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An Empirical analysis of Cost Effective Solutions of Baggage Handling at airports- Suggested improvements to industry problems

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Abstract - This research proposes innovative solutions for the baggage loss happened due to the long queue at airports. Baggage logistics and handling is major concern which could happen due to multiple reasons such as mishandling, software glitch, financial constraints, peak seasons etc. Transnorm curves and components are used by the biggest airports, e-commerce hubs, and package carriers in the world to maintain the flow of their vital operations. However, still there are challenges faced by the airports. This study highlight the challenges and reflect on possible solutions.

Keywords: Mishandling, software glitch, financial constraints, baggage, peak season travel, long queue, baggage loss

INTRODUCTION

Conveyor systems at airports are used for luggage handling, and the system includes a number of inspections and procedures. It is meant to measure the weight of luggage, count bags, and screen baggage for security reasons (Al-Hilfi et al., 2018). Load balancing, bag information retrieval, and autonomous bag transportation are all facilitated by this device's inclusion. In addition, luggage handling systems serve three primary purposes. There are a number of ways to move luggage, such as moving it from check-in to departure, moving it from one gate to the next during a transfer, and moving it from arrival to baggage claim (Yoon et al., 2015).

While the luggage handling system has improved in recent years, it is not without defects and drawbacks. Baggage loss and damage are two of the most common complaints about BHS, and these problems are expensive for everyone involved, from airlines to luggage owners (Al-Hilfi et al., 2018). As a result, airport baggage claim areas are extensive and congested; resulting in long waits for passengers who don't know when or where their luggage is (Williamson et al., 2013). Consequently, our group's effort will Centre on devising strategies for preventing luggage mishaps and reducing airport wait times (Williamson et al., 2013). Potential exists to improve the existing state of baggage handling systems (BHS) at airports across the world. Baggage reception operations at airports may be severely disrupted when deliveries are delayed or other issues arise (Williamson et al., 2013). For a traveler who wants to travel in luxury and save both time and money, this might be a tiresome and time-consuming procedure. Even more worrisome in today's environment, when demand for flights is at an all-time high throughout the globe (Al-Hilfi et al., 2018; Malandri et al., 2018).

Literature Review:

There are nonetheless various obstacles and hurdles that have been faced in deploying the luggage handling system. The issue at hand is: Luggage mistreatment - at times, there are occurrences of mishandling of the baggage at the Airports.

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Customers are unhappy as a consequence of this (Williamson et al., 2013). At times baggage gets lost in the course of transit and this is a huge difficulty for the Airports in the U.A.E as well as in other areas of the globe.

Software glitch-This system malfunctions often lead to extra complexity and difficulties. Airports are nonetheless trying hard to prevent this type of complications (Wayne et al., 2005). Because of the high cost of technology deployment and maintenance, airports are sometimes forced to cut services. Airlines throughout the globe suffer losses of $2,5 billion a year as a result of mishandled luggage. In airports across the globe, baggage screening has led to delays and problems with bags on occasion (Yoon et al., 2015). In high travel seasons, there are not only incidents of increased airline delays but also increased issues/problems with luggage handling. But airlines in the UAE and throughout the globe are making significant strides in addressing current issues and delivering answers that will lead to the grandeur and success of the airlines in question.

A) Baggage handling

Baggage handling has a significant impact on the quality of airports and airlines. When it comes to luggage handling, mechanization and automation aren't always necessary. The goal of the process perspective is to eliminate bottlenecks and peak flows by optimizing the whole process chain. Aircraft turnaround might be negatively affected by the time it takes to unload and reload luggage at the aircraft stand, as well as other factors. Increasing quality and decreasing costs may be achieved by clearly separating the two processes and establishing procedures that can meet both the speed and timeliness requirements, depending on the needs. The quality and on-time performance of a baggage handling system can be created at an acceptable cost? There will be sub-optimization and an unwieldy process chain if conventional engineering approaches are used, since they would attempt to fix every issue. Without any master planning, scenario thinking, or sensitivity analysis, processes and systems suited entirely to today's needs may be of little value in the future (Wyld et al., 2005). In order to keep up with demand, baggage handling systems must be constantly reworked and expanded. This can only be accomplished with frequent updates and reviews of passenger and luggage flow projections, which provide the necessary timing and anticipation (Williamson et al., 2013; Haq et al., 2020). Queuing effects and waiting times need to be better understood in order to improve system performance under peak loads (Williamson et al., 2013).

