of the firms from the economic environment. The globalisation process, the competition for localisation, as well as the regional policy that encourages the mobilisation of resources and valorisation of the regional potential have determined the emergence of regional networks. Moreover, Sprenger (2001) considers that the decision of setting-up a regional network is influenced by the existence of a competencies deficit in the institutions that implement policies, insufficient and sometimes the lack of local funds and resources, by the increasing importance of soft factors for localisation and even by attracting new partners in the process of drawing-up and implementation of the regional policy.

Thus, the international literature identifies different forms of regional networks: regional clusters, regional centres of environmental excellence, regional employment and environment initiatives, Local Agenda 21 initiatives.

The regional clusters can be defined as regional accumulation of productive and services companies, research, education and other training institutions from various fields of activity, offering complementary services so that to encourage the cooperation within a network (Sprenger, 2001). Clusters are frequently found in automobile industry (e.g. Stuttgart, Upper Austria, etc.), but also in the area of environmental protrection (e.g. Tyrolean Energy-Efficient House Cluster- Austria).

The regional centres of environmental excellence have as objective the creation and extension of the international competencies in research field and increase of economic implementation of research results. The aim of regional employment and environment initiatives is to maintain and create jobs and to help establishing the regional and local economy. These are characterized by bottom-up initiatives, partnership activities, innovation and integration of various politics (industrial, environment, social). Through the Local Agenda 21 initiatives is encouraged the dialogue between administration, citizens, local organization and private sector.

The regional networks can be of various types by taking into consideration the partners involved, the partnership type within the territorial network being influenced by the region's particular problems and institutional framework, as well as by the objectives to be achieved.

The networks, including strategic alliances, joint-venture, working groups represent a form of cooperation. The particularities identified by the international literature refer to the following aspects:

- networks allow all types of cooperation, even if the dominate relations are vertical and horizontal; there are also relations with other partners that do not participate in the network;
- networks are not characterised by detailed contracts or particular legal forms;
- they are set up without any time constrains and in some cases the cooperation relations are the basis for another types of partnership, respectively joint venture;
- network is not dissolved by the withdrawal of one partner; the remaining companies continue the activity within the network and can even accept new partners (Sprenger, 2001).

At the European level, the employment of the economic growth factors by turning them into good account within regional networks is supported by the regional policy of the

European Union and by each country as well. By means of the Structural Funds were encouraged partnerships and created collaboration networks by initiatives such as LEADER, URBAN.

At the same time, the member states, through the national funds, support a considerable number of programmes for creating regional networks (examples: Austria - promoting the industrial clusters, Finland – programmes for the centers of expertise network regarding improvement of the industrial firm competitiveness in the international environment; France – programme coordinated by DATAR for setting-up regional and local networks in order to support the initiatives within Agenda 21; Germany - innovation networks – cooperation between at least two research institutes or universities and four production firms), networks for strengthening the innovation capacity of the small and medium enterprises, networks for promoting cooperation in the industrial research (examples: Great Britain – programme for setting-up cooperation centers in research area between the research departments within the companies and research institutes, universities; Italy – local production systems, especially in the north-east and center of the country – NEC systems, based on a dense connection network between firms from different sectors of activity and the other regional actors). In the regional policy area, the network has recorded various forms according to the potential partners' reasons for cooperation, as well as the localisation in specific areas.

Internationally, the territorial network issue needs a multidisciplinary approach between the instruments offered by the economy, regional policy, management, network modeling (Table 1).

Table 1. Anticipated advantages of regional networks

Economic advantages	Socio-cultural advantages	Ecological advantages
− Finding and using the regional development potential − Increasing the regional added value − Increasing used of synergies effects through cooperative planning − Reducing the reaction time to regional structural problems − Development of new services and products	− People affected become participants − Are supported the regional initiatives, creativity and cultural identity − Solving the regional conflicts is supported by intermediary structures	− Increased importance of environmental regional problems − Increased regional responsibility − Improvement of the regional resource cycle − A better integration of the environmental dimension into regional development by ex-ante evaluation, indicators, project selection.

