

Impact of Robotic Dispensing Machines in German Pharmacies on Business Performance Indicators

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Abstract

Aims and objectives: To assess the impact of robotic dispensing machines in community pharmacies on staff efficiency and sales of over-the-counter drugs. **Setting:** The study was done on 253 community pharmacies in Germany that use a robotic dispensing machine manufactured by ROWA during 2008. **Method:** Data concerning the financial and economic impact of using a robotic dispensing machine in community pharmacies was gathered using a structured questionnaire and analysed in terms of its financial implications. **Key findings:** The response rate was 29%. In most pharmacies (79%) the robotic dispensing machine was retrofitted. In 59% of the pharmacies additional space was gained for self-service and behind-the-counter display. As a result of using a robotic dispensing machine, personnel costs were reduced by an average of 4.6% during the first 12 months after start-up. Over-the-counter sales increased in the same period by an average of 6.8%. Despite average initial costs of 118,000 euros, total costs within the first 12 months fell in 50% of cases and at least remained the same in 44%. **Conclusions:** On average, robotic dispensing machines lead to modest savings in personnel costs and slight increases in sales of over-the-counter drugs. Substantial savings can be achieved only if the staffing level is adapted to the changed personnel requirements.

Key words: *Community pharmacy, Germany, Robotic dispensing machine, Robot.*

Introduction

Robotic dispensing machines have been available for more than 10 years as an alternative storage system to conventional pull-out drawers in community pharmacies. This system is an electronically controlled automated storage system that offers the capacity of a distinctly larger, conventional storage, while taking up only a minimum of space [1].

The robotic dispensing machines are bound for community pharmacies with a wide range of goods. The warehouse in German community pharmacies contains 8,000 to 10,000 different products [2].

In advertising their machines, manufacturers emphasise space saving, reduced personnel costs as a result of saved time, and increased sales due to improved counselling [1, 3-5]. In times of falling margins in German pharmacies, [6] such advertising claims to cost savings are tempting for pharmacists. Although acquisition costs are high, mostly in excess of 100,000 euros, they are expected to be rapidly amortised. Already, 7% of the community pharmacies in Germany operate with a robotic dispensing machine [7].

However, manufacturers' claims have not been scientifically examined to an adequate extent. This paper aims to analyse the impact of robotic dispensing machines from a business perspective in order to identify whether the manufacturers' promises can be achieved.

More specifically, our objective was to explore the effects of a robotic dispensing machine on the following:

- sales volume;
- acquisition costs;
- costs situation;
- stock value;
- over-the-counter (OTC) sales volume;
- space;
- inventory.

No studies have been published in the German-speaking region on the efficiency of robotic dispensing machines in community pharmacies, but such studies have been performed in the USA and Great Britain and also on how robotic dispensing machines are used for preparing unit dose packs. The studies in the United States evaluated the impact of robots on the machine packaging of drugs in unit doses. Unit dose means the delivery of a single, packaged, clearly identifiable drug to a specific patient. This form of drug dispensing is receiving more attention from both the qualitative and the safety perspective.

An analysis was performed during 2001–2002 in Michigan, USA. In a pharmacy belonging to the pharmacy chain Punched Pharma Plus, Lin et al. [8] evaluated the impact of a robotic dispensing machine on the preparation of unit dose packs. A retrospective study was performed on the process of preparing unit dose packs before and after the installation of the robotic dispensing machine. Overall, a significant saving in time was registered for the preparation of unit dose packs. However, the saving in time occurred only if the staffing level was adapted to the changed requirements.

Franklin et al. [9] studied the effect of introducing unit dose robotic dispensers from two different manufacturers into British hospitals from the aspects of drug safety, efficiency and staff satisfaction. After introduction of the dose robotic dispensers, the number of dispensing errors decreased significantly for both brands, and labelling errors were also reduced, though to a lesser extent. The dispensing time was also shorter and staff satisfaction increased. These effects appear to be independent of the brand of robotic dispenser.

Pedersen et al. [10] examined 1173 hospital pharmacies in the USA in to assess the role of the pharmacist in the respective drug distribution system, and concentrated on the respective administrative effort associated with

distribution of the drugs. A differentiation was made between the conventional manual unit dose and stationary fully automatic robot technology. Evaluation by a questionnaire led to the conclusion that the use of robot technology increases drug safety, not only in filling the individual patient's drugs, but also in administering the drugs to the patient.

