Journal of Global Economics, Management and Business Research
2(4): 190-200, 2015
International Knowledge Press
www.ikpress.org

TASK AND COMPETENCE BASED TEAM COMPOSITION AND TEAMWORK- ECONOMIC AND SOCIO-PSYCHOLOGICAL ANALYSIS OF AUXILIARY STAFF INTEGRATION IN NEW PRODUCT DEVELOPMENT PROCESSES

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AUTHORS' CONTRIBUTIONS
This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Received: 10th November 2014
Accepted: 20th December 2014
Published: 11th April 2015

Original Research Article

ABSTRACT

The objective of this study is to reveal cause effect relations between the integration of auxiliary staff in the execution phase of variant construction projects within a 3D CAD (Three Dimensional Computer Aided Design) environment and economic and socio-psychological efficiency project outcomes. The analysis starts with the engineering environment, best described with the theories of job enrichment, driven by SW-developments (Software) to reduce personnel costs. The result is a job profile, in which the engineer is not only responsible for transforming information about the requirements for a new product into the information necessary to produce the new product but also executing all related activities to make the new product producible. In opposite to this situation the authors are elaborating their novel model of a coherent, task related integration of auxiliary staff in New PD (New Product Development) processes. Data obtained from 130 interviews with professionals reveal the hypothesized increase of economic and socio-psychological efficiency by using the model within the delimited area.

Keywords: New product development; economic/socio-psychological efficiency; division of labour; teamwork; modern product development methods; task satisfaction; SW- forced job enrichment.

1. INTRODUCTION

Recent analysis of the workload of engineers in MDDs (Mechanical Development Departments) disclosed that at least one third of the work are related to supporting activities, to distributable work, which is mainly concerned with product documentation [1,2]. Time for the actual development of products is drastically restricted and in practice proven concepts which offer the best possible solution with given resources are often preferred [2,3]. The model of "Task and Competence based Integration of Auxiliary Staff" in MDDs - to relieve bottleneck employees, the engineers, from documentation activities, to improve the efficiency in New PD noticeably - represents the novelty, by comparing the benefits of the new model

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with the actual working conditions of SW-driven and SW-forced job enrichment with a reduced division of labour to a minimum. As the majority of investigation in the area of New PD are concentrating on the question of how to reduce the diverse constraints in the cooperation of the various professions resp. operational business functions (e.g.[1,2,3,4]) this issue is analysing the efficiency potential within the individual working unit of MDDs. The aim is to reveal cause effect relations between the integration of auxiliary staff in the execution phase of variant construction projects within a 3D CAD environment and the projects economic and socio-psychological efficiency outcome. Based on a review of related theories the empirical findings should allow the establishment of coherent team structures, coherent integration of auxiliary staff, in that carefully restricted scenario.

2. THEORETICAL BACKGROUND

The empirical evidence of unbalanced task allocation in the nucleus of New PD due to over-assessed SW tool capabilities on the one side and the insights received from intensive literature review and extended theoretical analysis on the other side encouraged the authors to propose and discuss a model, a theory to improve the efficiency of New PD in MDDs. This model describes a task and competence based Integration of Auxiliary Staff (IofAS) in contrast to a model without any task related support for engineers, characterised with the well know term of job enrichment, driven by the 3D CAD implementation in MDDs. The model of efficiency improvement by task and competence based IofAS, the overarching topic of the present proposal to compose coherent teams in New PD, is approached by the discussion of selected, model relevant efficiency increase measures within New PD processes. The theoretical basis of that new model is specified and discussed starting with the relatively imprecise, spacious, but never the less fundamental theory complex of division of labour (DoL). The ongoing proceeding receives a first refinement by the discussion of the topics team composition, teamwork, competence diversity, familiarity and shared mental model. With the subsequent extensive treatment of overlapping development activities this literature research already concentrates on the central subject of that work and achieves his final focus by adding the relevant socio-psychological aspects, especially the theory of cognitive dissonance (see Fig. 1). Thus the major mechanisms related to economic and socio-psychological efficiency improvement by the model of IofAS are identified - with a particular view on possible implications on basic operating units in MDDs.

Efficiency and effectiveness/effectivity/efficacy are very common terms, not only in connection with business affairs. In general, an activity is effective, if it produces the intended result; i.e. according to P. Drucker, if the right things are done related to a defined goal. In comparison, an activity is efficient, if it is performed with the least waste of resources, time, cost or man power, i.e. again according to P. Drucker, the classicist of modern management theories, if the things are done right, without any waste [5]. As the authors intend to evaluate in the presented model of IofAS both, the effectiveness in terms of target achievement and the performance, both terms are workable in this context and the authors follow the simplification, also applied in other scientific research papers, by consistently using the technical term "efficiency" (e.g.[6]). The economic efficiency dimension subsumes primarily objective cost-benefit ratios while the socio-psychological component of efficiency subsumes all indicators, related to the individual and / or collective satisfaction based on the subjective assessment of all participants [6]. The concept of economic efficiency is a decision criterion, which selects the one alternative among several equally important measures which generates the lowest economic costs and is also called cost efficiency [7]. Socio-psychological efficiency is a decision criterion for all areas of human actions, transactions and interactions, interpersonal relationships and leisure and is analysed by measurable variables, such as satisfaction and acceptance. The intension is to combine the economic terms (cost aspects) with the evaluable variables of sociological, psychological and socio-psychological provenance and to undertake cost-benefit analyses [6]. The evaluation of this research resulted in the structure, visualised within Fig. 1 (cf. [44]).