B) Software glitch

As the number of passengers using major airports continues to rise, baggage handling systems need to be expanded and changed on a regular basis to keep up. This can only be done by frequent updates and reviews of passenger and luggage flow estimates, as well as peak rates and connection times connected with them, which are crucial for proper timing and anticipation (Yoon et al., 2015). In addition, there should be enough spare capacity to allow for the temporary shutdown of lines required to link current and new facilities (Pisinger et al., 2021). In order to avoid the adoption of unrealistic quality and throughput objectives amongst various parties, flow assessments should be conducted throughout the whole baggage handling chain (Williamson et al., 2013). Static capacity and prediction calculations are often inadequate when it comes to the design of the baggage handling system. System behavior at high loads, such as queuing impacts and waiting times, needs to be better understood, as does the impact of shifting flight schedules (Yoon et al., 2015).

In order to do such dynamic testing, computer simulation is a fantastic tool, but it is not as straightforward as it may appear. In addition to providing information on how the system will operate in different operating modes, a good model may help designers identify possible bottlenecks and control issues early in the design process (Yoon et al., 2015; Haq et al., 2022).

C) Cost and Financial constraints

For a number of reasons, such as handling a broad range of luggage dimensions and satisfying the optimization needs of many stakeholders, it is attractive to devise a vast and intricate system. These systems, on the other hand, might become too massive and complicated to be successful. It's fairly uncommon for a typical engineering approach to result in a process chain that is too complex and wastes resources by attempting to tackle every issue with the most appropriate technology answer.

Overcoming these challenges may be achieved by optimizing the whole process chain instead of focusing just on one function. Instead of striving to attain their own goals, all parties in the baggage handling chain must work together to share knowledge and expenses. It's crucial to keep an eye on the procedure as well; for example, some major airports have several check-in lines with their own security screening machines, which wastes space and money.

It's also important to keep in mind that most of the time is spent waiting between operations rather than actually handling the luggage. When dealing with large quantities of luggage rather than one item at a time, this might lead to problems. It is possible to combat this problem by minimizing the number of waiting points, removing time-critical elements from a group, and reducing group sizes.

Smoothing out the highs and lows of luggage flow may also have a significant impact. The luggage handling process is

characterized by brief but severe peaks, yet it is vital to realize that over 95% of the baggage items in that peak might be delayed for several minutes without having a substantial impact on the quality of service in general. The baggage handling system's capacity requirements may be reduced if non-time-critical goods can be identified and handled off-peak. When considering luggage handling alternatives, it is important to take into consideration the expected costs of errors and delays. In the long term, a less costly method that creates only a little more luggage misdirection might end up costing a lot more. An item that misses its scheduled flight may cost up to $100 in additional fees for handling and delivery, for example Just in time (JIT) is a manufacturing concept that may be applied to the baggage handling process, but it is more often utilized in the manufacturing sector (Williamson et al., 2013).

D) Forecasts and design

In light of the rates of growth within most large airports, baggage handling systems have to be expanded and rebuilt often to guarantee they can comply with throughput needs (Zeinaly et al., 2012). Proper timing and anticipation is crucial for this and can only be done by the constant updating and evaluation of passenger and luggage flow estimates, with peak rates and connection times linked with them (Williamson et al., 2013).