Mobach investigated in a Dutch pharmacy the extent to which time saved from logistic work is used for giving more pharmaceutical advice. During 2004 and 2005 he studied a Dutch pharmacy before and after introduction of a robotic dispensing machine. The acquisition costs were amortised after three years. He demonstrated a displacement of logistic work in favour of pharmaceutical duties, resulting overall in an increase in drug safety [11].

Methods

Sample

We surveyed the economic impact of bringing a robotic dispensing machine into service in community pharmacies using a structured questionnaire. The target population consisted of independent pharmacists who have replaced their conventional drug storage system with a robotic dispensing machine during the last few years. For reasons of practicality and feasibility it was decided not to approach all 21,551 community pharmacies because only about 1600 of them (7%) work with a robotic dispensing machine [7]. So we asked ROWA to provide a list of 253 reference customers who were using a ROWA robotic dispensing machine of type ROWA Select in 2007. Reference customers are defined as those who agreed to have their addresses passed on to others.

Test construction

The questionnaire was developed along the lines recommended by Bortz et al. (2006) [12]. The 20 items on the questionnaire are intended to reveal to what extent the installation of a robotic dispensing machine changed the economic situation in the pharmacy during the first year. The construction of the questionnaire took into account that revealing business figures would be highly sensitive, especially in view of a possible liberalisation of German pharmacy law with permission to form pharmacy chains. The questionnaire was therefore kept anonymous. The questionnaire is in the Appendix.

The level of OTC sales in the pharmacy depends on numerous factors—price policy, amount of advertising on radio and television and in the printed media, and, last but not least, the selling skills of the pharmacy staff. For that reason, the changes in OTC sales cannot simply be attributed to the impact of robotic dispensing machines. The pharmacists surveyed were therefore asked to estimate as accurately as possible the changes in sales of OTC drugs that derive from the impact of robotic dispensing machines.

The answer formats are multiple choice answers (closed) and open ended questions to which the respondents must phrase their own answers (open). Among others, the pharmacists were asked about the procurement and installation costs. The comprehensibility of the items on the questionnaire was tested and adapted in a pre-test on 12 pharmacists [13].

Questionnaire distribution and analysis

The study population of 253 customers was surveyed by post. Since the survey was fairly small, respondents were notified by telephone in advance. All 253 customer addresses already included telephone numbers. All 253 pharmacies could be reached within five working days. An attempt was made to talk to the pharmacy manager. If this was not possible, the member of staff was asked to inform the pharmacy manager about the intended research and to tell them that the questionnaire would arrive the following day.

Statistical analysis was performed using SPSS 16.0. The significance tests were based on a 95% confidence interval. The chi-square test was also used.

Results

A total of 74 questionnaires were returned of the 253 that were sent out. This corresponds to a return rate of 29.2%.

Sales volume

Of the pharmacies surveyed, 84% (n=74) stated that they achieved an annual sales volume of more than 1.5 million euros (Table 1).

Table 1 Sales volume breakdown of all pharmacies compared with "robotic dispensing machine" pharmacies.

Sales volume (net annual sales in million euros)	Fraction of all pharmacies in Germany in this sales volume category	Fraction of pharmacies with ROWA robotic dispensing machine in the respective sales volume category (n=70)
< 1.5	43.4%	11.4%
1.5 – 2.0	39.4%	27.1%
2.1 – 2.5	11.6%	24.3%
> 2.5	5.6%	37.1%

In most of the pharmacies surveyed (79.2%, valid n=72), the robotic dispensing machines were installed at the time the pharmacy was established. Subsequent installation incurs more costs as a result of rebuilding measures and the need to remove existing drawers. Thus the cost of installation is about 12,000 euros if the dispensing machine is installed at the time the pharmacy is first opened, compared with more than double that for subsequent installation. Of the pharmacies with an annual sales volume of more than 2 million euros, 91% installed the robotic dispensing machine in the beginning; this is the case for only 60% of pharmacies with an annual sales volume of less than 2 million euros.

Of the pharmacies surveyed, 68% were located in towns with a population of more than 20,000, predominantly in the town centre (38%) or suburbs (31%).

Pursuant to the Shop Hours Act [14], pharmacies in Germany can open for up to 84 hours per week. On average, German pharmacies are open for 52.04 hours

[15]. The pharmacies surveyed are open on average for 57.5 hours per week ($n=74$, $\sigma = 7.42$). The opening hours of the pharmacies surveyed are therefore approximately 10% above the average. This correlates with the sales volume breakdown for all the pharmacies (higher sales volumes than the typical pharmacy).

