Assessing Vendor Managed Inventory (VMI) for Humanitarian Organizations

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ABSTRACT

Logistics activities are of high importance for the success of a humanitarian operation and can be responsible for up to 80% of its costs. Vendor Managed Inventory, a concept successfully applied in commercial logistics, might be a possibility to enhance the effectiveness of humanitarian logistics operations. However, there is a lack of an appropriate assessment of the VMI applicability for a humanitarian organization. We propose an adjusted VMI Readiness Score for humanitarian organizations, a tool adapted from a commercial context for the specific requirements of humanitarian scenarios, to gain a general impression of the suitability of VMI. The tool is applied exemplary to the IFRC and the result indicates that it is worthwhile to further investigate the applicability of VMI for humanitarian organizations.

Keywords

Humanitarian Logistics, Vendor Managed Inventory, Humanitarian Supply Chains

INTRODUCTION

The number of disasters and the severity of their consequences have increased for the last years. Disaster management and humanitarian logistics are important to be capable of an effective response. The question whether concepts which have been well-tested in commercial logistics are applicable to the humanitarian sector arises (Bölsche, 2009). Theoretically, the concept of a Vendor Managed Inventory (VMI) promises to be able to cope with many challenges of humanitarian logistics because it supports the relief organization to focus on their core competence being providing help. If a customer and a vendor engage in a VMI-based relationship, the responsibility for the time and amount of order is transferred from the customer to the vendor. Benefits such as reduces costs or an increase in goods availability would also be of advantage in humanitarian scenarios (Bookbinder et al., 2010).

This paper aims at providing a method to examine the potential benefit of VMI application for humanitarian logistics in general. Before investing time and costs to investigate quantitatively and technically how the VMI concept could be implemented in a humanitarian organization, it is beneficial to first assess whether it is suitable on a rather level. To support a general assessment of VMI, we propose a humanitarian-specific adaption of the VMI Readiness Score, which was originally developed to judge the suitability of VMI for organizations in a commercial context. Based on a literature analysis on VMI and its applicability in humanitarian logistics, we identify, analyze, and adjust an appropriate assessment method as a starting point to evaluate case-specific VMI fittingness. To evaluate the concept, we apply the VMI Readiness Score exemplary for the International Federation of the Red Cross (IFRC) based on available documents on organizational structure, procurement processes and other relevant data.

The first section describes the challenges of logistics in the context of humanitarian operations and the basic concept of VMI. In the main part, we present and discuss the adjustment of the VMI Readiness Score. A Use-case based application of this Score for the IFRC will be presented to reflect benefits and limitations. Finally, a conclusion summarizes the findings and points out limitations as well as future research possibilities.

LOGISTICS IN THE CONTEXT OF HUMANITARIAN OPERATIONS

Humanitarian logistics describes "(…) the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people" (Thomas and Kopczak, 2005). Overall, the term subsumes a wide range of tasks and does not denote a definitive field of activity (Blecken, 2010).

Logistics is a key factor for the success of a humanitarian operation. Up to 80% of the occurring costs can be ascribed to logistics activities (Blecken, 2010). Only since the South-east Asian tsunami in 2004, the topic of humanitarian logistics has gained more attention and the number of corresponding publications has increased significantly (Kunz and Reiner, 2011). One important reason for this paradigm change is uncertainty in the following areas: Needs for goods and services, personnel, equipment, stock levels, financial means, number of affected people, state of infrastructure etc. Short lead time – contingent on the often sudden onset of disasters – and lacking initial resources are further challenges needed to be addressed by decision makers, who can themselves be a challenge due to their high number and variety (Ortuño et al., 2013). The number, type and severity of the arising challenges are dependent on the type of the occurred disaster, focus and location of the organizations and the environment of further stakeholders (Kovács and Spens, 2009).

The uppermost aim of humanitarian logistics is to save human life and alleviate suffering. To do so, humanitarian organizations operate across the disaster management cycle per Figure 1, which can be described by the four phases: mitigation, preparedness, response and recovery (Holguín-Veras et al., 2012). Because humanitarian operations are encompassed by various requirements, each stage consists of specific tasks and functions. However, the boundaries between the four phases are blurry and the four phases are overlapping and interrelated (Blecken, 2010; Kovács and Spens, 2009; Ortuño et al., 2013).