Adequate excess supply must also be made available to enable for temporary shut-down of lines required to link current and new facilities. Such flow assessments should be carried out throughout the full baggage handling chain to avoid excessive cleanliness and throughput objectives being employed between various parties and to acquire knowledge about the potential for improvement in current systems (Yoon et al., 2015). Static capacity and prediction calculations are often inadequate when it comes to the design of the baggage handling system. System behavior at high loads, such as queuing impacts and waiting times, needs to be better understood, as does the impact of shifting flight schedules. In order to do such dynamic testing, computer simulation is a fantastic tool, but it is not as straightforward as it may appear. In addition to providing information on how the system will operate in different operating modes, a good model may help designers identify possible bottlenecks and control issues early in the design process (Williamson et al., 2013).

RESEARCH FRAMEWORK

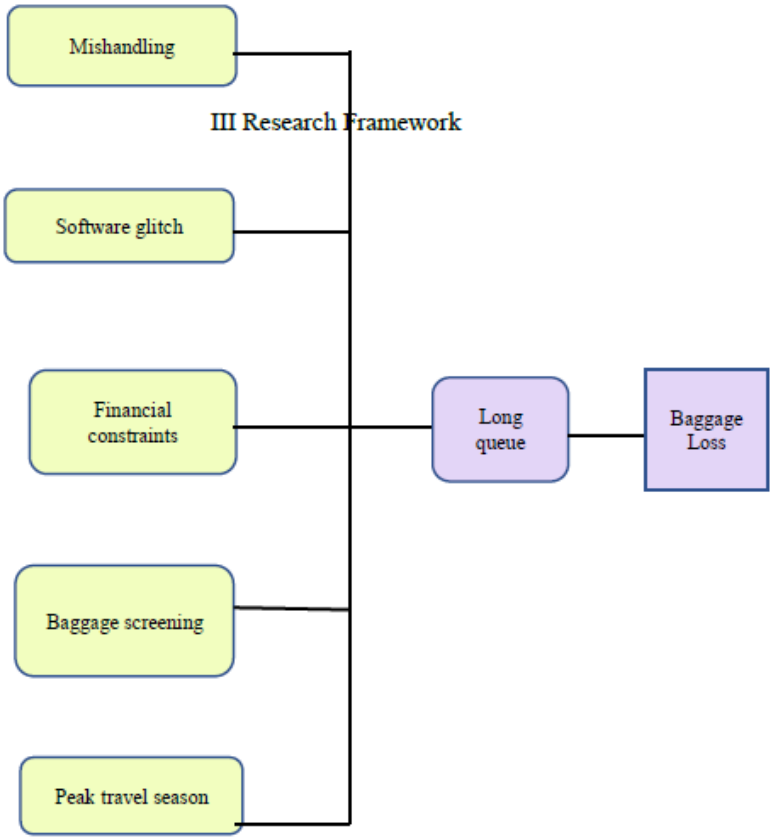

Figure 1: Research framework

E) Speed versus quality

Airline companies place a high value on aircraft turnaround not just to maximize capacity but also to ensure that passengers have a positive experience (Yoon et al., 2015). Aircraft turnaround times have a considerable impact on the amount of time that passengers have to wait to connect between flights. Baggage on conveyor belt to airplane the

baggage handling procedure may effect aircraft turnaround in numerous ways, principally the time necessary for the actual unloading and sequential loading of the luggage at the aircraft stand. Fastness of screening, sorting and transportation are other essential considerations (Mingxiu et al., 2012). This applies to both check-in luggage and the transfer of baggage items between two connected flights. This might cause luggage to be misplaced, delayed, or even lost entirely, which would put passengers' flights at risk of cancellation. It's possible that security checks like hold baggage screening and bag reconciliation may cause additional delays if they're implemented too late in the handling process or have a high false alert rate.

