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MODIFIED SINGLE MINUTE EXCHANGE OF DIE FOR REDUCTION OF AMBULANCE RESPONSE TIME

Dr. Mukesh Shyamkant Desai, Department of Mechanical Engineering, OP Jindal University Raigarh, 496109, Chhattisgarh, India. E-mail address: mukeshsdesai@gmail.com, ORCID 0000-0003-0231-3716
Dr. A. M. Rawani, Former Director, National Institute of Technology, Raipur, 492010, Chhattisgarh, India. E-mail address: amrawani@rediffmail.com; ORCID 0000-0003-4439-4163
Dr. M. I. M. Loya, Department of Telecommunications and Emerging Technologies, Navtech Pvt. Ltd. Singapore, E-mail address: imloya@gmail.com; ORCID 0000-0003-0766-2456

Abstract
Single Minute Exchange of Die (SMED) is a Japanese methodology used to reduce setup time of the machines in the manufacturing organisation. Researchers have applied SMED in different manufacturing sectors for reducing the setup time. But, its application in service sectors is not attempted. An earlier study by the authors identifies compatibility gaps between SMED and ambulance response time (ART). This study aims to develop a Modified Single Minutes Exchange of Die methodology for reducing ART, by addressing the identified compatibility gaps. ART is the key indicator to check the performance of the ambulance services. This study is expected to assist improving performance of ambulance services to reduce ART.

Keywords:
Ambulance, Ambulance Response Time, Emergency Medical Services, Modified Single Minute Exchange of Die, Reduction.

I. Introduction

Delay in ART is one of the major causes of death and disability in the world [1;2]. Emergency Medical Services (EMS) is an essential part of the overall healthcare system as it saves lives by providing care as soon as possible. “ART is the period between the record of an emergency call and the arrival of an ambulance at the scene”. It is a well-accepted fact that a patient who receives basic care from trained professionals and is transported to the nearest healthcare facility within 15-20 minutes of an emergency has the greatest chance of survival [3]. It is extremely important to get ambulance services or pre-hospital care in medical emergencies [2;3;4]. The need for reduction of ambulance response time is well recognized in the literature. Numerous tools and methodologies have been attempted to reduce ART. However, a search of literature reveals that Single Minute Exchange of Die (SMED), though a promising methodology, is never applied for reduction of ART. SMED, is a Japanese methodology, popularly used to reduce the manufacturing system's setup time. Researchers have applied it in different manufacturing sectors for reducing the setup time, but never for reduction of response time in service sectors. An earlier study by the authors identifies compatibility gaps between steps of SMED and activities of ART [5]. This study aims to develop a Modified Single Minutes Exchange of Die methodology for reducing ART, by addressing the identified compatibility gaps.

1.1. Single Minute Exchange of Die (SMED)

SMED methodology was invented by Dr. Shingo in 1950 in Japan. SMED methodology is mostly used for the reduction of setup time reduction or changeover time reduction [6]. SMED was originally developed to improve die press and machine tool setup, but its principle applies to change over in all types of manufacturing processes. The setup operation is defined as the post-adjustment performed

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once before and after each lot is processed [7]. Shingo classified the setup operations into two parts: internal activity, and external activity.

"Internal activity can be done only when the machine is shut down" i.e. attaching or removing the dies. "External activity can be done when the machine is still running" These operations can be performed either before or after the machine is shut down; for example, getting the equipment ready for the setup operation can be done before the machine is shut down [7;8;9].

1.1.1. Four Stages of Single-Minute Exchange of Die

The four main stages of SMED, also given in figure number 1 can be summarized as follows:

Stage 0: Preliminary Stage

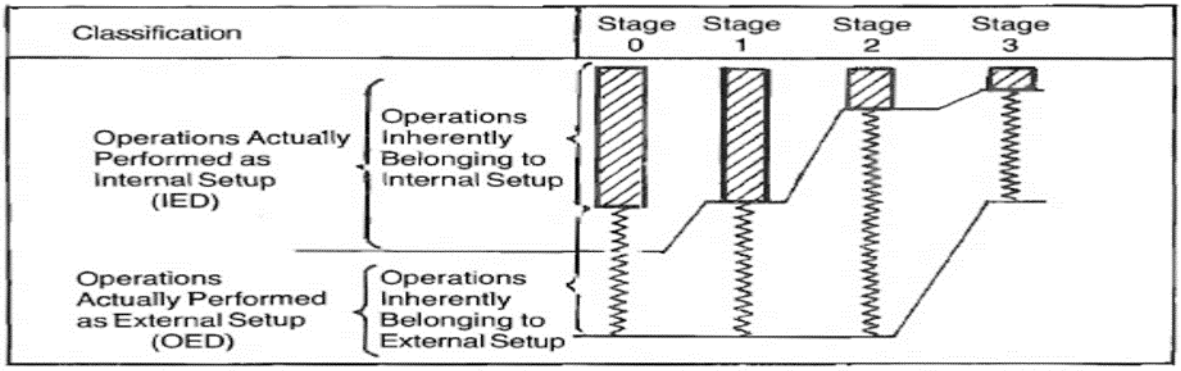
Stage 1: Separating internal and external activities