Source: Sprenger, 2001, p. 21

The scientific research undertaken in Romania with regard to the set-up of territorial networks is still incipient, the regional policy not approaching explicitly, systematically this subject. Various journals (such as *Entrepreneurial barometer of the National Council of Small and Medium private Enterprises*, *SME Magazine*, *Economy and Local Administration*) or studies developed within research projects (carried out by the International Centre of Entrepreneurial Studies from Bucharest, the Group of Applied Economics) have identified activities where incipient forms of clusters are developing. This is the case of software

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industry (Bucharest, Timisoara), navy construction (Galati, Constanta, Mangalia), woodcraft industry (Covasna, Harghita, Neamț, Suceava), textile industry (Vaslui), china industry (Alba). Furher on, the set-up and development of territorial network in Romania can be stimulated by establishing at the administrative level the general rules of implementing the policy, so that the economic actors can find, within the legal framework, the methods for a flexible integration on the market. (Constantin, 2002)

At the European level, as a result of globalization and intense economic exchanges, territorial networks tend to evolve to supra-regional ones by attracting the international competitors. The globalisation process increases the importance of regions as location for businesses and transforms the product competition into a distinct competition for localisation. Thus, the regional and local partners are determined to improve their regional economical culture and to promote the regional competitive advantages.
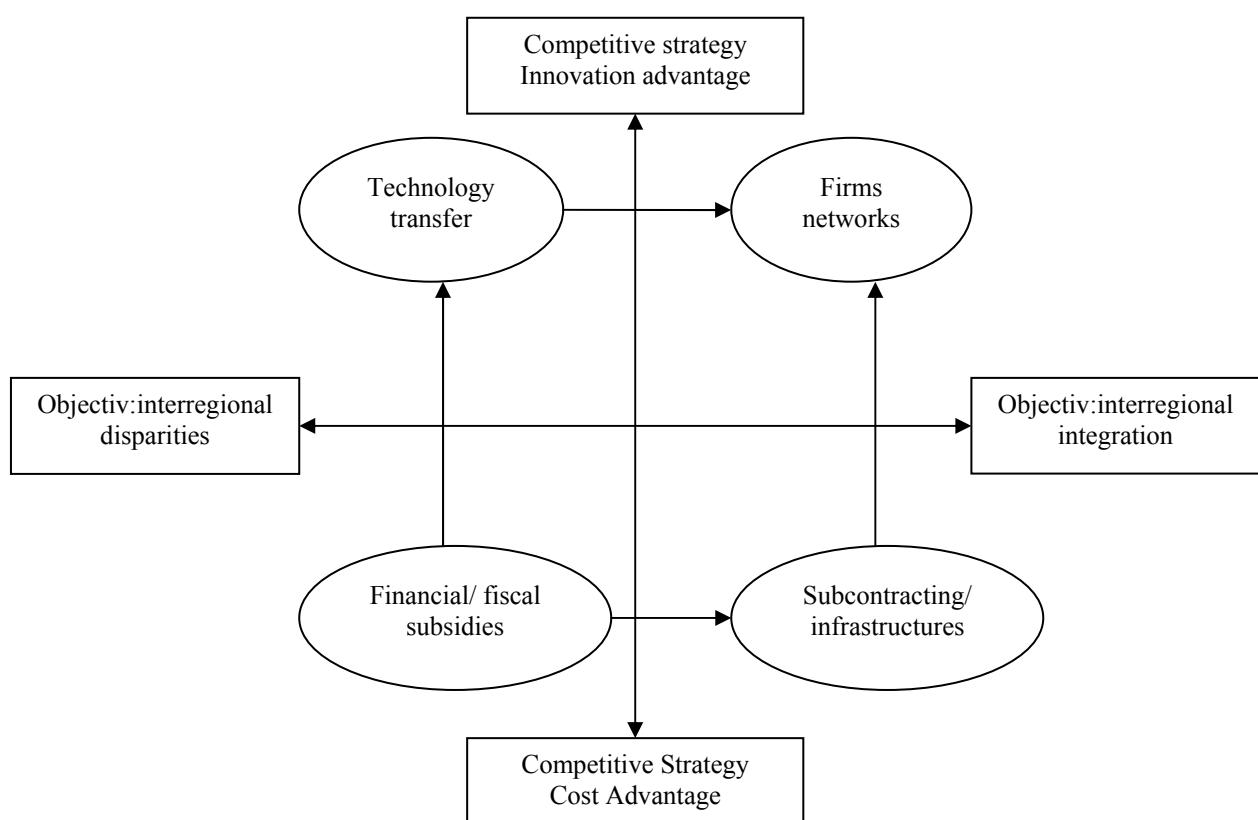