Acquisition costs

The average acquisition costs are 118,400 euros ($n=72$, $\sigma = 27.01$) and average installation costs are 23,000 euros. The service life for tax purposes is 15 years [16].

Assuming a linear depreciation, the total costs of the robotic dispensing machine per accounting period can be calculated in consideration of the capital costs as follows (Table 2) [17].

Costs situation Figure 1 and Table 3 show that 12 months after installation of the robotic dispensing machine, the costs situation in the pharmacies surveyed deteriorated in only 6% of cases. In 50% of the pharmacies the costs situation improved and in 44% it remained unchanged. Thus, in 94% of the pharmacies surveyed the costs situation either remained the same or improved. Pharmacies in a sales category of greater than 2 million euros annual net sales appear to benefit more from costs savings than pharmacies with a lower annual sales volume.

Table 2 Sample calculation of the total costs of a robotic dispensing machine.

Costs per year	Robotic dispensing machine
<i>Initial data</i>	
acquisition costs	118,400 euros
installation costs	23,000 euros
liquidation proceeds (estimated)	10,000 euros
<i>Capital costs/year</i>	
duration of writing off in accordance with the AFA (depreciation deduction) table	15 years
interest rate p (assumed)	6%
<i>Operating costs/year</i>	
energy costs	1,000 euros
maintenance (full service contract)	10,000 euros
Total costs/year	24,303 euros

Of the pharmacies surveyed, 64% ($n=70$) stated that their personnel costs had not changed during the 12-month period after installation of the robotic dispensing machine. For 36% of the respondents the personnel costs were reduced by an average of 12.27% during this period as a result of the robotic dispensing machine. In a pharmacy with a net annual sales volume of 2 million euros and assuming 11% personnel costs (EUR 220,000

p.a.), this corresponds to an annual reduction of about 27,000 euros.

Stock value

The stock value remained unchanged for 23.9% ($n=67\%$) of the pharmacies surveyed. With respect to a reduction in tied capital, 58.2% of the pharmacies surveyed were able to reduce their stock value by an average of 17.4%. This could be attributed to a different stocking strategy for lowering the stock level because, in contrast to manual dispensing in a conventional store, there is no advantage to be gained from large orders when the goods are stored in a robotic dispensing machine. Nonetheless, 18% of the pharmacies surveyed reported higher stock values, which are partly the result of structural changes. The stock turnover rate, which rises when the stock value is reduced at the same level of stock outgoings, increased by 6.4% on average among the pharmacies surveyed. This correlates with the change in the stock values 12 months after installation of the robotic dispensing machine.

The personnel costs also correlate with the changes in the stock values. Pharmacies that focus on saving personnel costs when using a robotic dispensing machine also appear to reduce the stock value (Table 4).

Table 3 Costs situation broken down by sales volume category.

Costs situation	Sales volume category		Total cases	Total in %
	≤ 2 mill. euros	> 2 mill. euros		
has improved	12	20	32	50
has remained unchanged	9	19	28	44
has deteriorated	3	1	4	6
Total	24	40	64	100

OTC sales volume

Of the pharmacies surveyed, 52% attributed increased sales in the OTC sector to the impact of the robotic dispensing machine. The sales increases amounted on average to 6.8% ($n=67$, $\sigma = 9.7$). It is possible that these increases resulted from time saved as a result of robotic dispensing being used for additional sales. The presence of the pharmacy staff at the counter during the entire sale appears to benefit the sales conversation with the customer. However, this effect was not observed in 48% of the pharmacies surveyed. There are no significant differences between sales volume in the categories of < 2 million euros and > 2 million euros.

Savings in personnel costs and increased OTC sales volumes appear to be inversely dependent. Pharmacies that aim to achieve substantial increases in OTC sales by using a robotic dispensing machine must accept the fact that this is possible only if the staffing level remains unchanged. On the other hand, pharmacies that save on

personnel costs by using a robotic dispensing machine cannot expect increases in OTC sales. This trade-off is illustrated in Figure 1.

