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BUFFER STOCK IMPLEMENTATION IN THE REGIONAL CONTEXT

Our objective is to identify the distribution of particular logistic models focused on specification of buffer stock concept implementation in order to avoid difficulties during/after its adoption. This paper deals mainly with the analysis of possible obstacles while buffer stock adoption and proposes a new methodology for buffer stock implementation. The analysis is based on both quantitative and qualitative surveys held in Czech Republic.

Keywords: *buffer stock; supply chain; inventory management.*
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ЗАСТОСУВАННЯ БУФЕРНИХ ЗАПАСІВ У РЕГІОНАЛЬНОМУ КОНТЕКСТІ

У статті описано розповсюдженість різноманітних логістичних моделей з акцентом на специфіці впровадження концепції буферних запасів та пов'язаних з ним складнощів. Проаналізовано можливі перепони на шляху імплементації моделі буферних запасів та запропоновано нову методологію її впровадження. Аналіз спирається на кількісні та якісні дані опитувань, проведених у Чехії.

Ключові слова: *буферний запас; ланцюжок постачань; управління запасами.*
Рис. 3. Табл. 5. Літ. 18.

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ПРИМЕНЕНИЕ БУФЕРНЫХ ЗАПАСОВ В РЕГИОНАЛЬНОМ КОНТЕКСТЕ

В статье описана распространённость различных логистических моделей с акцентом на специфике внедрения концепции буферных запасов и связанных с ним сложностей. Проанализированы возможные препятствия на пути имплементации модели буферных запасов и предложена новая методология её внедрения. Анализ основан на количественных и качественных данных опросов, проведённых в Чехии.

Ключевые слова: *буферный запас; цепочка поставок; управление запасами.*

Introduction. Today's turbulent and highly competitive business environment makes supply chain managers ensure sufficient inventory level while keeping inventory-related costs as low as possible, therefore, enormously important aspect of effective inventory management is placing the right amount of safety stock at right places (supplier, consignment stock, safety stock) in the supply chain for the possible lowest costs. Managing inventory, especially safety (also called buffer) stocks is one of the most challenging tasks supply chain managers are facing (Sitompul et al., 2008). Decisions related to inventory locations and their corresponding levels throughout the supply chain have fundamental impact on the service level, response time, delivery lead-time and the total cost of the supply chain. These interactions, present at each single link of a chain, render the analysis at the supply chain level much more difficult and complex (Sitompul et al., 2008). Stocks cannot be called safety stock. Two things work in our favour here: the law of big numbers, because it is dealing with items that are standard subassemblies and is consequently used across a range of end

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products. And the fact that with such items, to some extent at least, it will be buffered against fluctuations in end product demand by swings and roundabouts. An increase in demand for one end product may well be balanced by a decrease in demand for another. Real demand can be surprisingly stable at this level (Graham, 2015). Recent intertemporal consumption models emphasize the role of savings as a buffer stock against income fluctuations. It has solved sophisticated versions of such models. The fact that specific details of the model differ, emphasizing liquidity constraints or the probability of low income realizations, they share similar predictions. Buffer stock savers have a target wealth to permanent income ratio "such that if wealth is below the target, the precautionary saving motive will dominate impatience, and the consumer will save, while if wealth is above the target, impatience will dominate prudence, and the consumer will disserve" (Jappelli, 2008).

Literature review. The key implication of the buffer stock saving model has not been subject to empirical scrutiny. Current evidence of buffer stock behavior is based on two model implications: that consumption tracks income closely, and that precautionary saving represents an important reason for wealth accumulation (Jappelli, 2008). Past studies on balancing reconfigurable transfer lines assume that operational and set-up times are deterministic without concerning task attributes uncertainty. Task attributes are not known for certain; for instance, in manual lines, the effectiveness of operators vary with work rate, skill level and motivation, which may affect processing times. Scenario planning that corresponds to assignment of plausible task attribute values to the input data is necessary to set an optimum solution across all possible scenarios (Kristianto, 2014).