Figure 2. Instruments for regional economic policy
Source: Fischer, M. 2002, p. 49

As Figure 2 shows, the logic of current territorial development policies is that economic growth is based on the organisation of space that is shaped by a range of policies at all levels of government as well as by social trends, technological development and market forces. Some of these economic and social policies have unplanned spatial impacts which can compromise territorial development. Policies with a territorial focus not only counteract these effects but - more important - add value by integrating the economic, social and environmental dimensions of cross-sectoral policies. An important element in territorial development policies is the cooperation of various sectors of activity, levels of authorities and stakeholders, such as partnerships with the private sector and civil society that play an

important part in growth and development processes. Territorial development policies are an important instrument for strengthening regional territorial capital. (EC, 2006)

The partnership – an important step towards networking. Significance for the EU economic and social cohesion policy and Romania's regional development

The partnership represents one of the principles highlighted by the European regulations regarding the Structural Funds. They envisage a partnership among Commission, the member state, authorities and organisations appointed by the member state taking into account the national laws and their current practices (EC, 2006). The partnership principles mast be applied in all stages of the Structural Funds employment process. The Commission has revealed that even if the partnership within regional authorities is a well known and accepted practice, which generally functions satisfactory, the local partnership is less developed especially due to the economic and social partners' insufficient involvement.

Thus, at European scale, the partnership concept has been enforced due to the necessity of applying effectively the subsidiarity principle. This new direction takes into consideration the advantages of a public – private partnership: local interest compliance, investment cost and exploitation risks sharing as well as the lack of local public administration investments resources.

The public - private partnership concept represents a cooperation method among public authorities and private sector, respectively non-governmental organization, business association, companies for implementation of projects with positive effects on labor market and local and regional development. (Cappellin, 2000)

The partnership promotes cooperation between social and political actors, aiming to legitimate a political action, due to the fact that they are less involved in the decisional process and policy monitoring. The activities developed through partnership do not necessary follow profit results, but also performing social services, which contributes to general social welfare. Moreover, the partnership represents a collaboration instrument through which can be implemented public services improvement projects and can be ensured the programmes implementation coherence and their transparency. (Cappellin, 1997). At the same time, the partnership contributes to strengthening the governing system and local development.

Within the European countries does not exist and was not imposed a partnership standard system, even if lately is influenced more and more by the English model through two major objectives, namely labour market and local development in order to ensure the social and economic cohesion.

The partnership built between different levels of administration (central, county, local) and public sector plays an essential role in implementing the local and regional development projects financed by pre-accession and structural funds.

Public-private partnership arrangements appear to be particularly attractive for the new EU member states in view of their co-financing requirements, budget constraints, the need for efficient public services, growing market stability and the process of privatisation. Partnership, however, works only if there is an explicit policy commitment by national government to involve the private sector in public sector projects. A clear framework is needed for the application of partnership in different policy areas, since specific

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arrangements need to vary from case to case depending on how far costs can be recouped through user charges and the extent of social objectives. Any partnership framework applied in the context of the Structural Funds should include an obligation, for all projects above a certain scale, to evaluate the possibility of using some kind of public-private partnership arrangement. The European Investment Bank and the European Investment Fund could provide a valuable contribution in this regard (Cappellin, 1997).

Partnership remains a core principle for management, monitoring and evaluation of the Funds and can add much value, particularly where the roles and responsibilities of the participants are clearly delineated. The Commission recommended that partnership be strengthened since it contributes to the success of programmes by giving them greater legitimacy, by making it easier to coordinate them and by increasing their effectiveness as well as transparency.

While there is broad consesus that partnership adds value to the effectiveness and impact of the Structural Funds, it may also introduce new layers of complexity into the process of designing and delivering policies, which can slow down decision making. There is, therefore, a trade-off between the additional complexity resulting from partnership and the improvements in design and implementation, which it can bring.

In practice, the studies regarding the partnership development („Partnership in the 2000-2006 programming period", "Partnership for implementing the StructuralFunds" – DG REGIO) undertaken at the EU level demonstrate the growing importance of applying the partnership principles, even more if the European Commission requires that the projects financed from the Community Funds must respect this principle. One of the evaluation criteria of the projects is the level of partners' involvement in the implementation of the projects financed; within the evaluation reports of the European Commission there is always a chapter dedicated to the partnership effects on the projects.