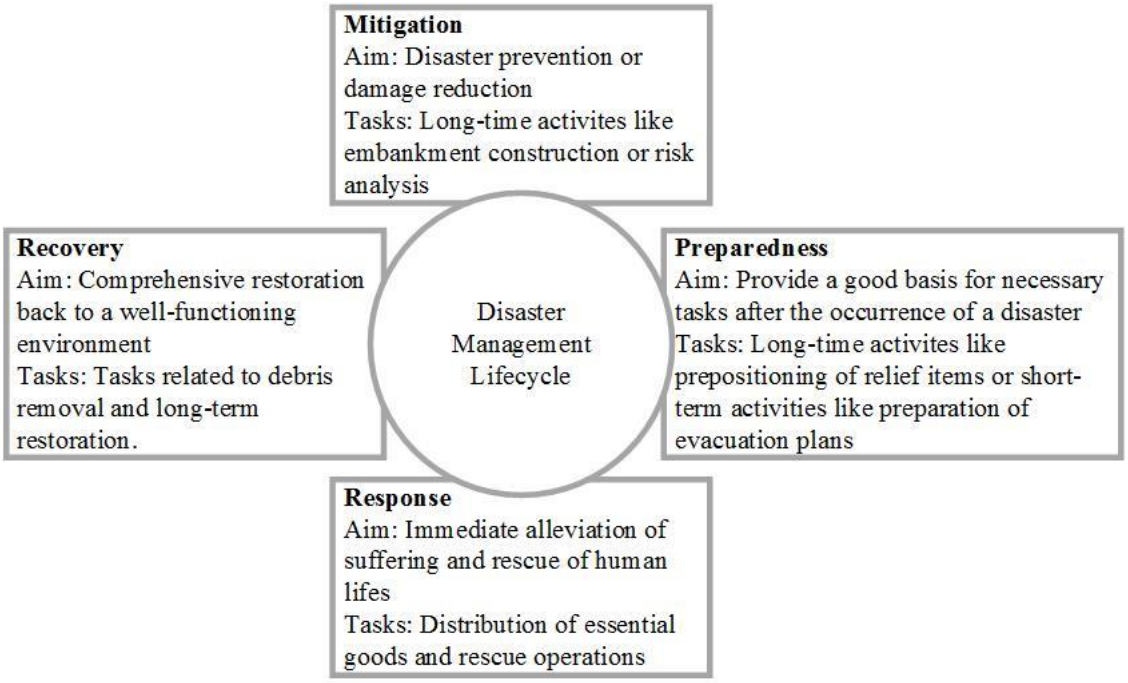

Figure 1. Disaster Management Lifecycle
(Own compilation based on Altay and Green, 2006; Celik et al., 2012; Ortuño et al., 2013)

