Your Lift Journey – How Long Will You Wait?

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Abstract. When passengers start their lift journey they initially wait for their call to be answered. Whilst travelling to their destination their trip is often interrupted by intermediate stops which are the result of other passengers' calls. Dispatching algorithms optimize the handling capacity and quality of service of lift groups. The main criteria for quality of service is currently average passenger waiting time. Travel, overall journey time and number of stops are additional criteria. But which is the most important for passengers when they think about their trip? How can dispatching algorithms be improved and tailored to meet passengers' expectations? An online questionnaire has been conducted asking people how they feel while using lifts and to help identify what passengers want and expect. The questions and results from the survey are presented and it is shown how the results can be applied to existing dispatching algorithms.

1 INTRODUCTION

The main criterion used to assess quality of service in the lift industry is average passenger waiting time. Many research papers show that long periods of waiting for a product or service lead to increased customer dissatisfaction [1, 2]. However, there has been very little empirical research into the experience of waiting for and travelling in lifts.

When thinking about waiting in the context of lift-usage it important not to think of it in isolation, but in conjunction with the overall lift journey. Most situations in which waiting is required tend to have a period of waiting for a product or service followed by the end goal, being the receipt of that product or service. Lift usage is relatively unique in that is comprises a waiting stage, an in-between period of travelling in the lift, and then the end goal of reaching your destination. One of Maister's key principles [3] is that occupied time feels shorter than unoccupied time. In the lift context, this suggests that travelling time feels shorter than waiting time [4].

Dissatisfaction associated with waiting for a lift could also be due to the anxiety experienced. There are few indicators that show how long the passenger will wait before the lift arrives. Once the lift arrives, anxiety reduces as the passenger is on the way to his or her destination [5].

An important consideration in the psychology of waiting is that "waits must be appropriate" both in cause and duration [6]. Customers are happy to wait for an appropriate amount of time, taking into account the situational factors. There is a limit to the amount of time passengers will wait and travel before they become impatient, which is dependent on individual factors [7]. Waiting is an inevitable part of lift-usage, and customers are prepared to accept these inevitable waits, for a reasonable period of time. An additional benefit to waiting is that customers often deem a product or service to have an increased value if they have had to wait for it [8]. However, if a wait extends beyond what is deemed reasonable in the eyes of the customer, customer dissatisfaction will greatly increase.

There is a very wide range of factors that could be studied in regards to the psychology of waiting in the context of lifts. This paper focuses specifically on how passengers' waiting time preference is affected by overall journey times and intermediate stops.

The definition of waiting time and other stages of the passenger journey are defined by CIBSE Guide D [9]. However, for interaction with the general public, less precise definitions are required as there is no possibility of communicating the full engineering definitions. Consequently, for this research and throughout this paper simplified terms are used. Wait Time (WT) refers to the time from when the passenger enters the lobby until their lift has arrived. Travel Time (TT) refers to any time from when the passenger enters the lift, until they arrive at their floor, including any Intermediate Stop (IS). An IS occurs when the lift is stopped for other passengers to enter or exit the lift. Journey Time (JT) is the sum of WT and TT.

Smith and Gerstenmeyer [4] posed the scenario in which a dispatcher had two journey options, both had identical overall JTs, but differing WTs and TTs. They concluded that the journey with the shorter WT mostly would be the preferred option. Smith and Gerstenmeyer questioned whether participants would be willing to make trade-offs between WT and TT. For example, would passengers prefer a reduced overall JT at the expense of an increased WT?

The lift journey is often considered as comprising two parts: waiting and travelling, with travelling deemed as an occupied, anxiety-free portion of the journey. Barney and Dos Santos [10] observed that with increasing number of ISs there is an increased level of frustration in passengers. This suggests that the travel portion of a lift journey ought to be considered in two parts, transit and stops, accounting for their different psychological impact.

The research used an online survey to reach the maximum number of participants with limited difficulty on the part of the participant. Animations were used throughout in order to present a realistic representation of the different parts of the lift journey, whilst removing the bias that would be present in live footage. As a principle of waiting is that emotions dominate [6], the survey questions were designed to include emotive language, asking participants to focus on how they would feel experiencing a particular journey.

This survey presented participants with hypothetical journey scenarios, aiming to answer two main questions: (i) How do people feel about different parts of the lift journey? (ii) What is the preferred period of time to wait for a lift, and how does this differ depending on the factors of overall JT and subsequent ISs?