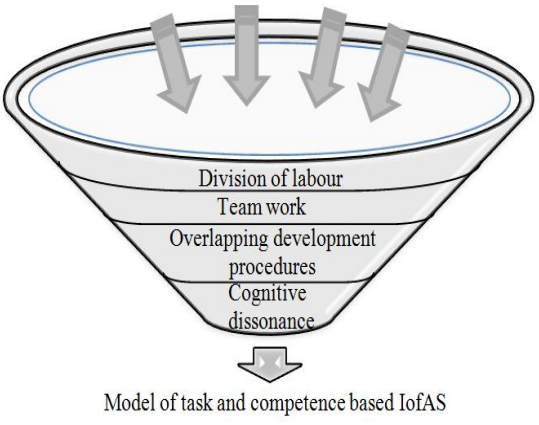

Fig. 1. Efficiency improvement in New PD by task and competence based IofAS - Agglomeration of model-relevant theories
Source: Authors

In the following the success criteria indicated above are discussed briefly.

2.1 Success Criterion "Division of Labour"

Given a solvable imbalance in respect to the allocation of personnel resources, the first step must be to examine the discussion on division of labour in detail. Since the beginning of the industrial revolution at the end of the 19th century up to the 60s of the 20th century the concept of Taylorism, the scientific management, was the dominant system for the organisation of operating procedures in order to achieve maximum productivity [8,9]. The headstone was already laid down more than 100 years before by Adam Smith with his proposal to increase productivity by specialisation via a process of deepening division of labour extensively [10]. According to that ideas productivity will increase by reduced work training, learning effects, higher speed of completing one's task, better assignment of responsibilities and identification of possible fault sources, reduced burden and less labour cost [11]. While A. Smith concentrated his research on macro-economic aspects of the division of labour, F. W. Taylor studied the micro-economic ones. F. W. Taylor's merits can be seen in the relief of work operations from their deficits laying in the workers, the tools and the materials by a systematic and methodical analysis. The result should be a re-connection of these operations with increased efficiency by deactivating all random and inefficient incidents [12]. The present work will follow up especially the arguments of achieving more speed and lower cost by a systematic and methodical analysis of work operations. The completely mechanical point of Taylor's view had to make way for the social welfare and human relation movement [9] for various reasons: the workman is condemned to monotonous routine and thinking, initiative, work satisfaction and joy are denied and individuality and innovative spirit are being destroyed. Insights about the extensive socio-psychological disadvantages of a division of labour are described many times [11,2]. According to these insights and accompanied by an overall change in values and increasing individualization, science of work has turned since the 70s of the 20th century to human orientated working surroundings. Re-integration is one of the basic attempts of previously eliminated labour contents to design integrative tasks in a way to get rid of the negative effects of the division of labour. The motivation of members of staff should be improved by job enrichment, use of different abilities, social interaction, areas of independent decisions and personal development (cf.[11]). But even task integration as well as specialization is limited: Therefore Weltz and Bollinger called for a task and job based specialization [13]. Kühn et al. [14] noted a rising integration of tasks by specialized experts, of tasks, which could easily been done by people with a different level of expertise. These are notable hints on economical as well as socio-psychological inefficient operations and already Mayer demands in the year 1988 a cooperative division of labour with a specialized expert in the centre [15]. There are no definite determinations concerning way and level of division of labour in the process of the development of products. Different kinds of division of labour exist simultaneously within only one company or even only one project. The concrete distinctness depends on the level of complexity of a project as well as on the size of the company. Within product development a task can in principle be divided sequentially - in different single steps, worked on one after the other - or parallel - divided according to quantities or objects [2]. In addition, a horizontal division - in tasks equal in ranking - and a vertical division - in managing and performing tasks or, what is the subject of this paper, in preparation, creative and execution/routine activities - must be under consideration [16]. Every mechanical development project is divided into three phases, the preparation phase (1), the creative phase (2) and the executive phase (3). In phases one and two engineers have to be present; the third phase does not crucially require an engineer completely [17]. During the preparation phase (1) specification documents are written, tasks and project definition are determined and plans for deadlines, costs and capacity are drawn up. This phase is tremendously pioneering to the success of the project since foresight, intellectual configuration of systems as well as the indication of later behaviour or rather of the strived for conditions / actions happen there. To achieve this experience and expertise knowledge at the highest possible level is absolutely necessary. The second, the creative phase (2) of a development project contains the search for concepts to solve technical problems. It is the actual main creative activity of an engineer's work. Here as well as in the first phase, knowledge about certain methods, specialised knowledge and experience are essential for the job of an engineer. In the final executive phase (3) the concepts are worked out to serial production. It contains apart from others the drawing up of product documentations, lists of items, drafts, assembly drawings, detailed drawings and calculations. This type of work ranges within the restrictions set up in phases one and two and therefore requires a less high qualification [17]. The AS is exactly educated for this type of tasks in phase 3 and is considered as well as an engineer to be an expert on these specific activities.