Stage 2: Converting internal activities into external activities

Stage 3: Streamlining all aspects of the setup operation

Stage 0: Preliminary Stage: Internal and External Activities are not Distinguished

In traditional setup operations, internal and external activities were confused; what could be done externally were done in the internal setup and hence machines remain idea for extended periods. To implement SMED in manufacturing industry, one should study the shop floor conditions in detail; production analysis performed with stopwatch; interviewing with the workers. Even better method is to videotape the entire setup operation. It is very effective technic to show the videotape to the worker/setup man immediate after setup operation completed. Give the opportunity to the share his view regarding particular setup [10]. As a result, some of the activities that could be done externally are done as an internal setup as illustrated in figure 1.



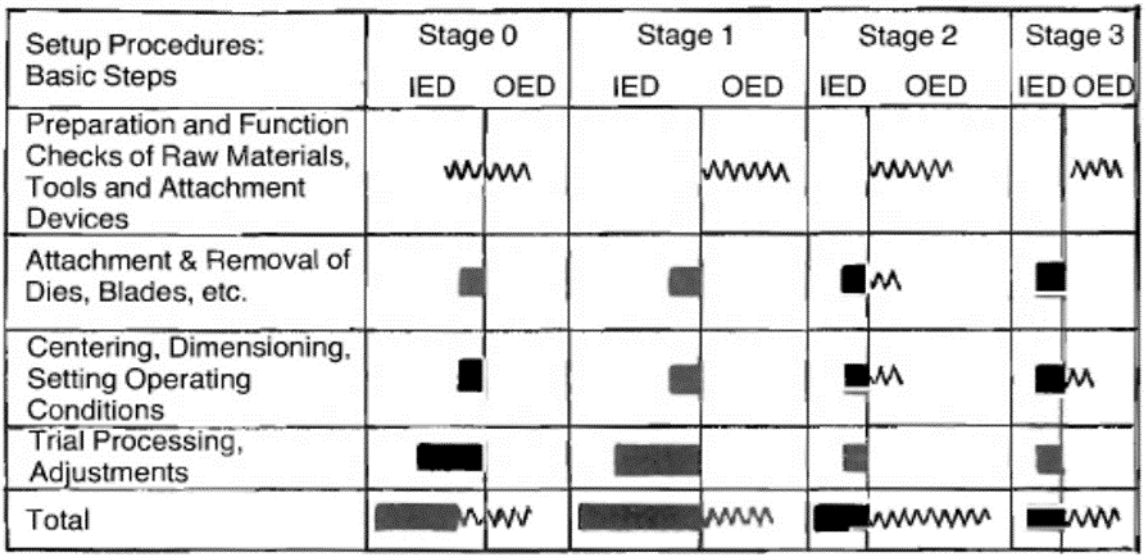


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Figure 1: Four Stages of SMED [10].

Stage 1: Separating Internal and External Activities

The most important step in implementing SMED is distinguishing between internal and external activities. The machines should not be stopped for the activities that could be performed while the machine is in operation. Consequently, just distinguishing between internal activities and external activities may often reduce the setup time by 30%—50% (Shingo, 1983).

Stage 2: Converting Internal Activities into External Activities

The conversion of internal activities to external activities comprises two important notions; the first is re-examining operations to see whether any steps are wrongly assumed to be internal and the second is finding ways to convert these steps to external setup. This requires a close re-examination of the true functions of all the operations that are now performed as an internal setup.

Stage 3: Streamlining all Aspects of the Setup Operation

This stage tries to improve all the setup operations, both internal and external, reducing their duration or even, if it is possible, trying to eliminate some operations. Although the SMED methodology recommends that one follows these four stages. The different steps in implementing SMED are shown in Figure 1.

II. Research Methodology

On the basis of the compatibility gap identified in the previous research of the authors [5]. First events relevant to ART and the time required in the context are defined. Then on the basis of the synthesis of conventional SMED, ART practices, the gap identified and information collected during the field study, the modifications on SMED are proposed to make it compatible with ART for the purpose of reducing the ambulance response time.