RELATED WORK

The Concept of Vendor Managed Inventory

VMI, also known as „continuous replenishment, automatic replenishment [or] supplier-managed inventory" (Razmi et al., 2009), is a strategy for supply chain management and was established by well-known companies like Wal-Mart or Procter & Gamble in the 1980ies (Sari, 2008; Waller et al., 1999).
Information exchange and a reallocation of responsibilities are central points of the VMI concept. While traditional supply chains leave decisions about amount and time of replenishment to every single member, VMI is characterized by transferring this responsibility to the preceding supply chain member (Kannan et al., 2013). Consequently, the customer delegates the responsibility for his inventory and its management to the vendor. When applying the VMI concept, the customer is responsible for providing the vendor with every relevant and helpful information ("point of sale" data), which is enabling bilateral or global optima (Claassen et al., 2008). The question on the responsibility for creating demand forecasts varies in the literature. While some sources assign this responsibility to the vendor (e.g. Achabal et al., 2000) others name it as one of the customer's tasks (e.g. Claassen et al., 2008; Kannan et al., 2013). Moreover, the vendor's autonomy of decision can be limited by agreeing on a safety or maximum stock or a certain service level which needs to be satisfied. The compliance is then monitored by the customer and in case of exceeding the agreed level, the vendor can be inflicted on the vendor (Darwish und Odah, 2010; Razmi et al., 2009; Sari, 2008).
In the literature, different advantages of implementing the VMI concept are discussed, which are justified for example by simulation (e.g. Southard and Swenseth, 2008), mathematical models (e.g. Choudhary and Shankar, 2015) or empirical evaluation (e.g. Kauremaa et al., 2007). Advantages are possible in the following categories: more precise demand forecasts, improved inventory management, reduced costs and increased service level. These categories are mutually dependent and benefit from each other.
Apart from the advantages mentioned above, the implementation of VMI harbors different challenges. One of the greatest obstacles is the need to establish intensified and long-term, relationships between the customer and vendor, which is trusting and faithful enough to allow the necessary level of coordination, e.g. exchange of sensitive data (Claassen et al., 2008). Additionally, customer and vendor often use different KPIs to measure their success (Angulo et al., 2004; Darwish and Odah, 2010). Apart from that, technical aspects offer huge range for pitfalls. To guarantee an adequate information exchange, information and communication systems of both partners do not only need to fulfill the according requirements but also must be integrated. Adjustments of the systems may be needed and can be costly and time-consuming (Choudhary and Shankar, 2015; Watson et al., 2012). Furthermore, even if the exchange of information is succeeded, there is still the challenge to provide the right information at the right point in time and then process and use it in the right way (Angulo et al., 2004; Sari, 2008).
Overall it can be stated, that the concept of VMI is not a universally suitable strategy. A successful application of it is dependent on the demand process, the environment, in which the companies are operating, as well as the type of products produced by the vendor (Choudhary and Shankar, 2015). The negotiations regarding the legal setting, framework agreements, types and amounts of covered goods, process alignments, technical setups and implementations are time consuming and expensive for the involved partners. The planning horizon is of strategic nature limiting the flexibility of both parties.

Vendor Managed Inventory in the Context of Humanitarian Logistics

Even though various advantages have been identified regarding the usage of VMI in commercial logistics scenarios and therefore suggest that this approach might also be beneficial for humanitarian ones, there are only few existing sources dealing with this topic. Moreover, they state different opinions on the realizable benefits: On the one hand VMI is considered to not be appropriate as in the case of a disaster there would not be enough time to implement an adequate information exchange and good-enough forecasts (Bölsche, 2009). On the other hand, this conclusion neglects the existence of predictable turnover of relief goods distributed in ongoing projects of humanitarian organizations on recurrent disasters or midterm projects initiated in response to ad-hoc missions. One example is the United States Agency for International Development (USAID), which applies VMI in the context of their DELIVER PROJECT (Watson et al., 2012). Within this project, VMI is used to increase the supply chain's performance and improve the availability of medical goods in developing countries. Especially in humanitarian operations, where only little forces are acting directly on-site, VMI can lead to a significant improvement. The usage of VMI allows on-site forces to concentrate on e.g. distribution work, and shifts the responsibility for logistics-related tasks to members of higher levels of the supply chain, who often have better suited skills. The resulting advantages are decreasing inventories and costs, reduced transport- and distribution costs as well as an increased product availability. Circumstances like possibly volatile programs, insecure financing, low-quality communication and information systems, highly variable demand or a lack of

trust are typical challenges. Nevertheless, operations by USAID show that these challenges can be overcome and that the usage of VMI in the context of a suited scenario can have major benefits for humanitarian logistics (Watson et al., 2012).
Having compared both examples and their converse opinions, it is remarkable that Bölsche (2009) uses a holistic viewpoint for the suitability assessment. Instead of using characteristics like type or cause of the disaster or the disaster's magnitude to distinguish different application scenarios, it is only differentiated between regional and central level. The question, whether VMI is suited for an application in a humanitarian scenario in general, is asked. This can be seen critically, since such a general examination does not reflect the manifold and individual challenges of humanitarian logistics scenarios.
It can be concluded that although the applicability of VMI needs to be assessed for specific humanitarian logistics scenarios (like one organization, a humanitarian network or a long-term project), there is so far no tool available to do so. Such a case-specific evaluation would allow the identification of benefits as well as the deduction of potential risks. Successful VMI examples such as presented by Watson et al. (2012) indicate the worthiness of a more detailed examination of specific application cases. Likewise, it is stated, that VMI is not the only possible improvement or solution and should not be regarded as a universal remedy. A decision on whether to apply or not the concept of VMI must be deliberately considered for every single case and should only be based on its specific circumstances.