On the basis of the three New PD phases, the preparation (1), the creative (2) and the executive (3) phase Hubka distinguishes five different kinds of tasks in the area of development / construction [17]:

- Skilled labour in terms of technical and scientific considerations to think ahead of a mechanical system (phase 1 and 2, remark of the authors).
- Activities associated with the description of the mechanical systems (phase 3, remark of the authors).
- Skilled labour, but no direct contribution to the design of mechanical systems (phase 3, remark of the authors).
- Supporting work, e.g. copy, cut and archive of drawings (phase 3, remark of the authors).
- Management activities.

Based on this structure Mayer [15] raises the question how the coordination between experts and supporting members of staff must be designed. Vertical division of labour proves itself so long as coherent as it does not lead to uneconomic use of (high) qualification. Wittenstein substantiates this demand with what she is calling "Sinnvoll verteilbare Arbeitseinheit", in English "practically distributable task package" [1]. One of the essentially influencing variables for a practicable distribution, one of the k.o.-criteria, is the ratio of effort of time for distribution of a work unit vs. the temporal scope of effort, of the work unit to be distributed; the smaller the ratio is, the better is the suitability for distribution [1]. According to these insights an integration model of AS (Auxiliary Staff) to relieve engineers from side tasks in carefully restricted areas could lead to more efficiency in respect to the economic indicators "project costs" and "project duration". As far as the subject of this paper is concerned there is clear evidence that in various ranges of duty coherent division of labour can operate in MDDs. According to the characterisation of these ranges of duty there are two directions of DoL identifiable. One direction is the DoL with the individual operational disciplines/functions within the company from marketing to production and dispatch to the customer (the basis for the team building across functions). The second direction is oriented to DoL within the MDDs, especially within the execution phase (3), the dedicated subject of this paper. Whereas the DoL in direction one is permanently carefully considered by management as well as by SW-developers to simplify the flow of information as much as possible, direction two seems to be disregarded, not existing or covered respectively solved by the SW in use - without supporting staff. However, recalling again those analyses which had shown that roughly one third of the time spent in MDDs for the development of a project can be allocated to AS [1,2] the extent of auxiliary tasks is more than remarkably.

2.2 Success Criterion "Teamwork"

Haon et al. [4] analysed eighteen surveys made to observe direct effects of functional diversity on the performance of New PD during the years 1988 and 2005. These surveys examined about 2000 projects/teams and more than 1400 managers had been interviewed. The results were heterogeneous as well as ambiguous. The overall conclusions range from "Projects developed by cross-functional teams have a higher success rate than those from a single company function" [18], over "Diversity has a direct negative effect on the performance perceived by members of the team itself and on product innovation" [19] to "Cross-functionality is associated with a higher success rate of new products" [20]. To get a deeper understanding of the causes behind that heterogeneity Haon et al. [4] decided to perform further surveys. What is obviously important for the success of cross-functional teams is not only the functional diversity as such; various conditions must be met to make a cross-functional team successful. Only the number of functions represented in a team is of marginal significance. The diversity of information and perspectives which companies want to use is to a large extent a result of competence diversity; this cannot necessarily be achieved by pure functional diversity. Individual competence, a cross-functional human property by nature [21] and a mixture of origin, cultural background, education, life career and professional career, experience and expertise, may differ largely within a functional department and may be relatively similar from members of different departments. With that understanding, the notion diversity is extended to a compound term of functional, educational, experience and expertise diversity [4]; this - extended - diversity has a positive influence on information and knowledge available in a team and enables the team for deeper thinking and the creation of a broader range of perspectives, considered to make decisions (e. g. [22]). Under these conditions, the possibility to develop a higher amount of different concepts for New PD exists [23]. The extensive survey of Hollenbeck et al. [24] resulted in a variety of team composition guidelines/recommendations of scientists on the basis of their research on analysing the multiple manifestations of teams. This survey, divided in the areas team composition, team training and team task design, illustrates that there are good reasons to rely on research results in the process of implementing and applying teams as opposed to intuitive decision making [24]. One of the essentials of team composition is the diligent analysis of the individual

task, in the case of the presented research, the development of new products. On this basis, teams should be capable for a better instrumental use of success related information to solve specific problems [4]. Within the execution phase of variant construction projects different competences for product design tasks and product documentation tasks are required. By allocating design tasks to engineers and documentation tasks to auxiliary employees this higher instrumental use of competences and hence a higher quality (product and documentation) can be assumed [45].