The partnership within regional policy tends to become the nucleus for setting-up a territorial cooperation network (*Maillat, 1990, Cappellin, 1998, Sprenger, 2001*), having as participants the public administration, the economic, social, but also cultural actors. Partnership in the design and implementation of programmes has become stronger and more inclusive, involving a range of private sector entities, including the social partners, as well as regional and local authorities. This has led to better targeted and more innovative projects, improved monitoring and evaluation of performance and the wider dissemination of information of their results, at the price, in some cases, of additional complexity of programme management.

In the partnership context, the regions have the responsibility of concentrating financial resources on the themes necessary to address the economic, social and territorial disparities at regional level.

Due to these reasons, institutionalised partnerships through **LEADER** (rural development through integrated programme and cooperation between local groups of actions), **EQUAL** (removing inequalities and discrimination in respect with access at the labour force), **INTERREG** (encouraging the interregional and transnational cooperation), **URBAN** (supporting the implementation of innovative strategies in towns and urban areas), are transformed into territorial networks aiming at the valorisation of the members advantages and obtaining multiplier effects.

The partnership importance at European level is revealed both through studies undertaken by independent research institutes (e.g. London Tavistock Institute – „Thematic

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evaluation of the partnership principle" – 1999), and through European Union institutions (European Economic and Social Committee – „Partnership for implementing the structural funds", 2003). The conclusions of such studies reveal that the role of the socio-economic partners is different according to the development stage of the measures financed under Structural Funds, respectively the programming, implementation, monitoring and their evaluation. Furthermore, the public participation is a key component of increasing the quality of programming documents and ensuring their acceptance by the citizens.

Furthermore, for the new programming period 2007-2013 the European Commission continues the partnership policy, by creating new initiatives such as **JASPERS** (Joint Assistance in Supporting Projects in European Regions), **JEREMY** (Joint European Resources for Micro to Medium Enterprises), **JESSICA** (Joint European Support for Sustainable Investments in City Areas), through which are promoted projects for investments, economic growth and creation of new jobs. („The Growth and Jobs Strategy and the Reform of European cohesion policy. Forth progress report on cohesion", EC, 2006).

In Romania, in the regional policy drawing-up process were used formal as well as informal partnerships in order to ensure:

- the appropriate and correct implementation of approved programmes, together with their consistency with the established priorities and the general programming framework;
- a clear distribution of responsibilities of the socio-economic and institutional partners regarding monitoring and evaluation of the financial assistance;
- an appropriate importance on the environmental component, within a perspective of sustainable development, which ensures the use of public funds in conformity with the community policy and legal framework in this field.

The Government Decision no. 1323/2002, regarding the elaboration in partnership of the National Development Plan, ensured the legal basis for creating and developing the inter-institutional relations and the partnership structures at national and regional level, establishing at the same time the clear role of the ministries, Regional Development Agencies and other institutions involved in designing the National Development Plan.

As a result of this government decision were set- up:

- The Inter-institutional Committee for the elaboration of the National Development Plan (ICP): the membership consists of representatives from ministries, Regional Development Agencies (RDAs), central public institutions, research institutes and higher education institutions, as well as representatives of economic and social partners;
- Regional Committees for the elaboration of the Regional Development Plans (RCP): the membership consists of representatives from the Regional Development Agencies, the Prefectures, the County Councils, the decentralised services of central public institutions, representatives of research institutes and of higher education institutions, as well as representatives of the economic and social partners.

The created partnership structures operate through *thematic working groups*, in accordance with the issues analysed, as well as through *plenary meetings*, in a format which ensures a balanced representation of the central and local public administration, and public and private partners.

Moreover, in Romania took place an ample partnership process for the development of the programming documents for the period 2007-2013, respectively the seven operational programmes (regional development, transport, environment, competitiveness, territorial cooperation, strengthening the administrative capacity and technical assistance).

Taking into consideration that the Regional Operational Programme has been elaborated for solving the regional development problems, numerous consultative meetings with the regional partners took place so as to obtain a consensus in the fields of intervention that will be financed. Furthermore, at the regional level, due to the permanent exchange of information, a process for creation of communication and information networks has been developed between the partners involved. The next stage of the Regional Operational Programme, respectively the implementation one, will determine the created network to react through an active involvement in this process.