H.A. Vergara and D.S. Kim (2009) have developed a new effective and efficient method for allocating buffers in serial production lines, namely buffer placement method. The method developed here works for all systems where network simulation is applicable. Currently this includes open, closed and mixed model systems with single machine workstations. Other features that can be modelled are buffer transit times, and specific job sequences on the line. Testing shows that this method gives optimal or near optimal buffer allocations. This method is fast and can also be implemented on a spreadsheet.

A set of ordinary differential equations is derived to model the system of buffer stocks and production flows between interacting machines, and many experimental results have demonstrated that variations of key performance indicators, such as processing velocity, throughput rate, WIP and throughput loss, were effectively captured in the proposed continuous flow models. While buffer stock models reemphasize a particular approach to the transmission mechanism of monetary policy, the main impact of these models has been a questioning of the interpretation of applied studies of money demand. Exogenous demand and supply shocks to money stock, and if there are slowly adjusting variables which cause a disequilibrium, then simple approaches to modelling monetary phenomena will be inadequate. Nevertheless, attempts to model buffer stock have been far less fruitful than the original insights. The model is very difficult, and virtually impossible in the single-equation contexts (Milbourne, 1988). J.J. Kanet (2010) has shown that dynamic planned safety stock planning is sensible whenever demand or lead time is non-stationary and have argued that non-stationarity is prevalent. One realization of non-stationarity – heteroscedastic demand and resulting heteroscedastic demand forecast errors — is indeed pervasive in the US industry case. Stock savings in going from a policy of constant safety stocks to time varying safety stocks can be significant. P.D. Owen (1990) characterizes shock absorber and spillover aspects of financial buffer assets in terms of parameter restrictions in an ex ante integrated model of expenditure and portfolio behavior. On the basis of the results obtained using quarterly data for the UK personal sector there is little evidence to support the view that money acted as the sole financial buffer for this sector over the period examined. Whilst money has the largest coefficient on unanticipated income it does not satisfy the restrictions for a sole shock absorber and, more surprisingly, there is little support for the existence of significant spillover effects on the rest of the sector's portfolio and expenditure behavior. As well as none of other assets or expenditure is acceptable as a sole shock absorber, the bulk of the shock absorber role appears to be shared across 3 asset and liability categories. Considering point estimates and the overall results for both sets of tests, short-term loans appear to have as much claim to be an important financial buffer as money does.

Problem statement and research objective. Traditionally, safety stock is exclusively stored at the final stage of a supply chain, i.e. at retailers dealing with customer demand. As a result, the effect of variation in demand is only addressed at this final stage. In reality, this variability cannot be fully addressed at this stage: its effect breaks into the upstream stages of the supply chain through to production stage and up to raw material supply stage (Sitompul et al., 2008). Therefore, it makes sense to consider placing safety stock at some critical stage of a supply chain. Naturally, this safety stock may consist of finished goods, semi-finished goods and raw materials. A more efficient way to tackle the effect of demand variability in a supply chain is locating safety stock at a number of stages. The problem then is to determine the right location (i.e. the right stage) and the right amount of stock that must be kept to ensure the required overall service level at the lowest cost (Sitompul et al., 2008).

The majority of the existing models for the problem reported in literature assume infinite capacity. Under the infinite capacity assumption, production lead-time is assumed to be independent of production-batch size. In practice, this is hardly ever the case. Actually, the problem of locating safety stocks becomes a lot more complicated if the production capacity constraint is taken into account. In a capacitated supply chain, lead-times depend on the ordered quantity. Thus, when the order quantity increases (or decreases) manufacturing lead-times also increase (or decrease) accordingly. To ensure a given service level, safety stock is needed to deal with lead-time demand variability. Once these relationships are determined, an appropriate strategy can be deployed to efficiently place safety stock (Sitompul et al., 2008).