2.3 Success Criterion Modern "Product Development Methods"

From the information processing point of view individual development activities are themselves viewed as information processors, receiving input information from their preceding activities, and transforming this input information into a form suitable for subsequent activities. "The sequential process assumes that the upstream-generated information is available for downstream use only at the completion of the upstream activity [25]". During the upstream activity, the development process continuously narrows and refines the information from an initial rough assessment of a design parameter to a final value. For this refinement process from the preliminary to the final value, Krishnan et al. [25] use the term evolution. The performance of this process can vary from fast to slow, depending on the character of the individual development project. The term fast evolution explains on the one hand a redesign respectively a variant construction development project. The components and the technology are mostly known. This means information in the creative and the design phase of New PD can be generated fast. In other words - major changes happen early, the exchanged information gets close to its final form rapidly and can be frozen and passed downstream early in the upstream process without much quality penalty for the upstream activity. The term slow evolution explains on the other hand an innovation, a product using new components and technology. In this case, the generation of information starts slowly at the beginning of the creative and the design phase and increases rapidly to the end of that phase. The modification of the interchangeable information increases as the upstream activity progresses. In this case, finalizing upstream information early in the upstream process either would be impossible or would entail a huge quality penalty for the upstream activity [25]. In the overlapped process, the upstream activity shares preliminary upstream information at defined breakpoints with the downstream activity, depending on the special evolution-character of the project. The downstream activity begins to perform its normal development iteration using the exchanged information. This iteration process is to be repeated after the next releases of the meanwhile improved information of the upstream activity until the final value is available. Under this aspect the downstream activity has – as Krishnan et al. are calling it – a particular sensitivity, ranging from high to low. If substantial changes can be accommodated quickly by the downstream activity the downstream sensitivity is understood to be low and if the incorporation of changes in contrast is joined with large, time consuming rework the downstream sensitivity is understood to be high. Whether overlapping can be installed as a measure for improving lead time etc. depends on a careful assessment of the particular project. Due to more communication and iteration the duration of the individual activity may actually increase with overlapping, while the total project lead-time can decrease by the concurrent work on different activities significantly [26]. To compress schedules by overlapping is very likely. Within the four extreme situations of overlapping the combination of fast evolution of the upstream process and low sensitivity of the downstream process seems to be most promising with regard to lead-time reduction. This situation appears within the execution phase of variant construction projects within a 3 D CAD environment and the proposed task sharing between design tasks for engineers and documentation tasks for AS. Krishnan et al. call this a "Distributive Overlapping" situation: When upstream evolution is fast and downstream sensitivity is low, it is possible to start downstream activity with preliminary information (no need for freezing early) and continue with the onward progress of the New PD process with preemptively finalized upstream information, because large changes in the upstream process happens early and finalized information - before the end of the upstream activity - do not lead to huge quality losses in the upstream process. The low sensitivity means that large changes in the magnitude of the upstream information exchange do not entail large iteration loops. Both activities, the upstream and the downstream, are contributing to an efficient overlapping process; the involvement is distributed [25]. This situation is most favourable for overlapping. This development situation appears, when a product redesign with known manufacturing technologies is generated or when an engineer redesigns a part, but for example manufactured with a defined method [25]. Based on the theoretical findings of Krishnan et al. with regard to overlapping of activities, a lot of additional researches followed to define the determinants of evolution and sensitivity more precisely, to design mathematical models to cope with uncertainty in respect of the degree of sensitivity, the extent of the

evolution and the probability of rework [27,28, 29,30,31]. These discussions increased continuously the positive perceptions of the advantages of overlapping by practitioners (by engineers as well as by managers) and the transition from an ad-hoc to a systematic application of overlapping in various industrial areas is considerably promoted [45]. Krishnan et al. verified the thesis that overlapping can reduce lead-time and cost within certain restrictions. Essential conditions are a diligent identification of the characteristics of the project in preparation, the availability of qualified manpower (a prerequisite of particular importance for single operating units), a favourable cooperation climate and intensive face-to-face communication. There is at least still one further area to be analysed - and intensified in addition - resulting from socio-psychological considerations, in order to achieve the desired success on a permanent base. This aspect is already slightly addressed in the context of competence diversity due to its remarkable success implication.