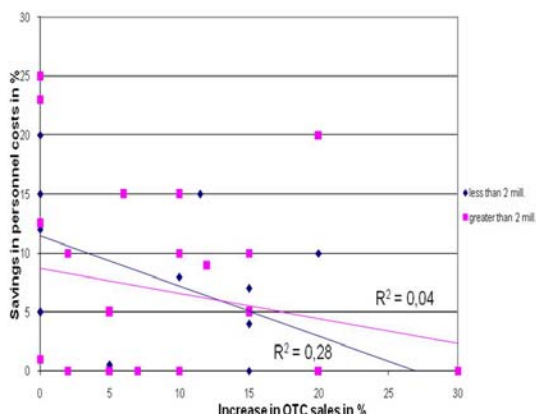


Figure 1 Trade-off broken down by sales volume category.

Space

Until 2007, ROWA robotic dispensing machines were all individually dimensioned and the floor space they required

varied accordingly. On average they occupy 12.1 m² (n=74, σ = 4.0). When installed from the beginning, the robotic dispensing machine replaces the conventional storage system—mostly pull-out drawers. Before the robotic dispensing was installed the average number of columns of drawers was 20.8. Assuming that the columns of drawers are of standard size (130 cm x 40 cm= 0.52 m²), this corresponds to an area of 10.8 m². If the floor area for accessing and pulling out the drawers is included, this amounts to a total floor space of 21.16 m² for the drawer system.

The difference in floor space is therefore 21.16 – 12.1 = 9.06 m², i.e. 43% of the original—a saving of over 40% (p = 0.26).

In 59% of the pharmacies the space saved is used as additional behind-the-counter (no customer access) and self service display area. The average gain in area amounts to 57.6%.

Table 4 Correlations between the most important statistical variables.

		Costs situation	Purchase price	Stock value	Personnel costs	Inventory savings	Gained self- /behind-the- counter service	Impact on OTC sales
Costs situation	Pearson correlation	1.000	-0.256*	0.329**	0.406**	-0.280*	-0.001	-0.149
	significance (2-tailed)		0.040	0.008	0.001	0.039	0.993	0.241
	N	67	65	64	67	55	64	64
Purchase price	Pearson correlation		1.000	-0.087	-0.149	0.046	-0.014	-0.093
	significance (2-tailed)			0.490	0.266	0.740	0.908	0.462
	N		72	65	68	55	68	65
Stock value	Pearson correlation			1.000	0.284*	-0.179	-0.078	-0.023
	significance (2-tailed)				0.020	0.190	0.544	0.859
	N			67	67	55	63	64
Personnel costs	Pearson correlation				1.000	-0.094	-0.085	-0.414**
	significance (2-tailed)					0.486	0.499	0.000
	N				70	57	66	67
Inventory savings	Pearson correlation					1.000	0.054	0.018
	significance (2-tailed)						0.697	0.898
	N					57	54	54
Gained self- /behind-the- counter service	Pearson correlation						1.000	0.238
	significance (2-tailed)							0.060
	N						69	63
Impact on OTC sales	Pearson correlation							1.000
	significance (2-tailed)							
	N							67

*The correlation is significant at 0.05% (two-tailed).

**The correlation is significant at 0.01% (two-tailed).

Inventory

The inventory in the pharmacy is done either on a specific day or continually. In the conventional store the time required amounted to 38.5 hours every year. After installation of the robotic dispensing machine, the time required on average was only 15.3 hours. This corresponds to a saving of 24.8 hours per year. This time saving is significant.

Discussion

Comparison of the distribution of sales volumes among all German community pharmacies with the sales volume categories of the pharmacies investigated reveals that the pharmacies with a robotic dispensing machine in this study generally lie above the sales volume category of a typical pharmacy. "Typical pharmacy" means a pharmacy in the highest populated sales volume category among the approximately 21,500 community pharmacies in the country. The modal value for 2007 was 1.2 million euros [18]. In 2007, the mean net annual sales of all pharmacies was 1.7 million euros [6].

In this study, the total costs amounted to 24,303 euros per year, which roughly corresponds to the average personnel costs of a Pharmaceutical Technical Assistant (PTA) in one year [19].

The estimated costs situation after installation of a robotic dispensing machine in the pharmacy depends to a large extent on four factors: the purchase price of the robotic dispensing machine (which, in turn, depends on the size and space requirements of the machine), the reduction in the stock value, the saving in personnel costs, and the reduction in the time required for taking inventory. In this context, the biggest influence is exerted by the personnel requirements, followed by the stock value.

Whether additional self-service area will be gained does not depend on the sales volume of the pharmacy or other parameters. The strongest correlation between additional self-service and behind-the-counter display area can be made with the development of the OTC sales volume (though this correlation is not significant).