The research may be applied to improve the design of dispatching algorithms to account for Quality of Service (QoS) from the passengers' prospective.

2 METHODS

2.1 Participants

The use of an online survey ensured a quick data collection process. Data was collected anonymously from 278 participants, no personal details were collected. Participants were an opportunity sample who either received a link to the survey directly by email, or were made aware of the survey on social media.

2.2 Materials and Procedure

The survey consisted of five questions in total, with the option to exit the survey after the first question. This was included to allow participants that were no longer interested in completing the survey to exit easily, whilst still allowing the retention of their data from the first question.

Question 1. The first question had four parts to it. Each part included a basic animation depicting a particular aspect of a lift journey (waiting, travelling, first IS, second IS), along with four multiple choice response options, see Figure 1. Participants were asked how they felt at each part of the lift journey. Response options were four animated faces, from green smiley face, yellow semi-smiley face, orange semi-sad face and red sad face, scored 1-4 respectively. The aim of this question was to ascertain an easily comparable rating system for how happy participants are to experience each aspect of the lift journey, relative to other aspects.

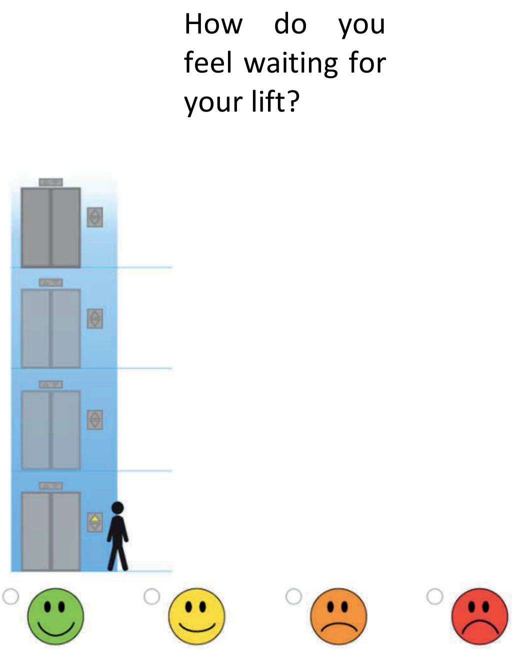

Figure 1 Presentation of Question 1 part 1 with multiple choice response options.

Question 2. This question aimed to assess participants' preferred WT. Participants were provided with three theoretical journeys. All journeys had the same overall JT, but with different WTs and TTs, see Table 1. The options were presented in the format given in Figure 2.

Table 1 Question 2 hypothetical journey options

WT (s)	TT (s)	JT (s)
15	45	60
30	30	60
2	58	60

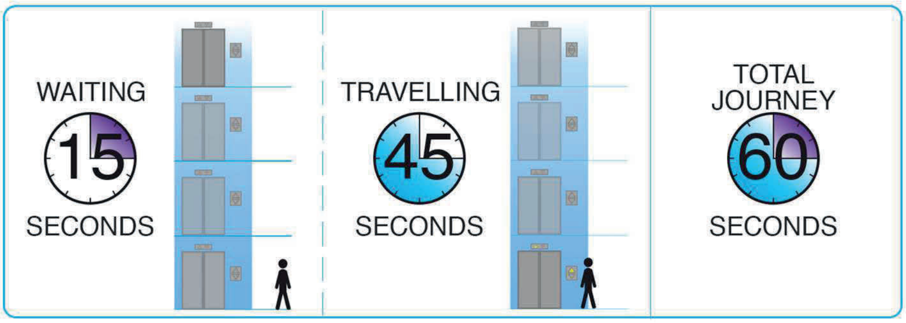

Figure 2 Format of hypothetical journeys in Questions 2 and 3

Question 3. Participants were provided with a different version of Question 3, depending on their answer to Question 2. Participants were presented with two theoretical journeys in the same format as the previous question. The first journey was identical to their answer to Question 2, the second hypothetical journey consisted of a longer WT, but a shorter overall JT, see Table 2. We knew from Question 2 that participants were happy to wait for their chosen length of time. By including this manipulation, it allowed an analysis of whether participants are willing to increase their WT in order to achieve a shorter JT.