The following elements of the luggage handling process are crucial to its overall quality: Especially when the luggage handling system switches over to the baggage handler, the interface between the various parties may be a significant cause of issues and delays. Queues, wait periods, and data loss are all too prevalent at checkpoints that aren't properly thought out. This also applies to inter-handler operations when arriving luggage needs to be moved from one handler to another and where priority setting of own vs. other handler's baggage is an issue (de Melo et al., 2015). Even when 95 per cent of the luggage is handled at a top-quality level, poor performance on the remaining five per cent of out-of-gauge goods may ruin it all Speed versus timeliness. A tiny number of time-critical objects demand quick processing, whereas the overwhelming majority only requires timely handling. Depending on the objectives, separating the two flows and implementing procedures that can accomplish both speed and timeliness are effective ways to improve quality while also lowering costs (Mingxiu et al., 2012). It is important for the sector to continue to grow and adapt. This necessitates a constant focus on how to improve or lengthen the luggage handling procedure. A lack of master planning, scenario thinking, or sensitivity analysis may render processes and systems useless in the future (Mingxiu et al., 2012; Gill et al., 2022).

PROBLEM DEFINITION

On any given day, millions of pieces of luggage will transit through an airport. Given that luggage is a necessary aspect of the airport's business, how does it manage this operation in a timely and cost-effective manner? A baggage handling system is an important aspect of airport logistics. Passenger pleasure and operational efficiency will both benefit from an enhanced and simplified baggage handling system. The International Air Transport Association (IATA) passed Resolution 753 in June 2018, requiring its airline members to track every piece of luggage from check-in to baggage claim and to share that information with all parties involved in the process until passengers receive their luggage at their final destination. This need ensures luggage monitoring for almost four billion passengers each year. According to the SITA Baggage Report, roughly 9,965 people in the United States lose a bag per day, or 5.73 pieces per 1,000 passengers. Each year, 26 million items are reported lost at airports throughout the globe (Zeinaly et al., 2012). Despite the fact that 95% of lost luggage is found within 48 hours on average, 5% of it is deemed permanently lost. A total of $2.1 billion was paid by the affected airlines to reconnect customers with their lost luggage or to compensate travelers for luggage that could not be discovered (Zeinaly et al., 2012; Chellakan et al., 2022).

Airports must monitor the acquisition and delivery of baggage at four specific stages to comply with Resolution 753, including passenger handover to the airline, airplane loading, delivery to the transfer area, and return to the passenger. IATA members must now show a chain of custody by documenting luggage delivery when custody changes, cataloguing baggage inventory upon aircraft departure, and sharing this information with other airlines as appropriate (Buser et al., 2020).

According to Airport Improvement, "airports are complex environments, with some having as many as 30 different scanner technologies and conveyors or claim carousels that are not designed for attaching scanner arrays, making it harder to establish that they have the infrastructure to support Resolution 753, making it harder to establish that they have the infrastructure to support FEIG Electronics' ECCO+, a hybrid barcode/RFID mobile device that facilitates the transition from barcode to RFID without needing costly infrastructure, process, or IT upgrades, is already being used by airlines to apply this technology (de Melo et al., 2015). The cost of this hybrid solution is a fraction of what it would ordinarily cost to switch to a new technology (Yoon et al., 2015; de Melo et al., 2015). Existing hardware, for example, may be utilized to enhance the system without incurring any new system or software costs. The only thing left to do is replace the printer's standard paper stock to smart, RFID label material (Yoon et al., 2015). Bag tags may be produced utilizing the printers that are currently in place. The bag tag is placed in front of the ECCO+ barcode/RFID scanner, which scans the barcode as it comes out of the printer and encodes the same information in the RFID transponder in line with the IATA protocol (Yoon et al., 2015). The IATA requirement is one of the most important in the business, and the case study was based on Delta Airlines, the first airline to attempt to significantly convert their baggage monitoring system to state-of-the-art RFID-Mobile Tracking Technology (Zeinaly et al., 2012). Delta's luggage monitoring software was the first of its kind in the industry, setting a new standard for more transparent and interactive tracking (Mingxiu et al., 2012; de Melo et al., 2015). An RFID chip placed in the luggage tag serves as the foundation for the integrated

system. Passengers may sign up for push alerts from Delta's Fly app, which gives information on their checked bags (Yoon et al., 2015; Williamson et al., 2013; de Melo et al., 2015).

