

The master's thesis "Development of a concept for risk assessment and minimising of risks in warehouses based on the analysis of damage events through survey reports prepared by the Battermann + Tillery Group" is primarily intended to answer the question of which risk represents the greatest danger for stored goods, taking into account the overlap of frequency and amount of loss. By answering this question, concepts and measures can be developed to make the storage of goods safer and to control storage risks. A total of 102 incidents of damage were investigated over a period of fifteen months in this master's thesis. In the following, I would like to take the opportunity to present the approach and the main results of my master's thesis.

## **DEVELOPMENT OF THE WAREHOUSE RISK MANAGEMENT CONCEPT**

With the aid of various literature, it was possible to define different storage risks. In summary, the following risk groups emerged: Risks due to building defects, handling errors, fires, theft/vandalism and natural hazards. The five characteristics define risks to which goods are exposed during storage. The risk due to building defects describes, for example, building defects such as leaking roofs or defective installations. Handling errors include errors that happen at the operational level. Fire risk defines a fire that can occur during storage and damage the goods. Security includes theft as well as vandalism and usually occurs due to inadequate security or surveillance of the building. Natural hazards include external hazards caused by weather events, such as flooding. Depending on the loss event, several risks may have caused or contributed to it. For example, a warehouse fire caused by a short circuit may be a combination of building defects and inadequate fire protection.

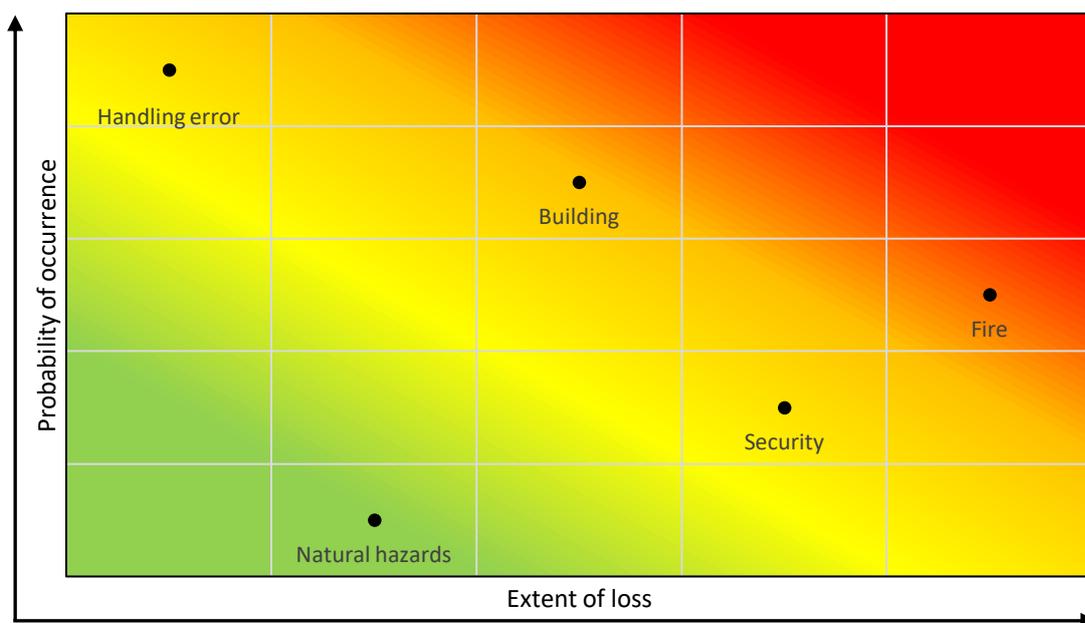
The further theoretical framework was provided by literature on various standards, laws and techniques in the storage of goods. In addition, the relationship between logisticians, customers and insurers was analysed to show the different interests and possible conflicts. The basis for the further development of the warehouse risk management concept was the ISO standard 31000.

The aim is to classify the storage risks in order to derive suitable loss prevention measures. In the further course of the project, the measures are to be constantly controlled and thus fulfil the customer's expectation of safe storage. Through continuous control and renewed risk assessment, a control cycle is to be established.

