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SOME BASES FOR DEFINING CORRELATIONS BETWEEN CHANGES IN A SEA PORT ORGANIZATON AND CHANGES OF PRODUCTIVITY

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Process of selecting port organizational model is characterized by high level of complexity and has to be based on previously clearly defined objectives to be achieved. Some from the group of main objectives are: improvement of productivity, rationalization of port structure, etc. After general considerations referred on port transformation process and principal theoretical approaches to this thematic, paper is focused on analyzing some important bases for defining correlations between made organizational changes in a sea port and changes of productivity in the cargo handling process.

Key words: sea port, organizational changes, productivity.

INTRODUCTION

Contemporary organizations are placed in a very complex, unstable and dynamic environment. One of the basic tasks they are encountering is a constant adapting to changes as to provide for compatibility with the environment.

Organizational change implies only the change of such variables which make the content of an organization as a process [10,12]. According to some authors an organizational change implies any change in the organization leading to a higher level of efficiency and effectiveness in functioning, including standards and methods of their measurement [06]. The following may be identified as the content of organisational changes [06,05,01]: changes in organizational structure (including implementation of the different organisational models and appropriate decision support systems), changes in management structure, changes in business processes, activities and tasks, changes in organizational systems, changes in technology, changes in organizational culture and changes in people.

Different authors define the organizational transformation in various ways. So, according to Collins and Porras organizational transformation implies “a group of theories, values, strategies and techniques of science of behavior, focused on the planned change of the organizational vision and regulation of work, with the intention of generating alpha, beta, gamma A and gamma B changes in the awareness of the members of the organization, for the purpose of promoting paradigmatic changes which assist the organization to adapt to the existent or create a desirable future environment” [07,08]. The main feature of this definition is the one that insists on behaviorist content of the organizational transformation.

According to the definition given by Gouillart and Kelly [11], organizational transformation views the organization as a living organism, which due to serious deficiencies in itself, must initiate a complete “medical” treatment, and transformation should be initiated as a radical and complete “therapy” which consists of: redirecting – change in the perception of what the organization is and what it may be; restructuring – changes in organizational structure; revitalization – achievement of growth through improvement of relations with the environment; renewal – change of the spirit of the organization, i.e. affecting the human factor in the organization through application of the model for development of personality and relations within the organization.

The process of organizational transformation is very complex and like in the case of other concepts of organizational changes, there is no universal model for its implementation.

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ELEMENTS DETERMINING NECESSITY FOR ORGANIZATIONAL CHANGES IN THE SEAPORTS

In the circumstances characterized by intensifying of exchange of goods, rapid development of science, technique and technology, problems to be resolved also change as well as the elements of the environment to which the port needs to adapt. Therefore, it is frequently necessary to also modify organizational structure of the port through improvement of the existent or introduction of a completely new one. Organizational model should fully respect the fact that traditional role of ports has significantly evolved and that ports are no longer selected only for their natural hinterland but for being the best centers for adding value to goods and nodes in overall transport chain of goods [09].

The process of selection of a port organizational model is, as well, complex and there is no perfect methodology for its implementation.

The process of improvement of the existent or introduction of a new organizational model, or process of selecting of the port organizational model, should be based on previously clearly defined goals to be achieved. Some from the group of main goals are: improvement of productivity, rationalization of port structure, orientation towards the processes for the purpose of creating the base for competitive positioning in the free market, attracting private capital, etc. After defining the goals, options and alternatives should be developed and assessed. Particularly, it is necessary to analyze results arising from selecting any specific option. A useful instrument for planning the process of selecting the port organization model (selecting the optimal options) is the decision tree.