III. Modified Single Minute Exchange of Die (MSMED) to reduce Ambulance Response Time (ART)

The modified Single Minute Exchange of Die methodology is versatile, unique, and economical, so it may be applied at various hospitals and NGOs for the reduction of ART. If implemented, it will reduce ambulance response time and will help to save the lives of many people. The events relevant to ART are illustrated in the Figure 2

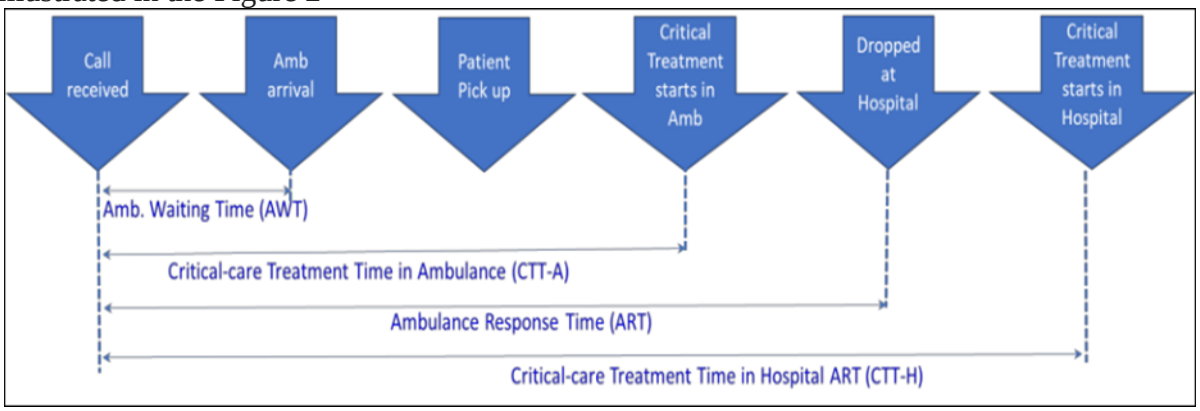

Figure 2: ART Terms

The time interval in the context of ART and are discussed below.

❖ **ART Terms:**

- Ambulance Waiting Time (AWT): Time between receiving the call to the arrival of the ambulance at the pickup site.
- Ambulance Response Time (ART): Time between receiving the call to dropping the patient at a hospital.

- Critical Treatment Time in Ambulance (CTT-A): Time between receiving the call to providing in Ambulance Critical Treatment to a patient. e.g.: For heart cases administrating administers aspirin or Sorbitrate.
- Critical Treatment Time in Hospital (CTT-H): Time between receiving the call to providing Hospital Critical Treatment to a Patient.

e.g.: For an accident case before the Patient reaches the hospital, an ambulance EMT reported the case of blood loss, blood group, head injury, consequently hospital is ready to receive the patient with the right blood group, neurosurgeon and OT is ready for the case. Without this advance reporting, critical treatment would have started with a delay. The delayed saving is a contribution of ART.

- **Re-defining Internal and External Activities for ART:**

The concepts of internal and external discussion in section 1.1 and figure 1 are vital for the implementation of SMED. This is because a significant improvement in time is achieved by converting internal activities into an external one. However, the concept of internal and external as defined in SMED is not compatible with ART.

The summary of the compatibility gap is mentioned in table number 1, point no 6, the aim in the context of ART is not to minimize setup time, but to minimize;

1.Ambulance Response Time: ART
2.Critical Treatment Time in Ambulance: CTT-A
3.Critical Treatment Time in Hospital: CTT-H

Accordingly, the concept of internal and external are re-defined in this section. In the context of traditional SMED, the activities involved in the exchange of dies are classified into two categories.

➢ Internal activities (A) are those activities that, can be performed only when the machines are stopped and

➢ External activities (B) are those activities that can be performed even when machines are operational.

Likewise, in ART, after receiving the call an ambulance should not be made to wait for the activities that can be performed without holding the ambulance. For example, checking the first aid kit, fuelling the vehicle, etc., can be done in advance before the call comes. Some parts of MOD's (Manager on Duty, at the base station) paperwork can be done after dispatching the ambulance, and some parts of EMTs (Emergency Medical Technicians) in ambulance paperwork can be done while the ambulance is moving. Similarly, Patient registration formalities/paperwork can be performed after transferring the Patient to casualty. Ambulance/Patients should not have to wait for such activities to be external. Accordingly, in the context of ART, Internal and external activities are defined as follows.

- **Internal activities:** are those operations/activities that can be performed "only when an Ambulance or Patient-transfer is held/made to wait"
- **External activities**: are those operations/activities that can be performed "while an Ambulance is moving or Patient is being transferred"

Concepts of Internal and external activities are illustrated in figure 3. The illustration also shows Travel Time -1 (TT-1) and Travel Time -2 (TT-2).

- Travel Time -1 (TT-1) is the time required by the ambulance to reach the site after it is dispatched from the base location.
- Travel Time -2 (TT-2) is the time required by the ambulance to reach the hospital after picking up the patient from the site.

External activities are those activities that are performed during TT-1 and TT-2, whereas the activities performed outside these are internal activities.