VMI READINESS SCORE

Key driver for a successful application of VMI are mutual trust and information exchange. Both supply chain members, the vendor and the customer, must be committed to engage in a long-term and close relationship making it possible to share the necessary and often sensitive data. Since the advantages of VMI can only be achieved in collaboration, customer and supplier are highly dependent on each other. To make such a relationship work, not only trust but openness and honesty are necessary. Relationship, information, information- and communication-system quality as well as the intensity of information exchange are the four crucial factors for a successful application of the VMI concept (Claassen et al., 2008). In addition, it is advised to concentrate on class A and B products, i.e. products causing a large part of the cost while only being produced in a low quantity. After successful implementation class C products build potential for cost savings as well (Kannan et al., 2013).
Nonetheless, possible advantages of VMI have been sufficiently discussed in literature, while the question on the circumstances under which benefits occur, has been neglected so far. Therefore, NIRANJAN ET AL. (2012) developed a *VMI Readiness Score* that can be used to assess the general applicability of VMI for a given scenario. Following a literature research approach, they identified features, which are summed up in three categories: product-related, company-related and supplier-related.
Each of these features has been weighted by experts from research and industry. After assigning values from 0 (totally disagree) to 4 (totally agree) to each of the features, these values are multiplied with the feature's weight and summed up. The result gives an indication on the general applicability of VMI for the considered scenario. A value below 200 (resp. 50%) reveals that the application of VMI is not promising and a value above 300 (resp. 75%) suggests that VMI might be a suitable concept. If the value lies between 200 and 300 (resp. 50 and 75%), VMI should at least be considered as a serious alternative, as although not fulfilling every requirement, the considered scenario holds the capability to lead VMI to a success.
Having established the 15 features, the score has been validated with case studies in ten different companies. Employees of these companies have assigned values to the features and calculated the responding VMI Readiness Score. All results correspond to the actual situation, i.e. the framework allocates companies not applying VMI a respectively low value and vice versa. Among companies with a medium readiness score (between 50 and 75%), some using VMI and some not using it are situated (Niranjan et al. 2012). Table 1 offers an overview of the 15 identified features, their weight and a statement about whether they are controllable resp. improvable.
Overall, the VMI Readiness Score is a tool to get a company-specific indicator on the suitability of the VMI concept. Since the score calculation is only based on simple mathematics, it is easily applicable – e.g. by using a spreadsheet calculation - and consequently well-suited for a humanitarian context.

Product-related	Company-related	Supplier-related
Products are standardized, i.e. customization is minimal (7.07)	Transaction costs pertaining to purchasing are high (5.14)	High levels of trust and long term relationships with the suppliers exist* (7.72)
Products are repetitive, i.e. infrequent changes in product specification by customer (8.04)	Company revenues have been stable over the years, i.e. neither grown rapidly nor fallen (3.86)	VMI benefits are evident to both our company and our suppliers (7.07)

Products have a standard product identification throughout the supply chain* (6.75)	The company has no problem sharing inventory/forecast information with suppliers* (9.97)	Key suppliers constitute a high percentage of purchase orders* (5.14)
Demand variance is low (4.82)	Information and communication systems are good* (6.75)	Suppliers are willing to cooperate with a VMI initiative (8.68)
Demand is forecasted and stock levels are closely monitored* (7.40)	Purchasing is a core competence of the organization (7.07)	The company's information system is integrated with the suppliers* (4.50)

Table 1. VMI Readiness Score (feature weight in brackets; * = feature is controllable/improvable)

Adapted VMI Readiness Score for Humanitarian Organizations

The original VMI Readiness Score has been developed for a commercial setting. Due to fundamental differences between commercial and humanitarian logistics (see Widera and Hellingrath, 2011), it has to be adapted to the specific requirements and challenges of the application domain. Consequently, every feature must be critically reflected regarding its applicability for the specific characteristics of humanitarian logistics. Due to the nature of VMI, the features differently affect the upstream supply chain focusing the information and financial flows and the downstream direction, mainly covering the subsequent material flows. Moreover, the special characteristics of humanitarian scenarios also affect the importance of each feature. Thus, even if a feature is applicable to a humanitarian context, it might be necessary to adjust its weight.