Table 2 Hypothetical journey options in Question 3

Question 2 answer			Question 3 possible answers		
WT (s)	**TT (s)**	**JT (s)**	**WT (s)**	**TT (s)**	**JT (s)**
15	45	60	15	45	60
			30	20	50
30	30	60	30	30	60
			40	10	50
2	58	60	2	58	60
			15	35	50

Question 4. This question considered the effect of ISs on preferred WTs. Participants were given four journey options with varying WTs and number of ISs, see Table 3.

Table 3 Hypothetical journey options in Question 4, with times presented in seconds

WT (s)	TT (s)/ISs	JT (s)
40	20/0	60
30	30/1	60
15	45/2	60
2	58/4	60

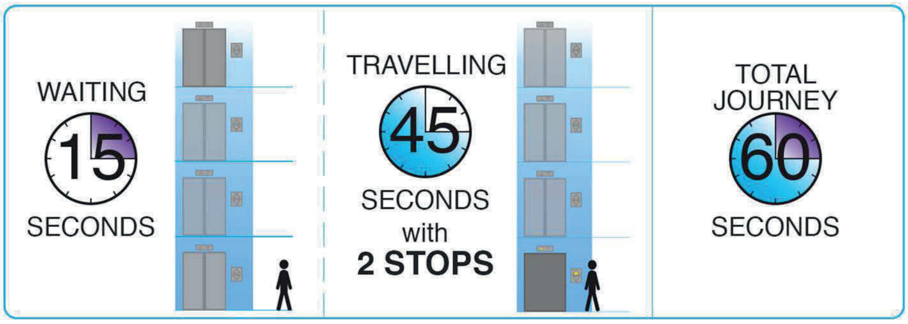

Figure 3 Format of hypothetical journeys in Question 4

Question 5. This final question was another assessment of WT versus TT using a Likert scale with considering 'relative lengths' rather than providing participants with specific timings for a theoretical journey. See Figure 4 for a presentation of the possible answers. The results of this question provide a specific ratio of preferred WT to TT.

Figure 4 Format of possible answers to Question 5

3 ANALYSIS AND RESULTS

3.1 Question 1

The independent variable was 'part of the journey', with four levels: waiting, travelling, first IS, and second IS. The dependent variables were the smiley face ratings scored 1-4 (happy-sad). A Friedman test was used due to the repeated measures design and non-parametric ordinal data. This was supplemented with Bonferroni-corrected Wilcoxon Signed-rank tests.

The Friedman test found that there was a significant difference in the how people felt about the different parts of the journey, $\chi^2(3) = 453.11$, $p < 0.001$, see Figure 5. Travelling in the lift received the lowest rating, followed by waiting, first IS and second IS.

Post-hoc Wilcoxon Signed Rank tests (α=.008) showed a significant difference between all conditions, see Table 4.

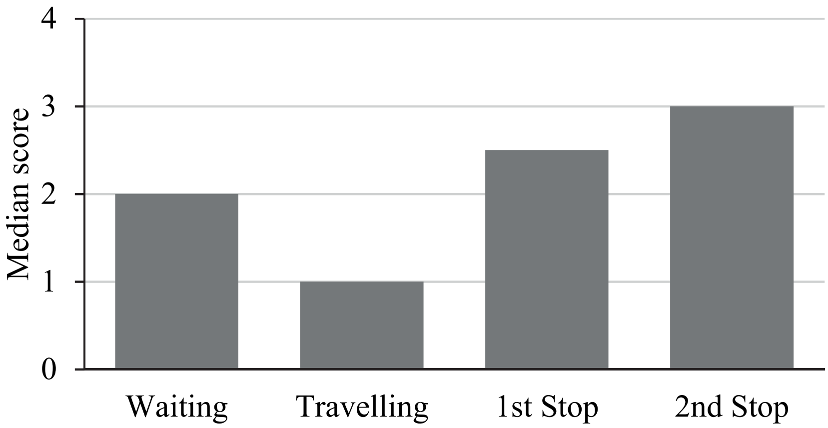

Figure 5 Median happiness score for each part of the journey

Table 4 Post-hoc Wilcoxon Signed Rank tests

	Waiting	Travelling	1st Stop
Travelling	$T = 69.00, p <0.001$		
1st Stop	$T = 71.38, p = 0.975$	$T = 82.00, p < 0.001$	
2nd Stop	$T = 84.75, p < 0.001$	$T = 52.00, p < 0.001$	$T = 79.63, p < 0.001$

3.2 Question 2

There were three possible answers to this question, 15 second WT, 30 second WT and 2 second WT. Therefore, a one-sample t-test testing for a significant difference in the journey chosen was used. There was a significant difference in the journey chosen ($t(256) = 39.69$, $p < 0.001$, $M = 1.69$), with significantly fewer people choosing a 2 second WT (13%), and the same number of people opting for both a 15 second WT (44%) and 30 second WT (44%).