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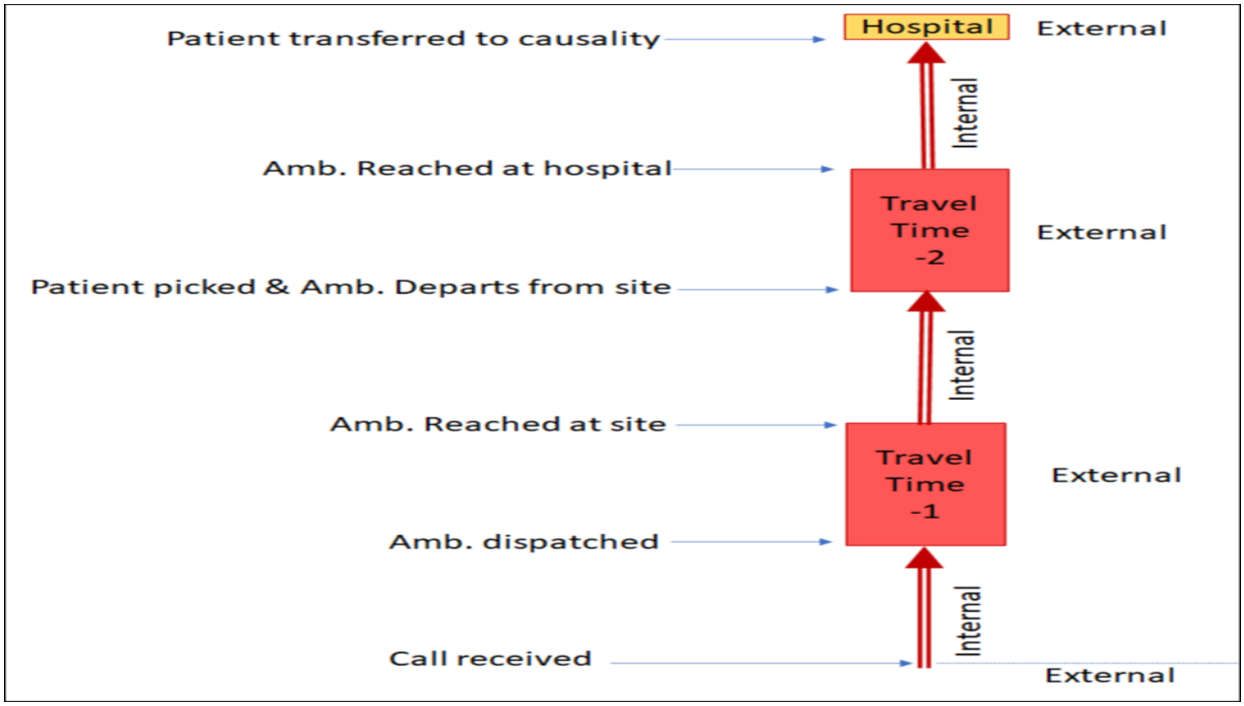

Figure 3: Internal and External Activities of ART

On the basis of the above definition of internal and external, in this section, modification in stages and steps of the SMED, in the context of ART, are proposed to address the entire compatibility gap listed in Table number 1 as follows;

Table 1: Summary of the compatibility gap between SMED and ART [5].

Sl. No.	SMED	ART
1	Setup schedule is known in advance.	Ambulance call time is not known.
2	Setup type is known in advance	Type of call is not known in Advance.
3	Working condition is known, standard and controlled.	The working conditions (traffic, distance, etc.) are not known until the call comes; it varies on each call and beyond the control.
4	The setup procedure is standard; thus, the same operations and tools are repeatedly involved every time. Hence time and motion study is very useful.	Each call is different. Various aspects such as the timing, address, distance, traffic, patient age, patient disease, etc., significantly varies on each call. For such call dependent activities time and motion study is not suitable.
5	In case of SMED specification of sample product is investigated.	Whereas the product in ART is a service, hence straight forward sampling and investigation of specification will not serve the purpose. The product should be investigated for the quality and performance of the service.
6	A key concern is to minimize the duration of machine stop time. Time taken while the machine is working is not a concern.	A key concern is to minimize various aspects. a. Dispatch time, Travel time, Pickup time, Return travel time. b. Time taken to trigger in ambulance treatment.

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		c. Time taken to trigger in-hospital treatment. Accordingly, the concept of internal and external need to be redefined.
7	The concern is production efficiency, wastage, and cost of production.	The concern is life and death of the person.

Various conceptual stages of the proposed Modified SMED for the reduction of ambulance response time are shown in figure number 4. It consists of six stages beginning with stage '0' to stage '5'. The initial four stages (i.e. 0 to 3) are similar to conventional SMED. Stages 4 and 5 are added here in the modified SMED looking for compatibility gaps. Stage '4' is providing Critical-Care. Treatment in Ambulance (CTT-A) and Stage 5' is providing Critical-Care Treatment in Hospital (CTT-H). All stages are indicated in figure number 4 and described below.