The cost of delivering misplaced luggage to a passenger's home, workplace, or hotel is now estimated to be about $100 per bag. RFID technology, according to CBS News, may save airlines $3 billion over the next seven years. Delta's investment will be more than compensated for by the advantages to their airline, which include the ability to trace bags throughout the whole airport procedure (Mingxiu et al., 2012; de Melo et al., 2015). With a 99.9% luggage monitoring accuracy rate, this has led in fewer lost bags, less theft, fraud, and an enhanced passenger experience. In order to enhance worldwide baggage monitoring, the ECCO+ has been implemented in 58 countries in accordance with the International Air Transport Association (Mingxiu et al., 2012; de Melo et al., 2015)

NEED IDENTIFICATION

We concentrated our efforts on the most critical facets in order to reach the broadest potential prospective. Automated and mechanized luggage handling isn't always the best option. As a result, it is one of the most sensitive and hardest issues to manage, because the majority of these services are performed by airline workers or by private organizations outside the airport. It's also a quality requirement to ensure that the complete automated airport baggage system is as energy efficient as possible (Yoon et al., 2015; Curtin et al., 2007). Therefore, the customer requirement we choose are easy to use, accessibility, speed, serviceability, reliable, cost, comfort and flexibility (Aziz et al., 2022; Sankar et al., 2023). We will discuss it one by one in a comprehensive manner.

A) Accessibility:

It is the goal of the airline industry to ensure that all passengers have access to safe, dependable, and dignified air travel. Accessibility is important because at times, airports have to deal with a lack of room for luggage storage. Much may be learned from the technique of batch construction in warehouses, which can reduce space and provide operators better control over luggage movement. It is possible to deploy batch construction in stages rather than requiring a total overhaul of the whole baggage hall. Airport operations, current makeup, and how to restructure it all play a role. Adding more conveyor lanes and racks, replacing gantries with conveyor lanes, or modifying some software might be all that is needed.

B) Speed:

It's easy to tell whether a baggage-handling system is successful: Is it possible for the luggage to travel at the same speed as the travelers? Bags that take longer to move may upset passengers who will have to wait for their luggage or miss connecting flights if they don't arrive on time. Passengers may miss connecting flights if luggage moves too quickly. Specifications vary from one airport to the next. How quickly a person can get from the check-in area to a gate influences the amount of time a luggage has to complete the same journey. It may be possible to walk to the main terminal at certain airports, but it might also be necessary to take a train to get there at others. Customer satisfaction may be improved by responding rapidly to their requests (Akram et al., 2023).

C) Reliable:

The reliable identification of bags plays a decisive role. The ability to accurately identify bags is critical. As more travelers check in online and print their own luggage tags at home, the read performance of bar code scanners is under growing pressure. As a result, the label's quality may suffer. As a result, there is a wide range in the placement and characteristics of the labels on the bag. When luggage is delayed, it affects everything from aircraft turnaround time to minimum connection times to gate management & airport capacity utilization. Baggage handling efficiency is critical to the smooth running of the airport as a whole.

D) Serviceability:

Passengers and checked luggage are often separated throughout the line haul of an aero plane flight, a practice that is uncommon in other types of transportation. Passenger separation and reunion must be done efficiently and reliably, which adds a significant amount of difficulty to the flight's logistics and the architecture of the airport's passenger terminals. Due to the fact that people are unloaded quicker than bags, this creates a dilemma for airport staff. As a further issue, checked luggage is subject to security inspections. If possible, the baggage claim area should be situated in close proximity to the terminal deplaning curb so that incoming passengers' checked luggage may be returned to them quickly. Checked luggage may be put on a shelf for passengers to claim in airports with low traffic serviced by small flights. However, almost all airports now use mechanical delivery and display systems. An airline's need for baggage claim devices is based on a variety of factors, including how many planes arrive at peak times of day and night, what number of passengers depart and how much luggage is checked on each flight, as well as the mechanism for transporting luggage from the planes to the claim area.