The main aim is to identify the distribution of particular logistic models in general and to particularize the buffer stock concept implementation in order to avoid difficulties during/after its adoption. This paper deals mainly with analysis of possible obstacles while buffer stock adoption and proposes a new methodology for buffer stock implementation itself. The analysis is based on both quantitative and qualitative surveys held in Czech Republic.

Buffer stock MIN and MAX concept policy. It is crucial to distinguish and compare the consignment stock MIN MAX concept with the buffer stock MIN MAX concept in order to understand the implementation process. While considering CS policy or buffer stock proposal, there are particular differences in policies. Basically, in the traditional concept there is always a single order by buyer followed by a single delivery by vendor as demonstrated in Figure 1.

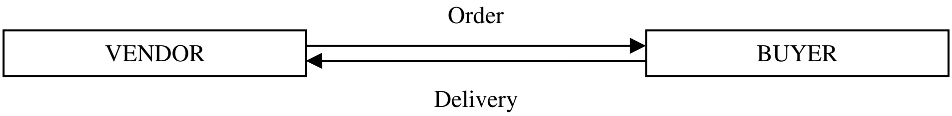

Figure 1. **Traditional concept,** *authors'*

As we are considering buffer stock MIN and MAX borders concept, basically buyer places a frame order and a vendor produces material into two "sections". The first one is meant to be delivered into a buyer's stock (among the particular MIN border s and MAX border *S*). The second one needs to be placed in vendor's stock in order to keep the minimal level of that particular material, which could be proved in any case, any time. A vendor delivers items/materials in accordance with his/her responsibility as well as with the available data (consumption, forecast, current material level, received deliveries, and claims), thereby among MIN and MAX borders.

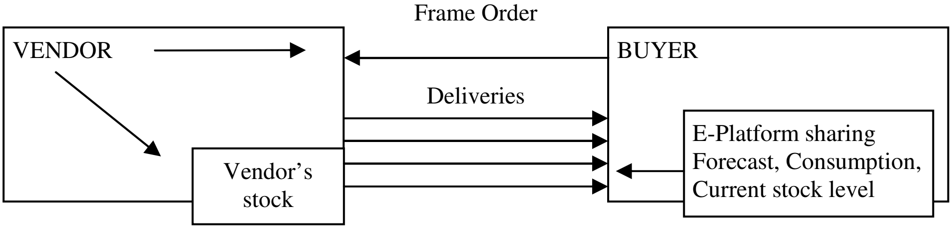

Figure 2. **Buffer stock concept,** *authors'*

In comparison to the consignment stock concept, the buffer stock concept adoption might include much lower borders. Due to the fact that vendor should be obliged to keep safety stock, it is possible to set MIN and MAX borders as low as possible, for example, 1 week average material consumption as MIN border and 2 weeks as MIN border. In case of the CS concept, there might not be a safety stock ensured, therefore, borders could be placed much higher.

Logistics and manufacturing constraints typical of actual industrial systems constitute the base for the model, followed by the 10 phases as D. Battini (2010) describes in more detail (Figure 3). During project implementation, it is necessary to accomplish each task independently from partners' constraints, which should be individually addressed by both partners. Effective communication from the beginning of partnership is of utmost importance to reduce start-up times and inception delays. A CS implementation project should be based on a concurrent engineering paradigm, to ensure that different activities, developed during project execution, will be carried out by a cross-functional buyer-vendor group, with a continuous reciprocal agreement to prevent any delay in implementation time. Only with an integrated approach will partners realize annual savings and effective implementation of this policy, without incurring high start-up costs (Battini, 2010). The CS concept doesn't vary very much from the buffer stock concept, except for some aspects. Basically, for this purpose, it is possible to get inspired from the CS implementation steps in Figure 3.