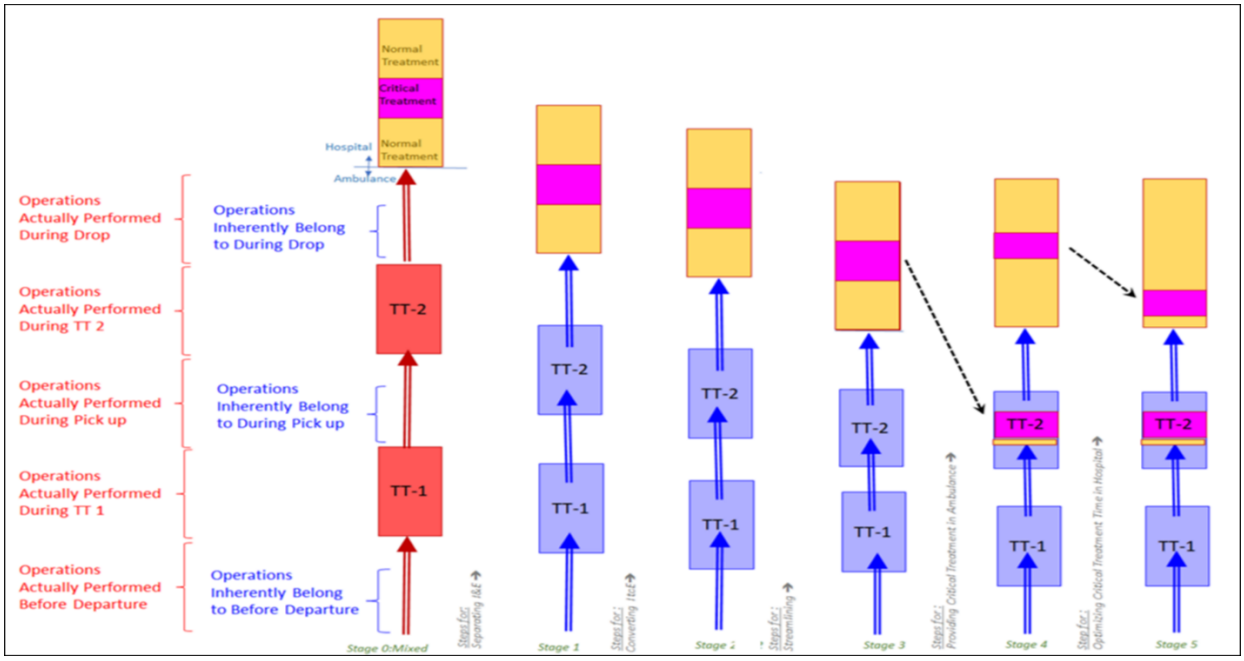

Figure 4: Conceptual Stages of Modified SMED for Reduction of Ambulance Response Time

3.2. Stage 0: Internal and External Activities of ART are not Distinguished (Mixed Stage)

Stage 0 represents the state of affairs prior to the implementation of SMED. As discussed earlier, ambulance movement and patient transfer should not be held up for activities that are external in nature. This is so obvious, yet implementations of SMED in the industrial context show that such obvious mistakes are mostly found. In other words, the activities that are external in nature are performed internally. In the context of ART, the activities which could be done during Travel Time 1 (TT1) and Travel Time 2 (TT2), if done before departure, during pick up, and during the drop, should be identified and noted in this stage for correction in subsequent stages.

Examples:

- Filling the log register before departure thus holding an ambulance for it (can be done while moving).
- Finding the location before departure (can be done while moving).
- Calling paramedical staff after reaching the hospital (can be done in advance).

These could be identified and done when an ambulance is moving.

❖ **Accordingly, analogous to traditional SMED, the following steps aim to identify and note such obvious wrong practices.**

Step A: To study the state of affairs: This step studies the operational environment and provides valuable insights which serve as valuable input while improving the ART in subsequent stages.
Step B: To analyze the performance of service production: In the case of ART some activities are standard.
For example: Preparing the ambulance, whereas some activities are call-dependent (not standard).
For example: Preparing the ambulance takes more or less duration for each call. Whereas travel time varies significantly for each call depending on distance accordingly, a distinction between the two is noted here and different methods of investigations are suggested for these two different types of activities namely standard activities and call-dependent activities.

- Standard activities are repetitive in nature thus they may be studied using the stopwatch and other time and motion methods and techniques.
- Whereas call-depended activities vary with the call may be studied in terms of Procedure, SOP, etc.

Step C: To study sample cases: Analyzing randomly selected cases, for the quality and performance of the service.
Step D: To interview the people involved in the production of services: This is a very effective technique for ART because the people who are involved in the production of services (ambulance services) know everything about service and the environment.
Step E: To do a videotape of selected cases.
Step F: To show the videotape to the people involved: In order to eliminate unnecessary inefficiencies.
Step G: To give the opportunity to the people involved to share/explore their views about the Ambulance Response Operation (ARO) they may give valuable input to reduce ART.
Step H: To take the consultant's advocate/advice in-depth for analyzing ARO for the purpose of improving ART: Many times the internal team is not able to reduce ART. In this case, it requires seeking advice from a researcher or expert in ART. By following the above steps, there will be a fair understanding of the operating environment and existing practices. This understanding will be required for proposing actions required for improving and migrating from stage 0 to stage 1; i.e. migrating.