The reports on the incidents of damage were examined using the method of qualitative content analysis in order to catalogue the incidents of damage according to various parameters. Furthermore, interviews were conducted with experts to classify and confirm the data collection. In general, the data from the qualitative content analysis of the reports could be confirmed by the interviews.

In order to assess risks according to the defined risk management concept, two parameters are crucial: the probability of a certain risk leading to damage and the expected extent of damage when the risk occurs. The interdependence of these two parameters makes it possible to calculate the risks.

After evaluation, the following result is obtained, which can be presented in a risk matrix.



Source: author's own depiction

Translation from left to right: handling error, natural hazards, building, security, fire. The vertical axis measures the probability of the damage event while the horizontal axis measures the extent of loss.

It can be clearly seen that the risk of fire or damage due to the building construction can be considered high or increased. The risk of damage due to handling errors is assessed as moderate due to the frequency, despite the low financial loss to be expected. The risk of theft is also moderate. Due to rarer occurrences and relatively lower amounts of loss, the risk of damage due to natural hazards is to be assessed as rather low.

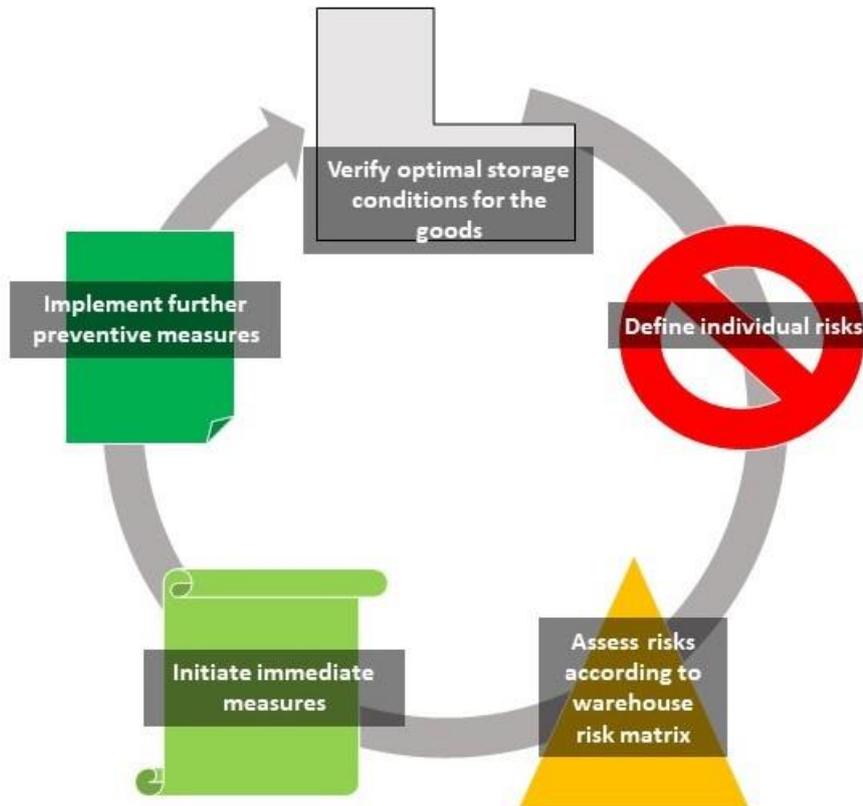
Ultimately, the risk matrix serves to visually identify and evaluate the individual risks. It should be noted that every risk within warehouses has led to damage events with financial losses, so the statement of the analysis is not that a particular individual risk should be devalued or underestimated. Rather, it is intended to enable a focus on critical components with regard to the implementation of risk analyses and loss prevention measures.

Therefore, the first three steps in developing a warehouse risk management concept are to be considered as being fulfilled. Identification and analysis of storage risks can be used to define preventive measures that can make the storage of goods safer. In individual cases, it is necessary to know the storage requirements of the respective goods and to carry out an individual assessment of the storage conditions at the chosen location.

Through the analysis of the reports, preventive measures from the area of operational change were named most frequently. Accordingly, there is potential for improvement especially in the area of warehouse organisation and management in order to avoid future damage.

In general, however, the preventive measures are mutually dependent. For example, the introduction of new technical measures or the development of standard processes also requires the training of staff. A combination of preventive measures from the areas of operational change, training, installation and maintenance can therefore ensure safe storage in the long term.