Product-related features

Product-related features mainly contain statements about the characteristics of the products or the demand. The judgement of whether a product is suitable for the use of VMI or not is therefore limited to the product and demand and not directly related to the aims and obstacles of the setting. Only the suitability of the products is analyzed and no attention is payed to the surrounding circumstances. Consequently, it seems that no adaption is needed to apply this section to a humanitarian scenario. It might be the case that different sets of relief items are needed in different disaster types, but in general, the portfolios of relief goods are organization specific, e. g. humanitarian organizations focusing on medical relief have a predefined set of standard items to be deployed in operations. This does not mean that the delivered supplies always need to be identical: the proportion of bandaging material and medications might vary between different disaster types, but the suitability of VMI has to be tested in context of an average mix of identified demands. Thus, average numbers (costs, amounts) of supplied items in a set time frame need to be considered in this category.

Organization-related features[1]

In contrast to the products-related features, a humanitarian setting leads to specific requirements for an organization. For example, the importance of a fast delivery is much higher than in a commercial setting whereas costs become less relevant. Therefore, the feature "The company revenues have been stable over the years i.e. neither grown rapidly nor fallen" may be omitted. Nevertheless, costs play another role in the sense that it is necessary to ensure a sufficient funding of humanitarian operations. So it is sensible to replace this feature with one that asks about reliable funding (Watson et al., 2012). The same argumentation indicates a reduction of the weight of "Transaction costs pertaining to purchasing are high". The relation of transaction costs to purchasing activities are still relevant, but as with costs in general this aspect becomes less important in a humanitarian setting. Another aspect which is not considered in the features is the capacity to manage and maintain information systems. Information systems themselves are supposed to be judged regarding their quality but no statement is made about whether organization members are capable of adequately handle them. Therefore, the feature "Information and communication systems are good" will be extended by adding "and there is sufficient knowledge on how to handle them".

Supplier-related features

The supplier-related features concentrate on the trust between the company and its supplier and on the agreement to use VMI. These aspects are requirements, which are independent from the environment companies are operating in and fundamental for the successful application of VMI. Consequently, the stated features do not have to be changed to make them applicable to a humanitarian scenario and their weight should remain the same

[1] The heading of this feature section needed to be changed, since it is not suitable to call humanitarian organizations "companies".

to still indicate the high importance of a profound relationship between the organizations operating under VMI.

Product-related	Organization-related	Supplier-related
Products are standardized, i.e. customization is minimal (7.07)	Transaction costs pertaining to purchasing are high (2.54) ↓	High levels of trust and long term relationships with the suppliers exist* (7.72)
Products are repetitive, i.e. infrequent changes in product specification by customer (8.04)	Funding for procurement is reliable –availability of donor funds or government funds (4.51)	VMI benefits are evident to both our organization and our suppliers (7.07)
Products have a standard product identification throughout the supply chain* (6.75)	The company has no problem sharing inventory/forecast information with suppliers* (10.62)	Key suppliers constitute a high percentage of purchase orders* (5.14)
Demand variance is low (4.82)	Information and communication systems are good and there is sufficient knowledge on how to handle them* (7.4)	Suppliers are willing to cooperate with a VMI initiative (8.68)
Demand is forecasted and stock levels are closely monitored* (7.40)	Purchasing is a core competence of the organization (7.72)	The organization's information system is integrated with the suppliers* (4.50)

Table 2. Adapted VMI Readiness Score (feature weight in brackets; * = feature is controllable/improvable)

Case-based Investigation

The adapted VMI Readiness Score is deployed to evaluate the applicability of VMI for a humanitarian organization. The International Federation of Red Cross and Red Crescent Societies (IFRC) is used as an exemplary case. The assessment of the different statements is based on publicly available reports published by the IFRC[2], among them their procurement catalogue, dedicated procurement reports as well as reports describing their work during various humanitarian operations. According to them, each features obtains a value between 0 (statement cannot be supported at all) and 4 (statement can be fully supported). It is important to notice that not all features can be answered solely based on these sources. Especially with regard to supplier-related features, feedback from an expert knowing the IFRC would be helpful. Whenever the sources for a feature's assessment are not sufficient, the medium value of 2 will be assigned to influence the score neither negatively nor positively.