3.3 Question 3

There were three different versions of Question 3 depending on the response participants gave to Question 2. One sample t-tests were used for each of the versions.

Question 3a. Participants could opt to stay with a 15 second WT but overall 60 second JT, or change their preferred lift journey to 30 second WT but overall 50 second JT. Significantly more participants opted to stay with a 15 second WT (67.57%) than change to a 30 second WT (32.43%; $t(110) = 29.67$, $p < 0.001$).

Question 3b. Participants could stay with a 30 second WT and 60 second JT, or change their preferred lift journey to 40 second TT and 50 second JT. Significantly more participants stayed with the same JT with a 30 second WT (52.34%) than changed to a 40 second WT (47.66%; $t(110) = 31.02$, $p < 0.001$).

Question 3c. Participants were presented with the option of staying with a 2 second WT and 60 second JT or choosing a longer WT of 15 seconds, but shorter 50 second JT. Significantly more participants opted to change to a 15 second WT (53.33%) than stay with a 2 second WT (46.67%; $t(30) = 17.04$, $p < 0.001$).

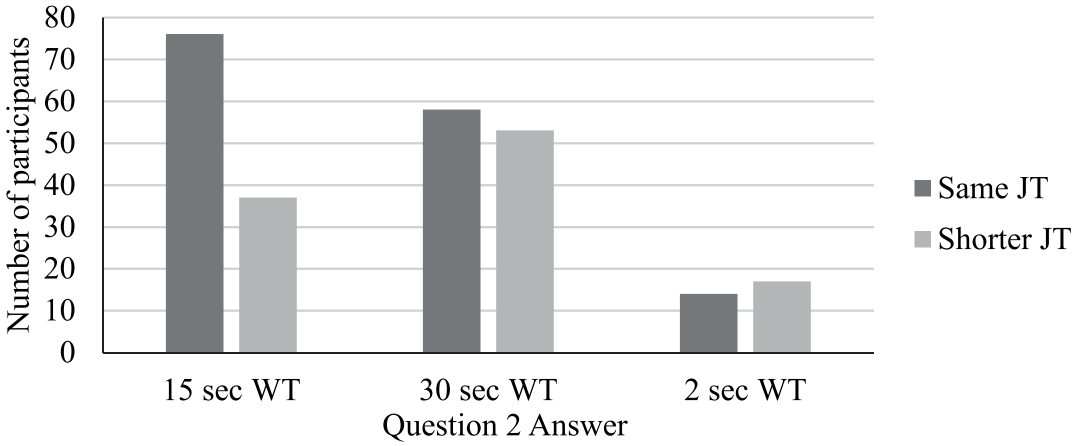

Figure 6 Number of participants who chose each journey dependent on WT preference in Question 2

3.4 Question 4

In order to ascertain the relative impact of number of ISs on WT, answers from Question 2 became the independent variable in this analysis. This therefore contained three levels, 15 second WT, 30 second WT and 2 second WT. The dependent variable was the number of stops chosen from 0 stops to 4 stops, scored 1 to 4 respectively. Due to the independent measures design and non-parametric ordinal data a Kruskal Willis test was used.

The Kruskal Willis test found a significant difference in preference for ISs in participants journeys, dependent on their preferred WTs as ascertained in Question 2: $\chi^2(2) = 20.20$, $p < 0.001$, see Figure 7. Participants who chose in Question 2 to have either a 15 second or 30 second WT opted for a journey with a 30 second WT but only 1 IS. Participants who chose a 2 second WT in Question 2 opted for a journey with a 15 second WT and 2 ISs.