3.3. Stage 1: Separating Internal and External Activities of ART

The most important step in applying Modified SMED in ambulance services for reducing ART is distinguishing between internal activities and external activities.
Step I: To prepare the checklist of all the devices, equipment, materials, and parts required in an operation and SOPs of the activities if any, and checklist of all the parts which is required in the ambulance, which includes the first aid box with all necessary primary treatment medicines, required medicines and stretchers, oxygen cylinder, mask, basic life support, advanced life support systems, tools and spanners required to in the ambulance.
Step J: To prepare the check table on which a drawing of the particular part has been made of all the parts and equipment/medicines required in the ambulance.
Step K: To place the corresponding part over the appropriate drawing/fixture, and be ready even before receiving the call. e.g.- To Prepare the ambulance and keep the required medicines, and *Injections.* Equipment like Stretchers, oxygen cylinders, masks, basic life support, advanced life support systems, tools, and spanners are required.
Step L: To check which part is missing: After preparing the checklist, checking the table, and placing the particular part on the drawing of the check table, there are very few chances of missing anything. This is a final / reconfirmation check in case anything is missing so that no time is lost for searching particular items after the call is received.
Step M: To perform a function, check: To check the expiry date of medicines, stretchers, oxygen cylinders, masks, and accessories needed in the ambulance, in advance even before the call is received.

By following the above steps, there will be improvement against obvious mistakes. The reason for these mistakes is – not carefully separating internal and external activities, as a result, some of the external activities were being performed as internal. One may wish that these mistakes should not be there in the first place, yet they are mostly found to be present in almost all the SMED implementation Once internal and external are separated and external activities are performed as external, it facilitates impressive improvement. Subsequently, the next level of improvement can be achieved by converting internal activities into external ones. Stage '1' of the modified SMED is shown in figure number 4.

3.4. Stage 2: Converting Internal Activities into External Activities of ART: it involves two important aspects.

- Re-examine all operations, and check whether any steps are wrongly assumed to be internal.
- Finding ways to convert internal activities into external activities.

For example, rather than detailed information sharing between the Call center and EMT. It could start with a quick command like "depart to pick up at location XYZ". The rest of the details could be shared while the ambulance is moving. Quick commands, as well as info sharing, could also be done by mobile app).

For Converting Internal into External Activities the Following Steps Are Proposed

Step N: To prepare operating conditions in advance: In the case of ART, emergency calls are extremely unpredictable, each call is different, and timing, address, distance, traffic, patient age, patient disease, etc. significantly vary in each call. The type of call (Urgent or not urgent) is not known in advance. Despite these limitations, various preparations can be done in advance such as the classification of calls and preparation of things required for each call, e.g. equipment, medicines, devices, and SOPs, required for each call.

Step O: To standardize essential functions.

Step P: To convert internal activities into external activities: Re-examining all operations of ART and checking whether any activity is wrongly assumed to be internal. Finding ways to convert these activities into external activities.

Examples:

- Doctors and Paramedical Staff attend to the patient and diagnose the patient inside the emergency department.
- After diagnosis, fill up the patient's admission form and other administrative activities carried out like fill-up the forms of the hospital

By the above steps, improvement is expected depending on the number and nature of internal activities that are converted into external ones. Subsequently, the next level of improvement can be achieved by optimizing various aspects of ART. Stage '2' of the modified SMED is shown in figure number 4.

3.5. Stage 3: Streamlining all Aspects of the ART Operations

This concerns improving the efficiency of the overall operation including the travel time; this involves a detailed analysis of each operation and creative thinking for minimizing the time required for various operations of ART.

Some examples to illustrate this step are as follows:

- Telephone is too far from the ambulance.
- Driver waiting for an area too far from the ambulance.
- Driver and EMT not together. EMT finds the driver after the call is received and vice versa.

➢ **The following steps are proposed for streamlining all aspects of ART**

Step Q: To improve external activities: include streamlining the storage, transport of components, tools and accessories, etc.