Products are standardized, i.e. customization is minimal

This statement is valid for the goods typically distributed by the IFRC, which can be viewed e.g. via the Emergency Item Catalogue (IFRC and ICRC, 2009). Those are fundamental relief items and cannot be customized. Also product-sets like dedicated baby-kits are composed of standard items. Consequently, not the goods themselves but their assortment is personalized.

Products are repetitive, i.e. infrequent changes in product specifications by customer

Also this statement can be confirmed by the IFRC reports. Product assortments can be changed according to actual needs but as mentioned before, an adjusted set is still composed of standard products.

Products have a standard product identification throughout the supply chain

The Emergency Item Catalogue (IFRC and ICRC 2009) not only gives an overview of available relief items but also assigns a distinct number to each of them. Since all members of the supply chain, i.e. the IFRC as the parent organization and various national societies, use the catalogue, it can be assumed that the product number is used as a reference in the whole supply chain.

Demand variation is low

This statement cannot be supported. During a humanitarian operation the demand for certain relief goods can vary because of numerous reasons, e.g. subsequent catastrophes or changing weather conditions. Moreover, in times between two different humanitarian operations, there is a high demand variation.

Demand is forecasted and stock levels are closely monitored

[2] Publications and reports issued by the IFRC can be found here: http://www.ifrc.org/publications-and-reports/

The IFRC already conducts demand forecasts (cf. Chomilier et al., 2000; IFRC, 2011) and have also contributed to and will use the results of the paper by Everywhere et al. (2011) dealing with the predictability of humanitarian demand. Still, it cannot be said whether these forecasts are detailed enough to serve as a basis for the usage of VMI. Regarding the monitoring of stock levels, the statement can be supported. The arrival and inventory level of all relief goods can be controlled with the help of a Commodity Tracking System (Chomilier et al., 2000).

Transaction costs pertaining to purchasing are high

Neither the independent auditor's report (KPMG, 2016) nor other publicly available sources state something about the height of transaction costs. Consequently only the neutral value of 2 can be assigned to this feature.

Funding for procurement is reliable –availability of donor funds or government funds

Among the IFRC publications there are reports specifically listing the coverage of issued emergency appeals, i.e. how much of ne estimated needed budget has been covered by donor response in cash, kind and services. These numbers show that the amount of donor coverage varies depending on continent but the overall yearly average of 2014 to 2016 has varied between 45% and 73% coverage. So while funds are available, they are not sufficient to provide the entire budget needed for emergency operations.

The organization has no problem sharing inventory/forecast information with the suppliers

The IFRC has set up different requirements that future suppliers need to fulfill and reviews them accordingly. If a supplier passes this screening, a basic consent in values is ensured. Nevertheless, the need for detailed contracts and ongoing evaluation of the supplier show that the IFRC does not fully trust its suppliers and the sharing of sensitive information might be difficult. Overall, this feature can be assessed only based on insufficient information. The opinion of someone more familiar with the IFRC would be of benefit.

Information and communication systems are good and there is sufficient knowledge on how to handle them

The improvement of the applied information systems has been part of the 5-year strategy "Logistics 2015" (IFRC, 2011). Also the "Plan and Budget 2016-2020" includes a budget of 4 million Swiss Francs to invest in telecommunication and information systems (IFRC, 2015). This and the fact that in general information systems for humanitarian organizations are in the need of improvements results in a low value for this feature.

Purchasing is a core competence of our organization

The IFRC and their national societies aim at supporting people affected by disasters. The purchase of relief items is an important part in order to fulfill this aim. However, while purchasing is of high importance, it cannot be regarded as a core competence on its own. This is rather to provide help and can only be achieved in interaction with other ones.

High levels of trust and long-term relationship with the suppliers exist.

The IFRC has contracts with different suppliers and no general assessment of this statement is possible. The relationships are all based on a consent on the IFRC's values but still the level of trust seems not to be high enough to fully support this statement.