The application of a warehouse risk management concept in individual cases is as follows:



*Source: author's own depiction*

First, the storage conditions of the goods must be examined in order to define specific risks. In the further course of the project, these risks are to be evaluated with the help of the developed risk matrix. Depending on the initial situation, immediate measures may have to be taken to improve the storage conditions. In the long term, further preventive measures are to be implemented. Ultimately, the effectiveness of these measures must be continuously monitored in order to achieve a constant improvement in the storage of goods.

## CONCLUSION & SUMMARY OF THE RESULTS

Most often, the risk of improper handling of stored goods leads to a damage event. The probability of occurrence is therefore highest here, but the financial loss to be expected is rather low in contrast to damage caused by fires. Accordingly, the risk of fire is to be weighted particularly heavily with regard to the extent of damage.

Theft and building defects, for their part, lead to damage whose extent is in the middle range. The order in terms of frequency of occurrence is: Damage due to handling errors, building damage, fire damage, theft damage and damage due to natural hazards. The latter occur least frequently, but in individual cases have a greater extent than damage due to handling errors.

For the evaluation of the individual risk categories, this finding means the following: In the overlap between probability of occurrence and extent of damage, fire risk emerges as the highest storage risk, followed by building risk in second place. The risks of theft and handling errors come in joint third. The risk of natural forces comes in fourth place and is consequently the lowest.

The comprehensive risk assessment succeeds in fulfilling an important step in the creation of a generally applicable warehouse risk management concept. The final step in the implementation remains the development of preventive measures to reduce risk. Here it helps to have more details about the course of the damage events.

There are many different types of damage in the various risk categories. However, there are recurring events, such as defects in roofs, accesses, inadequate equipment in the building or defective sprinkler systems, which cause damage in several categories. Likewise, incidents repeatedly occur due to human error in everyday work or in the operational organisation of storage facilities.

Another finding that was arrived at by analysing the reports is that particularly vulnerable goods are foodstuffs and feed as well as machinery and equipment. The latter can only be used specifically and in perfect condition. Foodstuffs and feed, unlike other products, are also susceptible to damage from spoilage or pest infestation, which poses additional risks from building defects or handling errors.

Part of the prevention work is therefore to know the requirements of the stored goods and to adapt the storage process and the required technology accordingly. Furthermore, many sources of error can generally be changed through technical upgrades and operational measures. For example, the installation of a fire detection system and the introduction of standard procedures are immediate measures that should be taken by warehouse operators. In general, technical measures and operational changes offer many risk-reducing design-options, but continuous maintenance of equipment and training of staff are also indispensable for the safe operation of a warehouse. The urgency and intensity of the preventive measures should be based on the assessment of the risk categories, so ensuring fire protection is the top priority.

In order to implement the warehouse risk management concept, the warehouses must be assessed on a case-by-case basis by internal or external auditors in order to understand which risks exist, taking into account the goods to be stored and the nature of the storage site. The focus of the warehouse assessment should be based on the assessment of the risk groups, but should never exclude lower classified risks, such as the risk from natural forces, in order to establish the best possible storage conditions. The aim is to minimise and control storage risks in all areas. To ensure a control cycle, risk assessments must be repeated at fixed intervals. This will show whether preventive measures are working or even whether new storage risks are emerging.

From the customer's perspective, the storage of goods must be flexible, cost-effective and at the same time optimally adapted to the products to be stored. It is difficult for logistics service providers to meet this challenge. End customers and insurers in particular are therefore encouraged to create incentives through premiums or order terms and conditions that reward prevention work. It is therefore recommended to check the storage conditions before storing any goods or taking out an insurance policy in order to prevent financial losses due to damage. Otherwise, the individual risks will only become apparent when damage occurs.

The concept developed provides a basis for further research. First of all, the risks could be assessed even more precisely if the qualitative content analysis of the reports is continued over a longer period of time. The longer this period, the more data would be available. Annual reviews would be conceivable here, so that the data could be classified and compared. In addition, it makes sense to scientifically examine the effectiveness of individual prevention measures after implementation in order to design a further catalogue of measures.