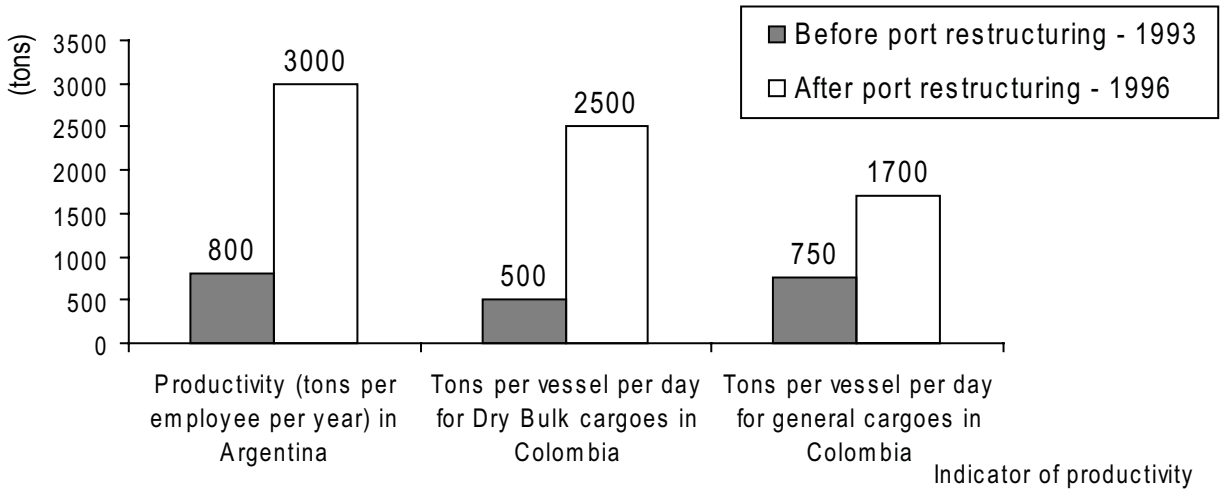


Figure 1. - Indicators od productivity before and after port organization transformation [15]

CHARACTER OF TRANSFORMATION EFFECTS ON THE PRODUCTIVITY LEVEL

In order to illustrate general effects of adequately modeled and realized process of port reform (organizational transformation, ...) on productivity in the cargo handling process, with Figure 1 are presented some data referred on ports in Columbia and Argentina before and after the restructuring process [15]. The level of productivity is quantified through the application of various indicators: for ports in Argentina – tons per employee per annum; for ports in Columbia – tons per vessel per day for dry bulk cargoes and tons per vessel per day for general cargoes.

In accordance with the results of the relevant researches, it may be stated that one of the principal objectives of the organizational changes (and restructuring in general) is increasing productivity in the cargo handling process (through fulfilling the organizational prerequisites, fulfilling preconditions for optimization of the investment intensity in the domain of the cargo handling technologies etc.).

Correlation between the productivity in the cargo handling process and the ship service time

Productivity improving process is realized through following basic phases: identifying bases for pro-

ductivity improving, identifying elements of cargo handling technology where improvements are possible, detailed analysis of identified improving possibilities, realization of improvements.

Some of the very important bases of productivity improving process are: cost analyses for previous periods, analyses of technological problems appeared during the cargo handling process, analyses of available resources (workers, port machinery, lifting accessories …), etc. Possible domains of productivity improving are: domain of workers (additional training, specializations...), domain of port machinery (introducing new port machinery with higher efficiency degree, reconstruction and modernization of existing port machinery …), domain of lifting accessories (introducing new lifting accessories with better performances …), domain of infrastructure objects, domain of internal transport flows, etc.
Increasing productivity has positive impact to very wide range of parameters that characterize realization of the cargo handling process in a port. There is a direct correlation between increased productivity and reduction of ship service time in a port (components of ship service time related to handling operations). Some results of related researches authors presented in the paper [02], [03].

Influential factors on ship loading/unloading time

Influential factors on ship loading/unloading time are numerous and of very different nature and influence intensity. Starting from basic structure of ship loading/unloading process model, implementing cause-effect (Ishikava) method, key groups of mentioned influential factors are identified (Figure 2) [04].

Key groups of influential factors on ship loading/unloading time are [04]:

- factors referred on management of ship loading/unloading process, F1;
- factors which are determined by ship (which is loaded/unloaded) characteristics, F2;
- factors which are determined by cargo (which is the object of manipulation) characteristics, F3;
- factors referred on manipulation type and its implemented variant, F4;
- factors referred on workers engaged during the loading/unloading process, F5;
- factors referred on used port machinery, F6;
- factors referred on used lifting accessories, F7; etc.