Considering the administrative structure and the Romanian legal framework, the public – private partnership may have as potential advantages:

- externalising the public administration activities that may be better carried on through private sector (concession, sale);
- the costs and risks distribution between public and private sector;
- community business involvement in projects of community interest;
- financial transparency during project implementation.

The risks that might appear during the partnership must be considered as well, respectively: the danger of partnership dissolving in a project implementation advanced stage, the doubtful legal status of owrnership, the lack of transparency among the partners.

The partnership remains the main principle for the management and evaluation of the Structural Funds, providing added value, especially where the roles and responsibilities of the participants are clearly defined. In several cases it has led to the creation of a new institutional framework based on a series of cooperative networks or relations with various social and economic partners. In most cases it has enhanced institutional networking and cooperation between national and regional authorities. (EC, 2006)

Conclusions

An organisational model such as territorial network is capable to promote the development and the continuous change of the available knowledge within an individual local production system by achieving a synergy between the internal resources of the local firms and the external resources of other regions and countries. Thus, it can be considered that the territorial network model encourages the connection between the organisation of the firms' economic relations and the regional territorial organisation, characterised by complex connections between industrial areas, urban centers, metropolitan quarters. Within the territorial network the institutional dimension of the local economic development process is very important. The increase of economies decentralisation and complexity determines the involvement of public institutions or of new collective organisations. Thus, the role of local and regional institutions is a catalyst one, integrator for promoting new solutions based on resource complementarity, stimulating local actors in project elaboration, proposals of strategic programmes and offering technical assistance for their implementation (Cappellin, 2002).

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Traditionally, through the regional policy is granted financial support for the firms in the less developed regions, in order to reduce the regional disparities. Even in these conditions, the regional policy must be implemented by taking into consideration the competitive advantages and by using various instruments. Thus, through the promoted measures can be created service centers for small and medium enterprises, incubators for new innovative enterprises, technological parks, can be developed relations among firms and research institutes. At the same time the promotion of collaboration among developed regions and the less developed ones is highly recommended. Moreover, the regional policy must not promote only the cohesion and territorial integration of the regions but has to encourage and set-up networks within firms or strategic alliances at interregional level as well. For the regions confronted with economic decline the attraction of new investments is not sufficient, the creation of economic partnerships or collaboration between firms being also necessary.

The economic regional development must not consider only the promotion of "regional champions", respectively those sectors with high competitiveness, but also the encouragement of the local development by establishing local agreements, service centres or development agencies. By this approach is encouraged the development of the partnership between small and medium firms, as well as a better integration of firms, territories and intermediary institutions.

Thus, the recent approach of the territorial networks in the field of regional policy reflects the necessity of adopting a systemic approach at regional level, by creating some territorial branches in specialised areas, supporting the sectoral integration at local level, diversification and production reconversion. Therefore, it becomes obviously that the general development of a region is not a sum of local economic systems development, but is the result of their integration at the regional level. This approach needs investments for consolidating the partnerships between different actors at regional level. Moreover, the territorial networks need the correlation of the local development with the integration on interregional markets (Cappellin, 2002).

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¹ Luiza Nicoleta Radu graduated from the Academy of Economic Studies of Bucharest, the Faculty of Management – Public Administration section. She is PhD student in Economic Cybernetics and Statistics at the University of Economics, with a thesis concentrating on territorial networks and regional policy. She is employed as an expert at the Ministry of Development, Public Works and Housing, within the Managing Authority for Regional Operational Programme. She has participated in several national and international conferences and has published eight articles on different issues of regional policy.

² Daniela-Luminita Constantin is Professor of Regional Economics at the University of Economics, Bucharest. She is also the President of the Romanian Regional Science Association and member of the Council of European Regional Science Association. She carried out numerous research stages abroad as Fulbright, DAAD and Phare-Tempus scholar. Daniela Constantin has authored or co-authored a large number of books and articles published in Romania and abroad and has participated in various national and international research project teams. Her main scientific interest concentrates on regional policies, regional convergence and competitiveness, EU structural assistance, migration, SMEs and entrepreneurship, environmental issues and human security.