2.4 Success Criterion "Task Satisfaction"

Work satisfaction normally is recorded by an anonymous survey. Work satisfaction is characterised through the analytical unit, the individual, the analytical element, labour, and the type of measurement, validation [32]. The reviews analyse mean values and dispersion and are referred to departments, subsidiaries and total organisations. Since the beginning of the humanization of the working environment, work satisfaction is an indicator for humanization. Robbins [33] defines job satisfaction as a subjective measure of workers attitudes; that is an individual's general attitude to his or her job. Job satisfaction is the attitude to work and to the work situation with different aspects, the evaluated comments to one's work or work elements. In this context Rosenstiel points to Locke (1976) who describes work satisfaction as a pleasant and positive emotional state that follows from the evaluation of the own work or work experience [32]. The search for equilibrium is one of the possible approaches to a classification of the various theories of work satisfaction, the classification into needs, incentives, humanistic and cognitive oriented concepts [32]. In the needs oriented approaches the organism seeks internal equilibrium. If the internal balance is disturbed, needs are recognised with the aim towards internal equilibrium. Incentive oriented approaches assume that work satisfaction is the highest, the most pleasurable emotion are available to the individual. The focus of the incentive-oriented approaches is to determine those traits of the organisation that influence work satisfaction to a particularly high extent. Humanistic approaches claim that the aim of human action is self-realisation and intellectual growth. Satisfaction arises through facing challenges, which leads to new experience and connotation. These concepts investigate the way of human life fulfilment in respect to how the individual can cope with existence and therefore are hard to operationalise. Cognitive equilibrium approaches are dealing with the cognitive concept of people who try to match the perceived environment with their designed cognitive plan. Disturbances are recognized as tension and imbalance and they lead to dissatisfaction. Decreasing tension leads to satisfaction as a consequence of the emotional reaction. Satisfaction is found when the perceived conditions of the workplace optimally match the perceived own role [32,34]. Demands and individual suitability, personal performance and wages should correspond to each other [35,36]. There seems to be the possibility that engineers increase their contentment with the tasks by quitting documentation tasks and by focusing on their engineering role, by allocating this documentation tasks to AS [44]. The study of the success criterion task satisfaction revealed a strong dependence / correlation between task content and self-image. It looks reasonable for managers and team leaders to note that they are a part of the success related interactions [37,38] and to experience and to consider more seriously how cognitive dissonance works, i.e. how an ambitious, dedicated engineer would deal with the disparity between his professional expectations and his professional reality: Special attention require his organisational commitment, the identification with the values and goals of the organization, the execution of extra effort on its behalf, the representation of his company, the recruitment of partners for his company, the loyalty to his company or - the readiness for a change. As related studies conducted so far, revealed mainly correlation statistical character between task content and job / task satisfaction [39,32,40,41], this study intends to go beyond these findings by the attempt to identify causal relations.

3. METHODOLOGY

3.1 Basic Hypothesis

Taking all the theoretical and empirical considerations made so far into account, the authors transfer their theoretical outline into the proposed model of task and competence based IofAS - as visualised in Fig. 1 – with the following set of hypotheses and propositions, subject to an empirical validation process:

Basic Hypothesis HB:

HB: The higher the degree of task and competence based IofAS, the higher the economic and socio-psychological efficiency of project outcomes.

This overarching hypothesis is structured into the area of the independent variable, the degree of IofAS and the area of the effect variables, the economic and socio-psychological efficiency. The independent variable deals with the question, which - determining, explaining - variables influence the construct of the latent exogenous IofAS intensity. The latent, independent variable is in this case observable by the indicators (X_1), contribution of auxiliary staff to the creation of the drawing set and (X_2), additional supporting documentation activities performed by auxiliary staff in the execution phase of variant construction projects within a 3D CAD environment. The effect variables deal with the question, which - latent endogenous, to be explained - variables, the efficiency dimensions, are influenced by the application of the model IofAS, by the degree of the IofAS into the selected development projects. The observable dimensions of the dependent variables are in that case deadlines (Y_1), cost (Y_2), drawing errors in the drawing set (Y_3), engineer's contentment with the task (Y_4), acceptance of the project progress (Y_5) and degree of utilisation of engineers' competences (Y_6). Following this structure the basic hypothesis can be specified in detail by the following compound propositions (P_1-P_6), pointing out the elements / indicators of the expected project outcome and, in addition, illustrating for each proposition the observable determination indicators (X_1, X_2) causing the observable effect indicators of the expected outcomes (Y_1-Y_6).

$PY_{1\text{-}6}X_1$: The higher the contribution of auxiliary staff to the creation of the drawing set, the higher / the possibility of meeting the project deadlines / the possibility of reducing the project costs / the possibility of reducing the drawing set errors / the engineers' contentment with the tasks / the acceptance of engineers and auxiliary staff with the project progression / the possibility of utilisation of engineers' competences.

$PY_{1\text{-}6}X_2$: The higher the additional supporting documentation activities, the higher - the possibility of meeting the project deadlines / the possibility of reducing the project costs / the possibility of reducing the drawing set errors / the engineers' contentment with the tasks / the acceptance of engineers and auxiliary staff with the project progression / the possibility of utilisation of engineers' competences.

3.2 Model Development

Furthermore, the authors created a causal model in order to visualise the system of hypotheses/propositions and to present a causal analysis, the method generally accepted in social sciences to examine proposed relations and assumed cause effects via empirical data collection and analyses, see Fig. 2 (cf. [44,45]).

3.3 Research Design

The proposed cause - effect - relations between the IofAS as the independent variable and the economic and socio-psychological efficiency as the dependent variable are analysed via the action research method, with an ex-post data collection, conducted via questionnaires from 130 selected professionals. In toto130 proven experts, 65 engineers and 65 auxiliary employees, evaluated 65 recent variant product development projects, one engineer and one auxiliary employee for each project, with a structured questionnaire. Five different industrial sectors of mechanical development departments within different companies participated in this empirical quasi field study. The industry sectors were automotive-, satellite reception-, frequency filter, mobile communication and measurement technology equipment-industry.