E) Cost:

Baggage pickup and delivery typically face two major hurdles. The first is customs; the second is security. Neither of these can be taken as a convincing argument. Baggage is thoroughly checked to verify that it is safe to go on board. Prior to this inspection, anything in your luggage might be a danger to you or others. Securing the luggage prior to screening has no effect on the security procedure and just adds expenses to the process (Zeinaly et al., 2012). Customs may also be able to see photographs of incoming bags and make an arrest based on the information contained inside. The major problem is standardizing the way local enterprises share information about the luggage journey so that they can provide a uniform product when picking up and putting bags. The industrial data model provided by IATA may assist in this endeavor (de Melo et al., 2015). The expected rise in air traffic is driving the worldwide market for airport baggage handling systems. In addition, the expansion of the market is fueled by the upgrading of new airports & technological breakthroughs. In spite of this, baggage handling system (BHS) costs are prohibitive for the market's expansion, and the repercussions of a system failure are severe. Robotics in airports is also projected to give profitable development prospects in the years to come, as is predicted.

F) Comfort:

Passenger comfort and safety are improved as a result of proper luggage management. Passenger comfort, airport operations and profitability all benefit from baggage handling technology investments as the number of air passengers grows. The success rate of luggage handling has already increased dramatically due to the steady adoption of new technology and better methods over the previous decade. Passenger numbers have risen by 1.2 billion in the previous decade but bag mishandling has decreased to just over 20 million.

G) Flexibility:

In today's baggage handling, technology and system flexibility are key. Airports need to focus on improving connection and implementing systems that promote decentralization in addition to flexibility and combining technologies. The airport has implemented a decentralized baggage transit system in order to meet this development in the future. A tote-based transport system as well as a sortation system are only two examples of Beamer technology that the airline utilizes to suit its baggage handling needs (Al-Hilfi et al., 2018). The airport has a network of tunnels that enable it to efficiently handle huge volumes of passengers during peak hours. The semi-automatic luggage loading system provides improved security and transparency because of its flexible interaction with current baggage handling systems (BHS) and IT infrastructures. Reconciling luggage with people is made possible by baggage identification, and luggage from passengers who failed to board but whose bags were checked in may be readily recognized in the appropriate container.
If we want to know how our solution stacks up against the competition, we must do a developing a strategic solution here. It assesses how appealing our solutions are to interested parties.

PROPOSED SOLUTIONS:

A) App:

Better luggage management will be made possible thanks to modern technologies. Increasing passenger numbers necessitates an increased attention on this issue. Apps for flying travelers that offer real-time information on the whereabouts of their luggage are becoming more common. According to the Insights study, one out of every four travelers has used an app to get baggage-related information, such as finding out which belt their luggage would arrive on. There is good news in the latest Passenger IT Insights report. Airlines and airports are eager to bring in mobile services for baggage monitoring, and customers are reaping the benefits of these services when they are available.

B) Conveyor Belt:

In an aviation baggage handling system, conveyors are organized into a network to do a variety of duties. As a final delivery method for arriving passengers, luggage is transported via a belt conveyor from arrivals to the baggage claim area. Systems that employ belts to move items or materials are known as Belt Conveyors (BCIs). Between two end-pulleys, the belt is looped indefinitely. In most cases, one or both ends have a roll tucked below them. Conveyor systems at Denver International Airport's main terminal form a vast network. Many distinct conveyors are connected via junctions. In order to get all of the luggage from all of the various airlines to the right terminal, the conveyor system must sort them all. The baggage-handling system monitors bag's whereabouts once it has been scanned. Conveyor systems know where your luggage is all the time. Your bag will either be allowed to pass or pushed onto another conveyor when it gets to an intersection by a mechanism called a "pusher." An extensive network of conveyor and connections enables automated delivery of luggage to almost any location.