Step R: To improve internal setups

Step S: To explore the possibilities of parallel operations: Parallel activity means the ambulance is in running condition and basic treatment is carried out on the patient as well as filling the different admission-related formats inside the ambulance only. Not only this but also be in touch with the Hospital Emergency Department and inform patient conditions so that they can prepare the operation theatre or ICU in advance for critical patients.
Step T: To improve the parking and exit passage for the ambulance.
Step U: To improve the storage and transportation of the parts and tools for streamlining the operations.
Step V: To use advanced equipment: Like automated guided wheelchairs, *electric* vehicles from the hospital door to the emergency department, stretchers with wheels, and hydraulic lifting bars.
Step W*:* To prepare the rack-room/garage: To prepare the garage in which old parts of the ambulance, spare wheels, oil cans, old stretchers, etc. are stored on three-dimensional racks and automated equipment is used to store the heavy parts of the ambulance. This garage is also useful as a restroom and lunch room for the Drivers and EMTs as well as to keep drivers' lunch boxes and lockers.
Step X: In the case of ART, it is much more complex. The status is simply not on-off-on, but it is '**dispatch-travel-pickup-travel'**, in ambulance treatment, and in-hospital treatment.
Step Y: In the case of ART, it is not only to bring the patient to the hospital as quickly as possible but also to facilitate treatment within the transport and also to reduce the time required to begin the critical in the hospital. For example, the early information facilitated before the arrival at the hospital may reduce the time required to begin critical care in the hospital.
Step Z: It is observed in step B; a large part of ART involves call-dependent tasks. Therefore, time and motion study is not applicable. Accordingly, additional tools (e.g. creative method) need to be incorporated which are missing in SMED.
Step AA: As observed in step N, in the case of SMED, the schedule is known in advance, whereas a call for an ambulance has much less predictability.
The above stages and steps are analogous to traditional SMED and are expected to improve ART significantly as it does in case of setup change. Considering the objective of ART is not only to bring the patient to the hospital as quickly as possible but also to facilitate critical care within the transportation process (in an ambulance) and also reducing the time required to begin critical care in the hospital, accordingly two more stages are added for ART. Stage '3' of modified SMED is shown in figure number 4.

➢ **Providing Critical-Care Treatment in Ambulance**

After streamlining all activities of ART, it is recommended to carry out preliminary care and critical care inside the ambulance itself by providing one Doctor/well-trained paramedical staff. This part of the care is so important that it is recognized as Golden Hours in medical fertility and relates to the life and death of the Patient.

- In order to facilitate critical care in ambulances, the following steps and sub-steps are proposed.

Step AB: *In emergency cases, for example, Cardiac cases, snake bite, etc., early administration of treatment can make a significant difference in saving a life. Providing such critical treatment in the ambulance which helps with a doctor or well-trained EMT is possible.* This reduces treatment response time considerably. Sub steps proposed for this step are as follows:

- Identify the need by case categories
- Study the treatment options
- Develop scenario-based SOP
- Hire competent EMT/Train EMT

Step AC: To facilitate an Advanced Life Support System (ALSS), in ambulances, if possible, so that medical treatment time will be saved as well as the patient's life. Stage '4' of modified SMED is shown in figure number 4.

➢ **Optimizing Critical-Care Treatment Time in the Hospital**

After getting the first aid care and preliminary critical-care treatments inside the ambulance as stated above, subsequent critical-care treatment is required in Hospital. *For serious patients like Heart, Cancer, Poisson, Stroke, and some emergency cases, providing Hospital-Critical-Care Treatment in-time makes a difference in life and death*. In case of time-sensitive cases such as accidents, cardiac cases, snakebites, Strokes, etc., EMTs' advance reporting can aid in making the hospital ready for the early start of critical treatment. This may speed up the required treatment and can make a significant difference in saving lives.

Step AD: To facilitate advance information so as to enable the hospital to understand the case, predict the requirement, and prepare for it, before the Patient reaches the hospital. Sub steps proposed for this step are as follows:

- Identify the need by case categories.
- Develop reporting SOP
- Develop Hospital Preparedness Protocol

ART consists of various activities and paperwork can be done while the ambulance is moving. Similarly, Patient registration formalities/paperwork can be performed after transferring the Patient to casualty. Ambulance/Patients should not have to wait for such activities that can be done by the Manager of Duty (MOD), Driver, and Emergency Medical Technician (EMT).

- Internal activities are those operations/activities that can be performed "only when an Ambulance or Patient-transfer is held/made to wait"
- External activities are those operations/activities that can be performed "while an Ambulance is moving or Patient is being transferred"

Various events and Internal and External activities are shown in figure number 4.

In the ART Process there are certain operations that are actually performed before departure to the scene, actually performed during TT-1, actually performed during pickup, actually performed during TT-2, and actually performed during dropping the Patient in the hospital. Operations/ activities inherently belong before departure to the site/ scene, inherently belong during pickup, and inherently belong during dropping the Patient in the hospital which could be done during Travel Time 1 (TT1) and Travel Time 2 (TT2).

The main aim behind this is to reduce ART by doing parallel activities/operations of ART at every stage and during TT-1 and TT-2 also. Some examples are given below;

- Filling the log register before departure thus holding an ambulance for it.
- Finding the location before departure (can be done while moving).
- Calling paramedical staff after reaching the hospital (can be done in advance). These could be identified and done when an ambulance is moving.
- Rather than detailed information sharing between the Call center and EMT. It could start with a quick command like "depart to pick up at location XYZ". The rest of the details could be shared while the ambulance is moving. Quick commands, as well as info sharing, could also be done by Mobile App).
- Result of this major activity we want to do during TT-1 and TT-2 for streaming all operations of ART as shown in stage 3, from step number Q to step number AA.