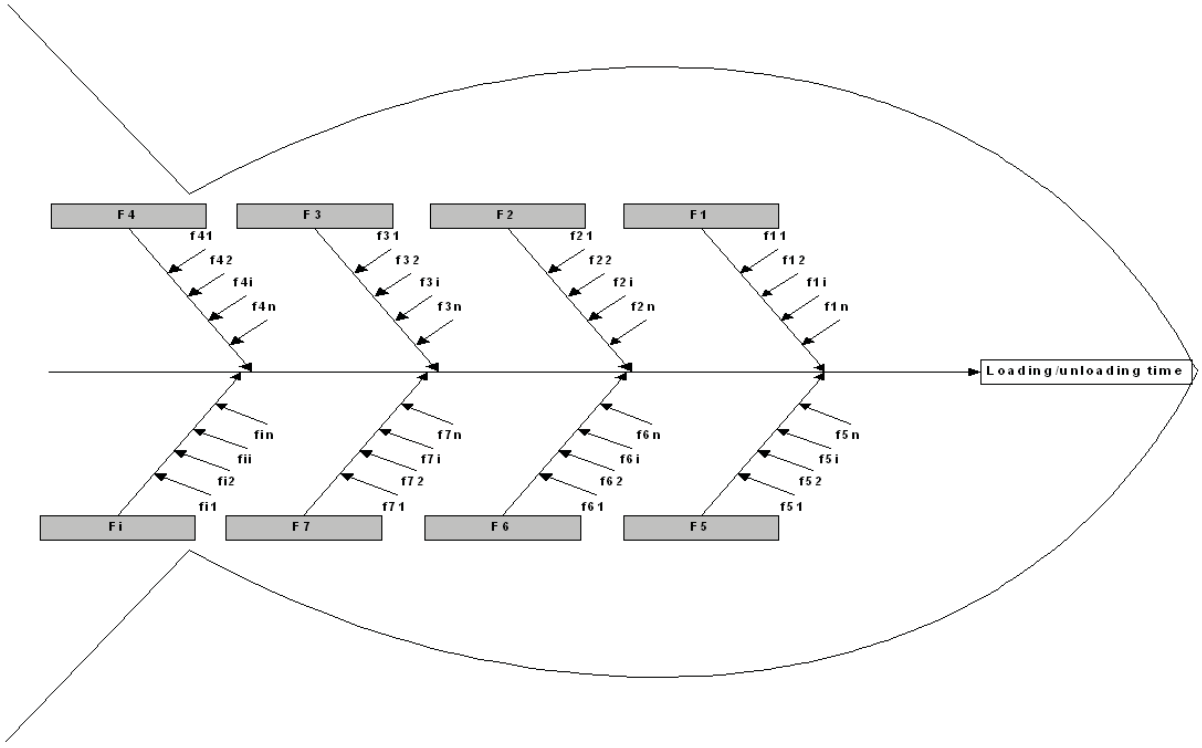


Figure 2. Cause – effect diagram

Factors referred on port machinery, F6

All identified groups of influential parameters have complex structure and are consisted of several elements. Group of influential parameters referred on port machinery, F6, involve following elements:

- port machinery coefficient of effective utilization during the loading/unloading process, F61;
- duration of loading/unloading process interruptions caused by used port machinery failure, F62;
- degree of used port machinery technological adequacy, F63;
- number of port machinery working cycles achieved during the loading/unloading process, F64;
- coefficient of port machinery capacity utilization, F65; etc.

In order to define "mechanism" of influence of these parameters on ship loading/unloading time, a research of influence of port machinery technological adequacy on ship loading/unloading time is done in the next paper segment.

Influence of port machinery technological adequacy degree on ship loading/unloading time

Port machinery technological adequacy degree (A) can be defined as a degree of coordination between its exploitation performances and technological requirements generated in the process of cargo handling – ship loading/unloading (where port machinery in question is engaged). Starting from hypothesis that there is a correlation between used port machinery technological adequacy degree and values of ship loading/unloading time, an analysis (investigation), whose results are presented here, is done.