4. RESULTS AND DISCUSSION

Table 1 summarises the results of the correlation analysis (Correlation Coefficient, CC-r; Coefficient of Determination, CD – r^2) including the levels of significance between $X_{1/2}$ and $Y_{1\ -\ 6}$ (P_1-P_6). The results of the empirical and theoretical findings combined with the research results and theoretical interpretations lead to the following conclusions in respect to the basic hypothesis and the related propositions:

Overall, the basic hypothesis, the higher the degree of task and competence based IofAS, the higher the economic and socio-psychological efficiency of project outcomes is tentatively substantiated as far as the dominant criteria time (Y_1) and quality of New PD (Y_3) and, in consequence, engineers' contentment (Y_4) plus the instrumental use of engineers' competences (Y_6) are concerned.

There are significant correlations between

1. The contribution intensity of AS to the creation of the drawing set and the meeting of project deadlines (CC X_1/Y_1=0,225) and the reduction of drawing set errors (CC X1/Y3=0,360), the economic efficiency dimensions,

2. The contribution intensity of AS to the creation of the drawing set and the engineers´ contentment with the task (CC X1/Y4=0,326) and the utilisation of engineers´ competences (CC X1/Y6=0,357), the socio-psychological efficiency dimensions
3. The additional supporting documentation activities, done through AS and the socio-psychological efficiency variable "engineer's contentment with the task" (CC X2/Y4=0,349).

This indicates that there are functional relations between AS integration and the respective efficiency variables. This was analogously also confirmed by the above referenced authors [1,4,22,25,26,30,32,34,39, 40,41]. However, the coefficients of determination (r^2) indicate that the variation of the dependent variables have been influenced by the independent variable "degree IofAS" with relative weights of about 5% to about 13%. This makes aware that a strong influence on the dependent variables is archived by additional impact factors, so far not represented in our model. However, the results are highly significant.

In addition, a multiple regression analysis was conducted between the different dependent variables and the two independent variables mentioned above. The results of the multiple regression analyses are depicted in
Table 2:

Themultiple regression function of the variable combinationY_1 and X_1, X_2, i.e.

Y_1 = a(constant) +bX_1+cX_2,shows the following empirical outcomes:

$$Y_1 = 2{,}562 + 0{,}377X_1 - 0{,}027X_2 \quad (1)$$

The constant and X_1 are highly significant. In general it can be stated that especially X_1 has a non-negligible impact on Y_1. In addition, the inter-correlation of X_1 and X_2 shows a highly significant r value (0,46**). This indicates that at least to a certain extent both independent variables influence the dependent variable "project deadline".

Comparable results of the MRA are achieved for Y_2 to Y_6, which additionally support the findings discussed above under point 1 to 3.

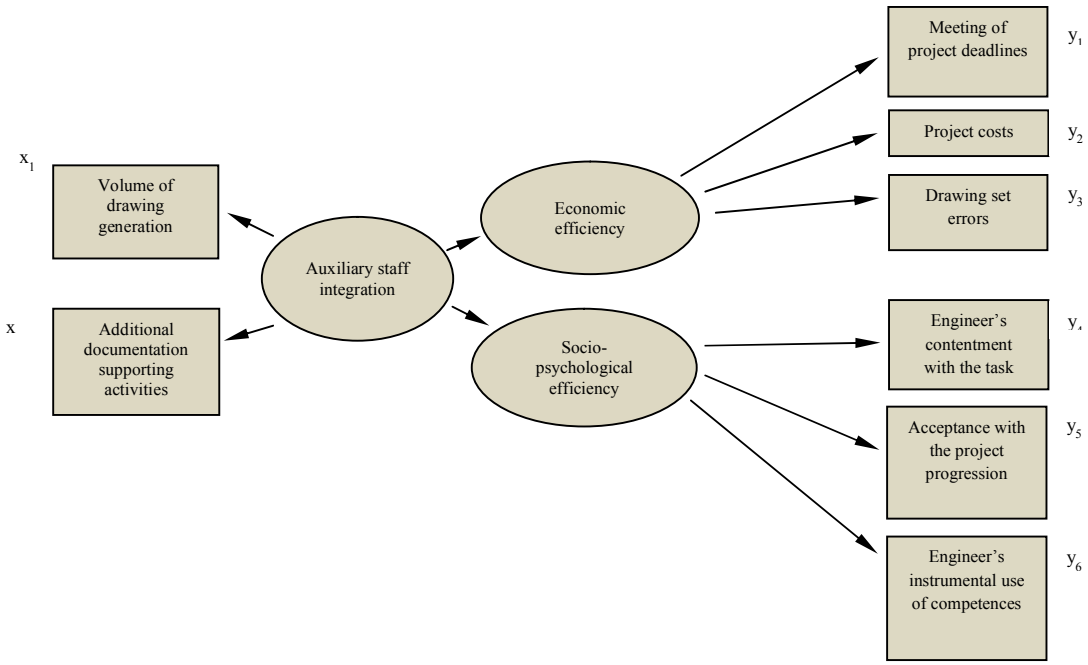

Fig. 2. Causal model

Source: Authors

Legend for the causal model:

$x_1 – x_2$ = manifest measurement variable for the latent exogenous variable IofAS

$y_1 – y_3$ = manifest measurement variable for the latent endogenous variables economic efficiency project outcomes

$y_4 – y_6$ = manifest measurement variable for the latent endogenous variables socio-psychological efficiency project outcomes

Table 1. Correlation coefficient (r) and coefficient of determination (r^2)

			X_1	X_2	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
Spearman-Rho	X_1	CC- r	1,000	0,460**	0,225**	0,172*	0,360**	0,326**	0,128	0,357**
		CD -r^2			0,050		0,130	0,106		0,127
		Sig. (two-tailed)		-	0,010	0,050	0,000	0,000	0,146	0,000
		N	130	-	130	130	130	130	130	130
	X_2	CC- r	0,460**	1,000	0,158	0,151	0,170	0,349**	0,131	0,143
		CD -r^2						0,122		
		Sig. (two-tailed)	-		0,073	0,086	0,053	0,000	0,138	0,105
		N	-	130	130	130	130	130	130	130

*** The correlation is at the ≤0,01 level significant (two tailed)*

** The correlation is at the ≤ 0,05and> 0,01 level significant (two tailed), Source: Authors*

Table 2. Multiple regression analyses (MAR)

Value	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
Constant (Intercept)	2,562	2,276	2,029	2,165	3,118	2,356
Sig.	0,000	0,000	0,000	0,000	0,000	0,000
CC - X_1	0,377	0,241	0,458	0,322	0,297	0,499
Sig.	0,000	0,021	0,000	0,001	0,001	0,000
CC - X_2	-0,027	0,046	-0,052	0,146	-0,019	-0,048
Sig.	0,698	0,543	0,537	0,036	0,756	0,460

Source: Authors

5. CONCLUSION

Overall, our empirical survey has by and large supported the underlying hypotheses of our causal model. However, it has to be considered that various additional independent variables do have an impact on our set of dependent variables related to the project success in New PD processes. This insight leads to additional theoretical considerations, concerning other influencing variables on the project success in economic and socio psychological terms.

Again utilizing the formal multiple regression approach, we can formulate the following function:

$$Y_{(1\ldots6)}=a+bX_1+cX_2+dX_3+eX_4+fX_5+gX_6+\varepsilon \qquad (2)$$

This regression function presumes a number of additional independent variables (X_3, X_4, X_5, X_6) and an unknown residual (ε), which determine the dependent variables ($Y_{1\text{-}6}$).

Theoretical considerations on the respective literature research suggested that i.e. the following independent variables should be taken into a hypothetical account - referring to Cooper and Kleinschmidt [42]:

High quality and rigorous product development processes (X_3); pertinent new product strategy (X_4);

sufficient and pertinent resources (people and money) (X_5) and the use of cross functional teams (X_6).

This particular set of additional factors suggested by Cooper and Kleinschmidt can serve as an extended theoretical framework, which may have to be tested by further theoretical and empirical research. This approach is also discussed in various articles (cf. [43], containing a summary of critical success factors and processes in project management analysed by various scientists, Cooper and Kleinschmidt and various others, in the years 1988 to 2001).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wittenstein AM. Bedarfssynchrone Leistungsverfübarkeit in der kundenspezifischen Produktentwicklung. IPA-IAO Forschung und Praxis. Heimsheim: Jost Jetter Verlag; 2007.
2. Ehrenspiel K. Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit. München / Wien: Hanser; 2007.
3. Kliesch-Eberl M, Eberl P. An extended perspective on innovation: Bridging organizational creativity to dynamic capabilities. EGOS Colloquium, Barcelona 2009 Barcelona: EGOS Colloquium. 2009;1-6.