VMI benefits are evident to both our company and our suppliers.

It is difficult to judge this statement as there is no publication or discussion on the application of VMI for the IFRC yet. It still can be assumed, that the existing collaboration and communication would lead to both parties, the IFRC and the national societies, recognizing the benefits of VMI equally.

Key suppliers constitute a high percentage of purchase orders.

The IFRC maintains contracts with various suppliers. Unfortunately, there is no source listing these suppliers or the amount of items they deliver to the IFRC publicly available. Consequently, in order to evaluate this statement an expert's opinion would be necessary and now only a neutral value of 2 can be assigned.

Suppliers are willing to cooperate with a VMI initiative.

There is no information available on the willingness of the IFRC to implement the VMI concept. Whether a supplier would agree to implement VMI depends on the volume of goods ordered by the IFRC and on other factors such as possibly existing experiences with VMI. Unfortunately, there are no information on this aspect.

The company's information system is integrated with the suppliers.

There is no information available on the integration of information systems between the IFRC and its suppliers. Again, only a neutral value of 2 can be assigned to this statement.

Feature	IFRC-Value
Product-related	
Products are standardized, i.e. customization is minimal (7.07)	4
Products are repetitive, i.e. infrequent changes in product specification by customer (8.04)	4
Products have a standard product identification throughout the supply chain* (6.75)	3
Demand variance is low (4.82)	0
Demand is forecasted and stock levels are closely monitored* (7.40)	2
Company-related	
Transaction costs pertaining to purchasing are high (2.54)	1
Funding for procurement is reliable –availability of donor funds or government funds (4.51)	1
The company has no problem sharing inventory/forecast information with suppliers* (10.62)	3
Information and communication systems are good and there is sufficient knowledge on how to handle them* (7.4)	1
Purchasing is a core competence of the organization (7.72)	2
Supplier-related	
High levels of trust and long term relationships with the suppliers exist* (7.72)	3
VMI benefits are evident to both our company and our suppliers (7.07)	2
Key suppliers constitute a high percentage of purchase orders* (5.14)	2
Suppliers are willing to cooperate with a VMI initiative (8.68)	2
The company's information system is integrated with the suppliers* (4.50)	2
RESULT	**231.18**

Table 3. Adapted VMI Readiness Score applied to the IFRC

Based on the above-described reasons, values can be assigned to every feature (cf. Table 3). Their weighted sum is 231.18 out of 400 resp. 57,8%. This percentage falls into the second category, i.e. a medium VMI readiness score. Organizations within this category can neither be judged as completely suitable nor as unsuitable to implement VMI. Consequently, the score indicates that a more thorough and organization-centric examination of the applicability of VMI is worthwhile but still needs to be conducted.

CONCLUSION

The adapted VMI Readiness Score turned out to be a user-friendly and comprehensive tool to give an elementary assessment on whether the concept of VMI is suitable for a humanitarian organization or not. Possibly realizable cost and inventory reductions coupled with increased availability of goods could lead to a better dealing with the challenges of a humanitarian operation. The exemplarily application shows that VMI in general could be treated as a possible alternative to currently implemented logistics strategies at the IFRC. Nonetheless, the Score can only serve as a first judgement or indication and an applicability of VMI needs to be evaluated further. One major drawback is that the disaster type an organization operates in, is not considered in the Score specifically but in average. Thus, depending on the investigated time frame (mainly regarding the product-related feature), the suitability of VMI might change. So future research could think about how to integrate this aspect into the Score, i. e. defining a representative random sample of historical data. Moreover, it has to be kept in mind that the exemplary case is based on publicly available information which sometimes have been incomplete or hard to interpret, so that assumptions had to be made. Especially in the category of supplier-related features, a lack of information resulted in high difficulties to judge the statements. Future steps would therefore be to involve the practitioners, recalculate the score based on more detailed information and then decide on whether to further investigate the applicability of VMI. During the writing of the paper, a detailed application of the Score in combination with a quantitative analysis at an interested humanitarian organization is ongoing. Overall, the results emphasize that more research should deal with the topic, since VMI has shown to be a possible logistics strategy to improve humanitarian logistics.

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