Definitions

Technologically adequate port machinery, Ta: Port machinery with performances which are totally in accordance with technological requirements appeared in the process of its exploitation.

Technologically inadequate port machinery, Tal: Port machinery (with smaller capacity than Ta) which can replace port machinery Ta in the cargo handling process;

Table 1. - Input data of investigation

N°	Cargo type	Manipulation with cargo	T_a (used in the warehouse)	T_{al} (used in the warehouse)	T_{ah} (used in the warehouse)
1	Bags (50 kg)	Ship to warehouse	Forklift – capacity 2 t	Forklift – capacity 1,5 t	Forklift – capacity 3 t
2	Palette	Ship to warehouse	Forklift – capacity 2 t	Forklift – capacity 1,5 t	Forklift – capacity 3 t
3	Big bags	Ship to warehouse	Forklift – capacity 2 t	Forklift – capacity 1,5 t	Forklift – capacity 3 t
4	Sawn timber	Ship to warehouse	Forklift – capacity 2 t	Forklift – capacity 1,5 t	Forklift – capacity 3 t

Technologically inadequate port machinery, T_{ah}: Port machinery (with higher capacity than Ta) which can replace port machinery T_a in the cargo handling process;

Input data of investigation

Input data of this investigation (which was performed in The Port of Bar, in the period from 2005 to 2009) [14] are systematized in Table 1. Parameters of working process with some characteristic cargo types are taken into consideration.

Technologically adequate port machinery (forklifts) which can match technological requirements appeared during the process of cargo handling in warehouse, T_a, was replaced with technologically inadequate port machinery T_{al} or Tah in following cases:

- when the number of technologically adequate forklifts, according to defined cargo handling technologies, was not enough to satisfy all customers demands (all forklifts from the group Ta were engaged);
- when some of forklifts from the group Ta were in "down time" status;

Results of investigation - Influence of used port machinery adequacy degree on ship unloading time

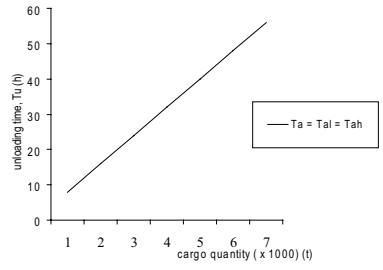
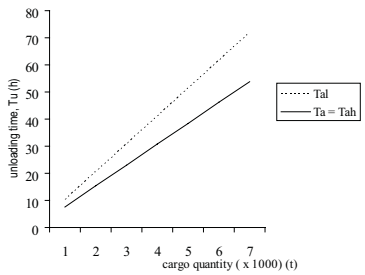
Graphs of correlations between ship unloading time and used port machinery adequacy degree, based on chosen cargo quantity in a ship, values of productivity per hour and assumption that during the complete unloading process only a gang per ship is engaged, are defined here. Systematization of previously mentioned elements is done by Table 2., where and some important relations between characteristic parameters are given also.

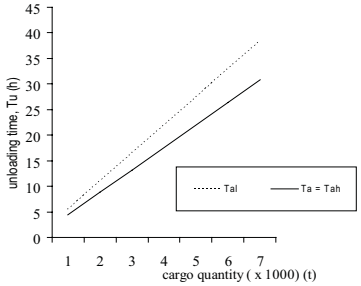
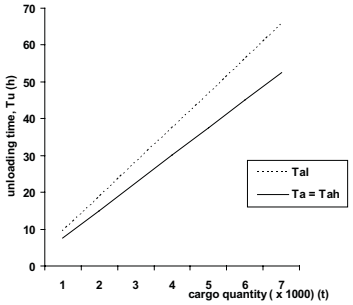
Symbols in Table 2 have following meanings:
i = 1, 2, 3, 4 – number of cargo types analyzed;
j = 1, 2, 3 – number of port machinery categories (j = 1: T_a; j = 2: T_{al}; j = 3: T_{ah});