4. Haon C, Gotteland D, Fornerino M. Familiarity and competence diversity in new product development teams: Effects on new product performance. Market Lett. 2009;20:75-89.
5. Drucker P. The effective executive. New York: Harper Collins Publishers; 1993.
6. Neuert JO. Sozio-ökonomische Analyse der "Integrierten Mediation" als Konfliktregelungskonzept. Realtheorie, Modelkonstrukt und empirische Befunde, Wissenschafliches Evaluationsgutachten. Kufstein: FH Kufstein; 2009.
7. Pareto VF. Coursd´économiepolitique; 1897.
8. Taylor FW. The principles of scientific management. New York: Cosimo, 2006. London: Reprint of Harper & Brothers; 1911.
9. Heinen E. Industriebetriebslehre (3. ed.). Wiesbaden: Gabler; 1974.
10. Smith A. An Inquiry into the Nature and Causes of the Wealth of Nations. Reprint Chicago 1977: University of Chicago Press; 1776.
11. Kieser A, Walgenbach P. Organisation (4. ed.). Stuttgart: Schäffer-Poeschel; 2003.
12. Gutenberg E. Grundlagen der Betriebswirtschaftslehre. Erster Band: Die Produktion.Berlin etc.: Springer; 1966.
13. Weltz F, Bollinger H. Dezentralisierung und Integration: Zauberformel der Büroarbeit. In: Office Management. 1987;3:52-56.
14. Kühn F, Pleuger G, Kreitel-Suciu A. Ressourcenmanagement - Schlüsselkompetenz für ein erfolgreiches Projektportfolio. In M. Hirzel (Ed.), Projektportfolio-Management: strategisches und operatives Multi-Projektmanagement in der Praxis. Wiesbaden: Gabler. 2006;143-166.
15. Mayer D. Arbeits- und Organisationsgestaltung im technischen Büro.Stuttgart: Univ. Diss; 1988.
16. Scholz R. Geschäftsprozessoptimierung: crossfunktionale Rationalisierung oder strukturelle Reorganisation (2. ed.). Bergisch Gladbach etc.: Eul; 1995.
17. Hubka V. Theorie der Konstruktionsprozesse: Analyse der Konstruktionstätigkeit.Berlin etc.: Springer; 1976.
18. Larson EW, Gobeli DH. Organizing for product development projects. Product Innovation Management. 1988;5(3):180-190.
19. Ancona DG, Caldwell D. Demography and design: Predictions of new product team performance. Organisation Science. 1992;3: 321-341.
20. McDonough EF. Investigation of factors contributing to the success of cross-functional teams. Journal of Product Innovation Management. 2000;17(3):221-235.
21. Javidan M. Core competence: what does it mean in practice. Long Range Planning. 1998;31:60-71.
22. Dahlin KB, Weingart LR, Hinds PJ. Team diversity and information use. Academy of Management Journal. 2005;48(6):1107–1123.
23. Schroeder RG, Anderson JC, Scudder GD. Measurement of White Collar Productivity. International Journal of Operations & Production Management. 1985;5(2):25-34.
24. Hollenbeck JR, DeRue DS, Rick G. Bridging the gap between I/O research and HR practice: Improving team composition, team training, and team task design. Human Resource Management. 2004;43(4)353-366.
25. Krishnan V, Eppinger SD, Whitney DEA Model-Based Framework to Overlap Product Development Activities. Management Science. 1997;43(4):437-451.
26. Marujo L. Rework impacts evaluation through system dynamics approach in overlapped product development schedule. Journal of Technology Management & Innovation. 2009; 4(2):90-101.
27. Onwubiko C. Introduction to engineering design optimization. Prentice Hall, NY: Upper Saddle River; 2000.
28. Roemer TA, Ahmadi R, Wang R. Time-cost trade-offs in overlapped product development. Operations Research. 2000;48(6):858-865.
29. Pena-Mora F, Li M. Dynamic planning and control methodology for design/build fast-track construction projects. Journal of Constr. Eng. Management. 2001;127(1):1-1.
30. Bogus SM. Concurrent engineering strategies for reducing design delivery time. Colorado: Univ. of Colorado, Boulder, CO; 2004.
31. Bogus S, Diekmann J, Molenaar K, Harper C, Patil S, Lee J. Simulation of overlapping design activities. Concurrent Engineering. 2011;(9): 950-957.
32. Rosenstiel LV. Grundlagen der Organisationspsychologie. Stuttgart: 5. Aufl., Schäffer-Poeschel; 2003.
33. Robbins SP. Organizational behaviour, Concepts, controversies, applications. New Delhi: Prentice Hall of India; 2003.
34. Aronson E, Wilson T, Akert R. Sozialpsychologie. 4. Aufl. München: Pearson; 2008.

35. Brophy A. Self, role, and satisfaction. Genetic Psychological Monographs. 1959;59:263-308.
36. Brehm J, Cohen A. Explorations in cognitive dissonance. New York: Wiley; 1962.
37. Stacey R. Complexity and Organizational Reality: Uncertainty and the need to rethink management after the collapse of investment capitalism. Routledge, London; 2010.
38. Stacey RD. The challenge of human interdependence: Consequences for thinking about the day to day practice of management in organizations. Stacey R. D. European Business Review. 2006;19:292-302.
39. Kappagoda S. The impact of work related attitudes on task and contextual performance: a comparative study in public and private banks in Sri Lanka. International Journal of Research in Commerce, Economics and Management. 2012;2(9):23-26.
40. Weinert AB. Lehrbuch der Organisationspsychologie. München: 4. Auflage, Psychologie Verlags Union; 1998.
41. Semmer N, Udris. Bedeutung und Wirkung von Arbeit. In Schuler H, (Ed.). Lehrbuch Organisationspsychologie.Bern: Hans Huber; 1995.
42. Cooper RG, Kleinschmidt EJ. New Product Performance: Keys to Success, Profitability & Cycle Time Reduction. Journal of Marketing Management. 1995;11:315-337.
43. Zwikael O, Globerson S. From critical success factors to critical success proccesses. International Journal of Production Research. 2006;44(17):3433-3449.
44. Staita C. Integration of Auxiliary Staff in New Product Development (New PD) processes. ISSWOV International Society for the Study of Work & Organisational Values, Riga, Latvia. 2014;280-287.
45. Staita C. Integration of auxiliary staff in new product development processes. The Journal of American Academy of Business, Cambridge. 2013;20(1):176-183.