C) Seggregation System:

This system is very crucial as there is a great deal of inefficiency in today's luggage culture. Despite the fact that airport

security screening technologies are often the same, some of the time and money is being spent on rescreening luggage because of the change in location. Baggage performance is presently evaluated by comparing the number of mishandled bags to the number of passengers. Performance can't be gauged in this manner. A few flaws are immediately apparent. Point-to-point carriers and airlines that provide a transfer service employ the same percentage. What's the use of using the same measurement when the activities are so different? Bags that were successfully loaded in a certain amount of time were compared to the total number of bags that could be loaded in that amount of time. Second, the figure conceals a great deal of information. Bags are accepted by airlines when they agree to take care of them. There are a lot of people engaged in transporting that luggage, and the necessary procedures need to be taken to ensure that the service standards agreed upon by all of them are being met. An airline ought to be able to evaluate the airport's services and choose the one that works the best for its passengers. Passengers and airline employees may both observe the current condition of service in relation to agreed-upon standards using a simple traffic light system.

D) Tag Reader:

Tag reader and laser technology has been the leading option for tag identification for over 30 years because of its endurance and compliance with even the most stringent industry standards. More than 4,500 laser-based automated tag reading devices have been marketed globally to this day. One of the main benefits of RFID is that it does not need a direct line of sight between sensors and tags. An RFID tag may hold more information. As a result, luggage can be tracked with greater accuracy. With RFID technology, airport baggage identification systems meet the requirements of the worldwide IATA regulations and fill up any gaps. With cameras, you can scan tags from all directions and perform additional vision operations like as character recognition or video coding. Automatic tag reading systems that use cameras to read labels may process the information on the labels in a variety of ways, including automated computer vision and video coding. Even if the bag source message is not accessible, the identification of the flight number or the location of the destination airport allows for the prompt transfer of bags inside the conveyor system. In order to improve the performance of automated tag reading based on optical process, the airport baggage identification system (ALIS) camera is the best option. Photographic cameras provide the best reading performance on all types of tags, even those that are badly printed, broken, unclean, crumbled, and twisted. Cameras may be used separately or as an addition to an existing automated tag reading laser system, which can be done quickly and simply. There are no modifications necessary to the transceiver module or the conveyor system.

E) Mobile:

Mobile tracking solutions are becoming more important in order to guarantee that operational data is not lost. When paired with a bag tracking software, a smartphone can simply keep tabs on a lost or stolen bag. For example, an airport employee may scan a suitcase with a camera on their phone, record vital information about it, and save it to a database for future reference. Passenger information such as their seat and sequence number will be sent to the delivery carousel along with their luggage. Another option is to utilize an API to control the actual distance and arrival of passengers to the conveyor belt. – In other words, you may ingest the data into an airport or airline mobile application and make it available to other passengers directly via the app. A usability study is a method of assessing an application's usability by having actual people use it. Observation of users doing activities helps identify where they get stuck or become confused, as well as whether or not the experience is what they expected. Recommendations for resolving these usability concerns will be made if enough people have the same difficulties. During a usability research, five people were asked to complete a series of activities to assess the proposed system's usability. All of the system's major functions, such as signing up, checking in and making appointments and appointments for a new family member as well as monitoring the driver's whereabouts and submitting a complaint were covered in detail. As a consequence, it was found that the application's major functions were easy to use in the execution of the various activities.

From above it can be seen that customer requirements are assessed against the functional requirements along with the customer competitive assessment. Direction of improvement and relationships are represented by using symbols. Importance rating and relative weight are calculated, with app as a functional requirement have the highest relative weight which approximately 23 percent.

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