It does not appear to be possible to save on personnel costs and increase OTC sales simultaneously by using a robotic dispensing machine. If the staffing level is held constant, the use of a robotic dispensing machine evidently leads to increased OTC sales. If the staffing level is reduced, personnel costs are lowered but no increase in OTC sales results from using the robotic dispensing machine. Pharmacies with low OTC sales volumes benefit more than pharmacies with high OTC sales volumes. However, an increase in OTC sales exerts a relatively small effect on the overall costs situation in comparison to parameters such as stock value and personnel costs.

In this study, in most cases the stock values could be reduced as a result of using a robotic dispensing machine. This leads to a lower level of tied capital and improves the costs situation.

Although the time needed for the annual inventory is substantially reduced after installation of a robotic

dispensing machine, this saving has only a minimal effect on the personnel costs. Nonetheless, the annual inventory normally takes place outside business hours so that the time saved reduces the need for staff to work in the evenings or on weekends, which could improve employee motivation.

The savings in personnel costs are rather modest. In order to achieve cost benefits, the staffing level must be adapted to the changed staffing needs. Higher OTC sales volumes are possible for smaller pharmacies that keep their personnel costs stable.

The space saving with a robotic dispensing machine is considerable compared with a conventional store, so that pharmacies with limited space or paying high rent can benefit especially. The present work shows that the annual costs for a robotic dispensing machine is about 25,000 euros. Since 2007, robotic dispensing machines of standard size have become available, and are about one third cheaper than custom built machines. The annual investment costs will therefore be lower in the future.

This study focused on the impact of the robotic dispensing machine from a single supplier. The results cannot be extrapolated automatically to the impact of machines from other manufacturers because different robotic dispensing machines vary, especially with regard to price. The impact on OTC sales and personnel costs was surveyed for a period of only one year after the installation of the robotic dispensing machine. It was therefore not possible to predict the long-term impact with regard to OTC sales volume and personnel costs.

Our results agree with the studies performed by Lin et al. on the pharmacy chain PUNCHES Pharma Plus, where automation led to time savings in the work processes, but cost savings required adaptation of the staffing level to meet the changed staffing needs [8]. We did not analyse the impact of automation on drug safety and employee satisfaction, as described in the work of Franklin et al [9], Pederson et al [10] and Mobach [11]. This could be topic for future studies of the impact of robotic dispensing machines in community pharmacies.

Conclusions

Robotic dispensing machines have advantages over the conventional storage system.

The savings in personnel costs after installation are rather modest, as is the increased sales volume in the OTC sector. The saving occurs only if the staffing level is adapted to the changed staffing needs. Reducing the staffing level by one pharmaceutical technical assistant appears to completely cover the annual costs of the robotic dispensing machine.

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Appendix

Questionnaire

- When was your pharmacy opened / taken over?
- When was the robotic dispensing machine installed in your pharmacy?
- What are the dimensions of your robotic dispensing machine?
- How high were the procurement costs (purchase price) for the dispensing machine?
- How high were the installation costs (for example, connection to the goods management system, essential structural conversions) for the dispensing machine?
- Was additional self-service or behind-the-counter (inaccessible to customers) display space gained in the course of robotic dispensing machine installation?
- How many work hours are required for the annual inventory? If a continual inventory is taken, please give the total time for the inventory over the year.
- How much space is required for large packs that cannot be stored in the dispensing machine? Please give the floor area in sq. m.
- In your estimation, how high is the impact of the robotic dispensing machine on the following parameters? Please enter the appropriate figure: personnel costs, sales area, storage costs, sales volume, search times, fetch times, self-service display, presence of staff for manual sales, time for counseling.
- Has the costs situation changed within the first year after acquisition of the robotic dispensing machine?
- What is the size (number of inhabitants) of the town where you are located?
- In what type of location is your pharmacy?
- Are you completing the questionnaire for your main pharmacy or a branch?
- Have there been structural changes in the period from 12 months after acquisition of the robotic dispensing machine?
- How many hours per week are you open (excluding emergency service)?
- Impact on the sales growth in the OTC sector during the first 12 months after acquisition of the robotic dispensing machine:
- Stock value one year after acquisition of the robotic dispensing machine:
- Change in personnel costs of the staff employed.
- Stock turnover: please enter the respective mean annual figure. Please take the figure from your goods management system, e.g. stock turnover = 12.
- Sales volume category:
- Please mark with a cross the category your pharmacy belonged to in 2007