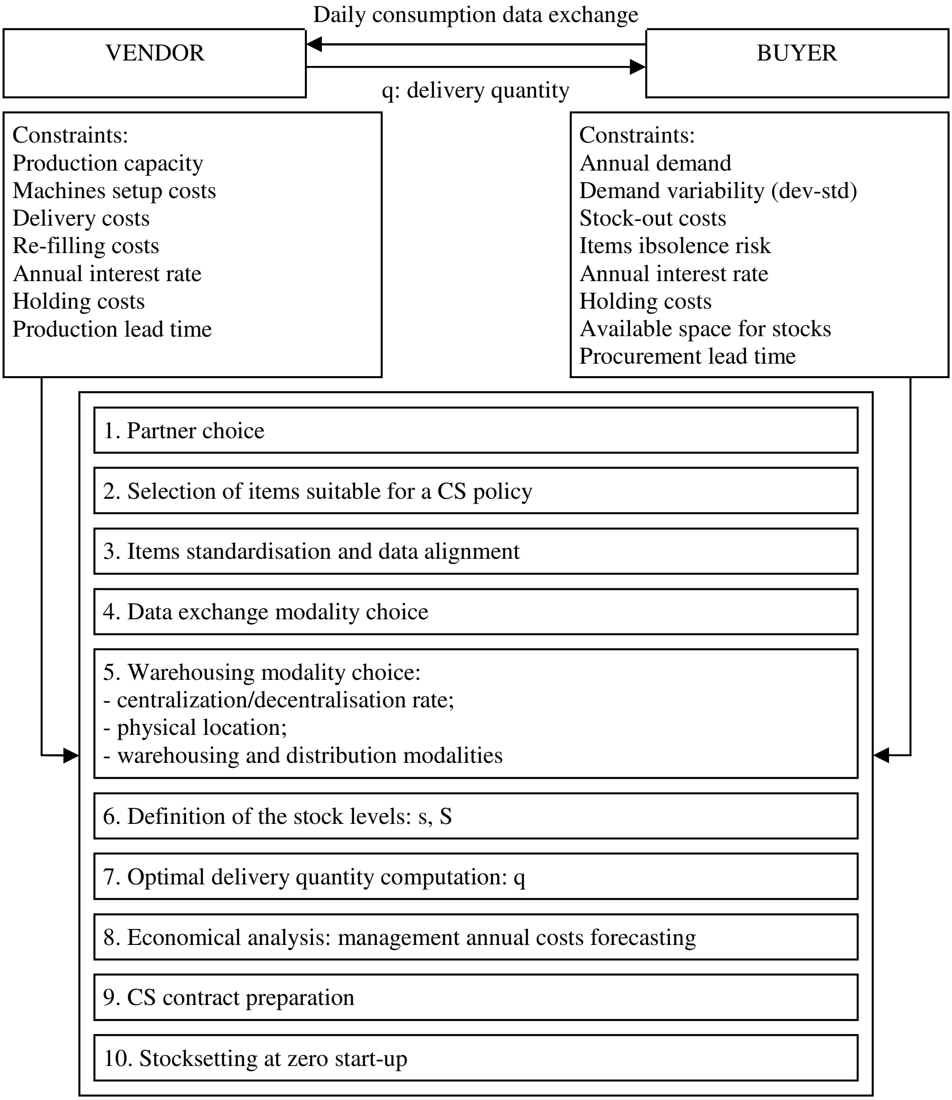

Figure 3. **Methodological framework for CS policy implementation** (Battini, 2010)

For the purpose of this paper, we used both quantitative and qualitative surveys in Czech Republic. A field of survey was used to investigate the research questions. A structured questionnaire was utilized as the main data collection tool. Respondent organizations were sampled from various industries, sizes and annual sales volumes.

In total there were 231 companies contacted in different areas of Czech Republic. 54 companies didn't give us any feedback or refused to participate, thereby we got 177 feedbacks. The response rate was thus 77%. The industry distribution of the sample is shown in Table 1. In addition, 68 participants were small, 51 medium and 58 large companies.