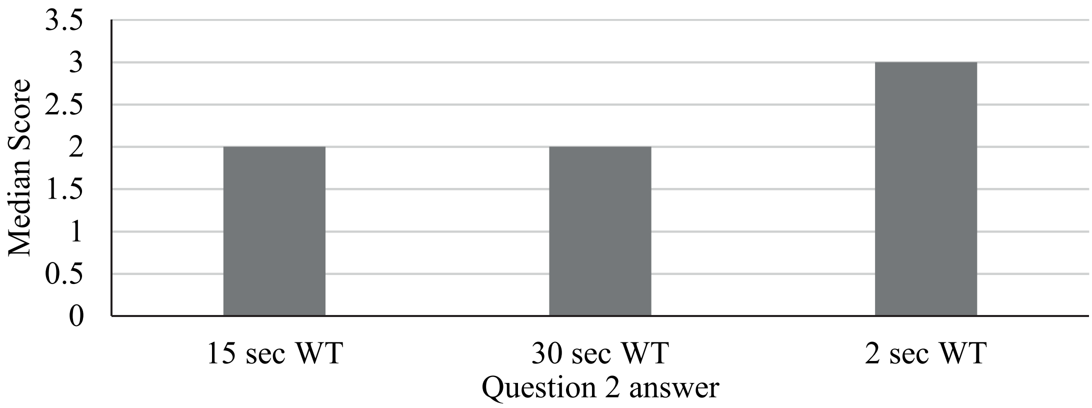

Figure 7 Median score of ISs preference dependent on WT preference in Question 2

3.5 Question 5

This question consisted of a Likert scale with 9 response options ranging from: less time waiting than travelling (scored 1), through to equal time waiting and travelling (scored 5), through to more time waiting than travelling (scored 9). Participants' data provided a mean score of 3.96.

4 DISCUSSION

4.1 Q1: feelings at different parts of the journey?

Participants gave travelling the highest happiness rating, followed by waiting, which was one step down on the scale, but still indicated a positive feeling. This supports previous research that travelling is more desirable than waiting due to the reduction in anxiety once the passenger is in the lift [4, 5]. It also supports Norman's [6] principle, that if waits are appropriate and reasonable passengers are happy to experience them.

Participants were less happy experiencing ISs than waiting, indicating a negative feeling for both ISs. The negative feeling increased from the first IS, to the second IS. These findings are able to provide empirical support for the observations made by Barney and Dos Santos [10] that passenger's frustration level increased with the number of ISs they experienced. In dispatching decisions, Maister's principle that "occupied time feels shorter than unoccupied time" should not be interpreted to assume that the delay associated with ISs is occupied time.

4.2 Q2: Preferred WT?

Participants were initially presented with three different hypothetical journeys. A small group of 13% of the participants opted for a journey with only a 2 second WT, with the rest of the participants were split evenly between choosing the 15 second and the 30 second WT. The most interesting point of note from these results is the varied responses, with no particular preference shown for one WT over another. This supports the idea that "waits ought to be appropriate" [6], but suggests that different people having different interpretations of "appropriate".

4.3 Q3: Wait longer for shorter arrival?

The aim of this question was to assess whether the benefit of a shorter overall JT was good enough to warrant an increase in the more negatively perceived WT. The survey found that the two groups of participants who chose previously to have a WT of either 15 seconds or 30 seconds, opted to stay with their original choice, rather than chose the alternative shorter journey. In contrast, of the small group of participants who originally chose a 2 second WT, a significant, but small majority of participants chose instead to have a shorter overall JT at the expense of an increase WT. For participants who had already chosen a substantial WT of either 15 or 30 seconds, the benefit of a reduced JT was not enough to encourage them to endure an increased, negative waiting period. However, for participants who had originally chosen only a 2 second WT, an increase in that WT still provided those participants with an "appropriate" WT, with the added benefit of a reduced JT.

4.4 Q4: Intermediate stops?

Participants who initially chose (prior to the follow-up JT question) to have a WT of 30 seconds went on to choose an IS journey with 1 stop, and a 30 second WT. Participants who had chosen a WT of 15 seconds in Question 2 now increased this to a WT of 30 seconds, and only 1 IS, as opposed to 2 ISs if they remained with a 15 second WT. A reduction in overall JT was not incentive enough to encourage this group of participants to increase their WT, whereas a reduction in the number of ISs was. This suggests that ISs provide a more negative experience than waiting.

Participants who originally chose a WT of 2 seconds chose to increase their WT to 15 seconds in order to reduce the number of ISs from 4 to 2. This affirms than passengers' preferences are not best served by simply considering WT.