Table 2. - Systematization of investigation elements

N⁰	Cargo type	Manipulation with cargo	Cargo quantity, Q (t)	Productivity , Pij (t/h)		Ship loading/unloading time, Utij (h)	
1	Bags (50 kg)	Ship to warehouse	Q_1	T_a	P_{11}	T_a	U_{t11}
			Q_1	T_{a1}	$P_{12} = P_{11}$	T_{a1}	$U_{t12} = U_{t11}$
			Q_1	T_{ah}	$P_{13} = P_{11}$	T_{ah}	$U_{t13} = U_{t11}$
2	Palette	Ship to warehouse	Q_2	T_a	P_{21}	T_a	U_{t21}
			Q	T_{a1}	$P_{22} < P_{21}$	T_{a1}	$U_{t22} > U_{t21}$
			Q_2	T_{ah}	$P_{23} = P_{21}$	T_{ah}	$U_{t23} = U_{t21}$
3	Big bags	Ship to warehouse	Q_3	T_a	P_{31}	T_a	U_{t31}
			Q_3	T_{a1}	$P_{32} < P_{31}$	T_{a1}	$U_{t32} > U_{t31}$
			Q_3	T_{ah}	$P_{33} = P_{31}$	T_{ah}	$U_{t33} = U_{t31}$
4	Sawn timber	Ship to warehouse	Q_4	T_a	P_{41}	T_a	U_{t41}
			Q_4	T_{a1}	$P_{42} < P_{41}$	T_{a1}	$U_{t42} > U_{t41}$
			Q_4	T_{ah}	$P_{43} = P_{41}$	T_{ah}	$U_{t43} = U_{t41}$

As well, using appropriate mathematical methods [13], concrete mathematical relations which adequately describe correlations between ship unloading time, Ut, and cargo quantity, Q, for analyzed cargo types and manipulation, are defined

Cargo	Bags (50 kg)	Palette
Graphic $U_{tij} = f(Q_i)$		
Correlation $U_{tij} = f(Q_i)$	When port machinery T_a or T_{al} or T_{ah} is used: $U_t = 0.008Q$	When port machinery T_a or T_{ah} is used: $U_t = 0.0076Q + 0.016$ When port machinery Tal is used: $Ut = 0.01Q + 0.05$

Cargo	Bags (50 kg)	Palette
Graphic $U_{tij} = f(Q_i)$		
Correlation $U_{tij} = f(Q_i)$	When port machinery Ta or Tah is used: $U_t = 0.0044\ Q$ When port machinery T_{al} is used: $U_t = 0.0055\ Q$	When port machinery Ta or Tah is used: $U_t = 0.0075Q - 0.02$ When port machinery Tal is used: $U_t = 0.011Q - 1.5$

Results comment

Results of analyses of correlations between port machinery technological adequacy degree and ship unloading time confirm that ship unloading time intensively depend on port machinery technological adequacy degree. Here two characteristic things can be pointed out: when port machinery Ta and Tah are used in the unloading process than optimal values of ship unloading time are identified. Case when port machinery of category Tal is included in the working process is characterized by bigger values of ship unloading time. Here and an "additional" conclusion becomes obvious – although in certain cases instead of forklifts from group Ta were used forklifts from category Tah (with higher capacity) productivity remain at the same level because other technological elements (workers, lifting accessories, …) are not adjusted with this change in implemented cargo handling technology.

Defined mathematical correlations between characteristic parameters could be used as a base for researching, through an "bottom – up" approach, and correlations between made organizational changes in a port organization and changes in the cargo handling process productivity. Ship service time could be used here as the optimal indicator.

CONCLUSION

By considerations done in this paper, some aspects of the complex thematic referred on the correlations between organizational changes and changes in productivity during the cargo handing process in a sea port were elaborated. It was stated that one of the principal objectives of the port organizational transformation is improvement of productivity what lead to the increased level of the port customer satisfaction level (increased level of port services quality), primarily through optimizing ship service time (its components related to loading/unloading operations). Mechanism through which correlations between organizational changes and level of productivity are concretized are numerous: enabling new investments in port machinery, enabling new investments in lifting accessories, … what is highlighted (partially) when an analysis of complex relations between productivity in the cargo process, ship service time (loading/unloading time) and influential parameters on ship loading/unloading time was done.

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