Table 1. **Industry distribution,** *authors'*

Name of industry	Number of firms	%
Auto / Auto parts industry	10	6
Building industry	12	7
Ceramics	7	4
Chemical manufacturing	9	5
Drug manufacturing	7	4
Electronics	11	6
Food manufacturing	17	10
Paper	9	5
Plastics	15	8
Retail	17	10
Services	8	5
Steal/metal manufacturing	33	19
Textile manufacturing	9	5
Transportation	6	3
Wood	7	4
Total	177	100

Table 2 demonstrates the share of particular logistic models usage. On one hand, it is obvious, that 78% of the respondents adopted some of particular logistic models. On the other, 22% of the respondents don't use any of the selected logistic models, either not interested, or don't have any need for such adoption based on a kind of industry, type of material, not such sufficient amount of orders etc. The consignment stock is the most spread model (33%), then goes safety stock (28%) followed by the buffer stock concept (13%). The last option – others – there might be included other concepts such as the smart bin concept, Kanban or a different agreement on safety stock, delivery conditions, stock optimization or different types of partnership based on inventory optimization.

Table 2. **Share of selected logistic models usage,** *authors'*

Type of the selected logistic model	# of answers	%
Consignment stock[1)]	58	33
Buffer stock[1)]	23	13
Safety stock	49	28
Other	8	5
None	39	22

[1)] MIN and MAX concept.

Another part of this survey was also to observe which particular logistic models the respondents would implement in the future. Table 3 demonstrates the respondents' willingness to a future particular logistic model adoption. A very significant share of all the answers got the option "Not sure" (47%) – almost half of the sample is not convinced about any future logistic models adoption as such. Buffer stock (MIN MAX concept) option wouldn't choose any of the respondents, the safety stock concept got 11%, the consignment stock – 10%.

Table 3. **Possible future models' implementation,** *authors'*

Type of the model	% of answers	%
Consignment stock	17	10
Buffer stock	***0***	***0***
Safety stock	20	11
Others	28	16
Not sure	***84***	***47***
No answer	28	16

Due to the fact that we are also working on the study dealing with the process of consignment stock concept implementation, we would like to focus on the buffer stock concept implementation in this paper. Therefore, according to the results shown in Table 3, there was another research investigated with just those respondents using the Buffer stock MIN and MAX concept. Structured phone interviews were utilized as the collection tool. Phone interviews conducted with the persons in charge of buffer stock concept adoption. During our phone interviews, we paid attention to comments and arguments the respondents gave to the presented process of the CS stock concept implementation, Figure 3. Specification of the key steps significant for successful implementation was another part of our survey. For the purposes of this survey, we contacted those 23 respondents that use the buffer stock MIN MAX concept as was found out in the previous research, see Table 1. We were able to conduct interviews with 18 companies/respondents, 5 respondents refused to participate.

Key results. According to the survey, the most significant steps in buffer stock implementation are partner and item choice, continual communication, buffer stock contract and definition of the Min and Max border as Table 4 shows.

Table 4. **Significant steps before/during/after the buffer stock MIN MAX implementation,** *authors'*

	The most important steps	
1.	Partner choice	
2.	Items choice	
3.	Continual communication	Including training, preparation for implementation, assistance during implementation and feedback after the implementation
4.	Buffer stock contract	Focus on conditions, claims, deliveries, penalties etc. in case of any difficulties, backlogs, additional costs etc.
5.	Definition of the stock levels: s, S	Setting up

In accordance with the interviews with the respondents that adopted buffer stock, while comparing the CS concept implementation (Figure 3) presented by D. Battini (2010), the steps in buffer stock implementation are defined/proposed using the consignment stock steps of implementation in Table 5.

According to our interviews, those respondents, who adopted buffer stock, found the most essential problems in the following aspects: communication, contract negotiation conclusions, suppliers' willingness to work with an e-platform for data exchange, optimal delivery quantity and MIN and MAX borders setting. The original

D. Battini's (2010) pattern was changed accordingly, amended in several phases, appended few more steps and presented in Table 5. First, we divided the original concept into 4 basic phases such as preparatory and analytical phase, implementation and the final phase. In accordance to our interviews, the following steps were added into the framework considered crucial by our respondents' — supplier's training for using the e-platform, placing a frame order, coordination of stock itself and deliveries, feedback, discussion the process running, suggestions for treatment and process improvement and possible implementation of the agreed amendments.