4.5 Q5: Waiting time versus travelling time

The structure of this question allowed for proportional data to be collected on WT preferences, as opposed to the fixed timings seen in the previous questions. Previous work suggested a rule of thumb that WTs could be a quarter of the total journey [11]. The results from this question suggest that passengers would prefer nearer a third of overall JT waiting. This is also reflected in the results from the other questions in which 44% of participants preferred to spend a quarter of the time waiting, and 44% preferred to spend half of the time waiting.

4.6 Limitations

Whilst steps were taken to ensure the validity of results, all surveys have limitations.

The first limitation is in regards to the ecological validity of the survey. Despite the use of animation to create a virtual lift journey experience for the participants, and the use of emotive language to encourage the correct frame of mind for the participants, answering questions on the survey is not the same as experiencing an actual lift journey.

Levinson [12] carried out a study on waiting and travelling in the context of driving. Half of the participants were given a set of scenarios via a computer survey format, and the other half experienced the scenarios in a driving simulator. Levinson found significantly different results depending on the condition the participants were in. Other research has also found that time is often perceived as passing differently to the actual passage of time [2] and that the extent to which perceived time differs from reality is conditional on whether the participant is waiting or travelling [13].

The second limitation of this study is the applicability of the results to dispatch operations with customer facing dispatch systems in their current form. In this study participants were presented with all lift journey options and then allowed time to make the decision about which journey they would prefer to take. At present, this is not an option afforded to lift passengers. Therefore, whilst a passenger may prefer a journey with a longer WT, because it is a direct journey with no ISs, the passenger would not know this information at the time of waiting for their lift. For that passenger they simply experience an increased WT, without explanation, and therefore would be experiencing negative emotions and a poorer quality of service [5]. This is seen in a study by Van Houton [14] in which a lift was programmed to have an increased door delay extending both the waiting and travelling times of the lift journey. They found that when the door delay was increased, significantly more participants opted to take the stairs instead of experience the unexplained increased wait. Providing passengers with information regarding their WT could not only reduce confusion, but also increase the perceived quality of the service [6].

5 QUALITY OF SERVICE DISPATCHING

The principle of considering passengers' perception is already built into some dispatch algorithms. A combination of Quality of Service (QoS) criteria can be considered by weighting individual components to create a pain index [11]. This provides the basis for QoS dispatching, optimizing dispatching choices based on our best understanding of passenger preferences.

Waits ought to be appropriate [6]. However, the survey responses affirm that WT alone should not be used as a proxy for QoS.

This research provides empirical data on which to base the weighting of WT and TT. TT includes periods of unoccupied time during ISs. To improve perceived performance with QoS dispatching, the passenger delay associated with ISs needs to be accounted for separately.

Whilst this paper has studied participant's feelings towards ISs, similar studies and assumptions could also be made regarding other lift journey delays. For example:

1. False stops which occur when passengers endure an IS without a passenger joining or alighting the lift.

2. In systems with more than one cabin or lift per shaft, there are periods when passengers experience delay while other unseen passengers are joining or alighting another cabin or lift [4].
3. In cases where the best dispatching compromise is to load a passenger while travelling in the opposite direction to their final destination, resulting in a reverse journey [15].

QoS dispatching will benefit from the best possible communication with passengers. An unexplained pause in lift operation or an unexpected reverse journey leads to confusion and mistrust.

Current dispatchers do not reflect the wide range of preferences reflected in the survey results. It is conceivable that personal preferences could be collected with a smart phone app and accounted for in dispatching decisions. The app could also support supplementary communication with the passenger.

6 CONCLUSION

The findings in this research confirm the principle of appropriate WTs [6], but suggest that the concept of appropriate may vary greatly for different passengers. They also suggest that the travelling part of a lift journey should not be considered as one section alone, but instead as a section containing multiple parts, to account of the unoccupied times of stopping interspersed within the travelling. The reduction in ISs is more motivating than a reduction in overall JT to increase WTs.

The application of the research through Quality of Service (QoS) dispatching has been discussed. In addition to choosing an appropriate optimisation function, the best possible communication with passengers has been highlighted as a priority in order to improve passenger perception.

Areas for future research include evaluating how people feel about other lift journey delays such as false stops, pauses in operation due to another cabin or car sharing the same shaft, and reverse journeys.

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BIOGRAPHICAL DETAILS

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Stefan Gerstenmeyer is the Head of Traffic and Group Control at thyssenkrupp Elevator Innovation GmbH. He has been involved in R&D projects relating to group and dispatcher functions for lift controls including multi car lift systems. He is a post graduated research student at the University of Northampton.