Table 5. **The process of buffer stock implementation,** *authors'*

A. Preparatory phase	- Partner choice – agreement with contractor at this phase required. - Selection of items suitable for the buffer stock MIN MAX policy – consideration of an agreement with internal specialists/departments, type of material needs to be taken into consideration, ABC/XYZ analysis could be highly recommended.
B. Analytical phase, preparation of settings	- Buffer stock contract preparation – negotiation of conditions convenient for both partners might cause a bit delay. - Items' standardization and data alignment. - Data exchange modality choice. - Warehousing modality choice: a) centralization/decentralization rate; b) physical location; c) warehousing and distribution modalities. - Definition of the stock levels: s, S. - Optimal delivery quantity computation: q – based on MIN and MAX borders setting, production requirements and many other operational factors. - Economic analysis: management annual costs forecasting. - Suppliers' training for using the e-platform necessary to ensure both sides' ability to cope with the platform as a significant communication and data exchange tool. - Contract conclusion – including summarization of all the agreed duties, responsibilities, conditions and rules. - Consumption of current stock – possible if much higher than the future MAX level.
C. Implementation	- Placing a frame order, coordination of stock itself and deliveries – might vary, but could be recommended for example, as 1 year or 6 months average consumed quantity. However, once buffer stock is implemented it is necessary to coordinate the current stock and schedule the first deliveries via an e-platform for further data exchange. - Deliveries using the e-platform – according to the shared data without any major buyer's assistance.
D. Final/post implementation steps	- Feedback, discussion regarding the process running. - Suggestions on treatment and process improvement. - Possible implementation of the agreed amendments.

Conclusion and directions for further investigation. One of the most challenging and crucial objectives of the supply chain inventory management is costs and inventory reduction in such an amount to assure the required high service level. The current trend is to find in innovative ways and/or methods for accurate managing of stock inventory. For this reason, we focused on the real information on particular logistic models spread in Czech Republic and developed a framework of the implementation of buffer stock concept.

This study develops a framework for buffer stock implementation. The presented research results show that 78% of the companies adopted any of presented logistic models and 22% are not interested or don't have any need for such adoption. The consignment stock and the safety stock are the most spread logistic models in Czech Republic. Actually, one third of all the respondents used consignment stocks. Furthermore, the potential for future adoption our respondents found mainly in the consignment stock and safety stock concepts. Despite the fact, that 13% of our respondents have adopted the buffer stock concept already in accordance with our survey, they wouldn't use this logistic model in the future any more. Deeper look on the respondents' opinions regarding buffer stock concept helped us define the crucial parts/steps/points in the implementation process such as communication, contract negotiation conclusions, suppliers' willingness to work at an e-platform for data exchange, optimal delivery quantity and MIN and MAX borders setting.

Further, this survey pointed out several difficulties in the implementation, whereby we were able to amend the CS implementation process presented by D. Battini (2010) which we divided into 4 basic phases first and added more identified steps while the buffer stock concept MIN MAX implementing process such as supplier's training for using the e-platform; placing a frame order, coordination of stock itself and deliveries; feedback, discussion of the process running; suggestions for treatment and process improvement; possible implementation of the agreed amendments.

The proposed model provides a flexible framework for the buffer stock implementation in order to avoid difficulties such as additional costs, additional efforts, backlogs and many other inconveniences as much as possible to facilitate greater buffer stock utilization.

In conclusion, further research might focus on an analytical and a numerical model comparing vendors' costs (set-up costs, holding costs, obsolesce and stock-out costs) with real return on sales. More attention should be also paid to a partner/supplier and an item choice according to particular factors that need to be considered.

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