The above stages are analogous to traditional SMED and are expected to improve ART significantly as it does in case of setup change. Considering the objective of ART, it is not only to bring the patient to the hospital as quickly as possible but also to facilitate critical care within the transportation process (in an ambulance) and also reducing the time required to begin critical care in the hospital, accordingly two more stages are added for ART. Stage '3' of modified SMED is shown in figure number 4.

3.6. Stage 4: Represent Critical-Care Treatment in Ambulance (CTT-A) After streamlining all activities of ART, it is recommended to carry out preliminary care and critical care inside the

ambulance itself by providing one Doctor/well-trained paramedical staff. This part of the care is so important that it is recognized as Golden Hours in medical fertility and relates to the life and death of the Patient.

CTT-A is divided into the 3 parts namely

- Normal treatment inside the ambulance,
- Critical treatment inside the ambulance and
- Normal treatment inside the ambulance.

➢ Normal treatment inside the ambulance means first aid treatment on the Patient in the ambulance like; vital indications (Pulse, SPO2, Temperature, Blood Pressure, GCS).

➢ Critical treatment inside the ambulance means treatment by a Doctor appointed inside the ambulance as well to provide Advanced Life Support systems inside the ambulance so that, Critical Treatment Time in the Hospital is reduced by given Critical Treatment Time to the Patient during TT-2 and that has shown in the figure number 4 by giving arrow in stage 3 to stage 4. This reduces critical treatment time considerably after this Patient is admitted to the hospital as shown in figure number 4.

➢ Normal treatment inside the ambulance means providing an oxygen mask (if necessary), and monitors to the patient, If the patient is serious, then ask the emergency department, which drugs to provide to the patient.

3.7. Stage 5: Represent Optimizing Critical-Care Treatment Time in the Hospital (CTT-H): After getting the first aid care and preliminary critical-care treatments inside the ambulance as stated above, subsequent critical-care treatment is required in the hospital. *For serious patients like Heart, Cancer, Poisson, Stroke, and some emergency cases, providing Hospital-Critical-Care Treatment in-time makes a difference in life and death*.

Stage, no 5 TT-1 and TT-2 are the same as compared to stage no 4 but a drastic reduction in the Normal Treatment Time and Critical Treatment Time in the hospital due to the patient is already taking these treatments inside the ambulance (CTT-A) by Well-trained EMT and Doctor present inside the ambulance.

For improving CTT-H the following steps and sub-steps are proposed: To facilitate advanced information to enable hospitals to understand the case, predict the requirement and prepare for it before the Patient reaches the hospital. Sub steps proposed for this step are as follows;

- Identify the need by case categories.
- Develop reporting SOP
- Develop Hospital Preparedness Protocol

IV. Theoretical Contribution

From this study, it is very clear that conventional SMED is not suitable in the case of ART and it needs modification. In this study, we described the procedure of the Modified Single Minute Exchange of Die (MSMED) methodology. The suggested MSMED may be suitable for the reduction of ambulance response time.

V. Merits of the Modified SMED Methodology

The Modified SMED methodology has the following merits;

- It is concerned with the reduction of ART; Critical Treatment Time in Ambulance (CTT-A) and Critical Treatment Time in Hospital (CTT-H).
- In the Modified SMED methodology, activities of ART are identified and separated as internal and external.
- Internal activities are those activities that can be performed ‘only when an ambulance or Patient transfer is held/made to wait.

- External activities are those activities that can be performed 'while an ambulance is moving or Patient is being transferred.' The benefits of this EMT and driver are to prepare working conditions in advance or keep required medicines and equipment inside the ambulance when an ambulance is ideal/not moving with the Patient.
- It is suitable for Government hospitals, Private hospitals, NGOs, and ambulance services like 108 of the Chhattisgarh as well as the rest of the parts of the country and the World for reduction of ART.
- In the Modified SMED methodology, a key concern is to minimize various aspects of ambulance services like dispatch time, travel time, pickup time, and return travel time; time is taken to trigger in-ambulance treatment; time taken to trigger in-hospital treatment.
- It is versatile and economical because with moderate financial investment (salary of one additional Doctor who serves inside the ambulance) it will get good results in terms of reduction of Ambulance Response Time (ART).
- In the Modified SMED methodology, initial medical treatment is given to the patient by providing one Doctor with EMT inside the ambulance because this patient gets fast and appropriate medical treatment during the trip to the hospital.

VI. Conclusions

The modified SMED methodology suitable for the reduction of ambulance response time is developed on the basis of the identified compatibility gap. An internal and external activities are defined in context with ART and modified SMED is proposed. Creative problem-solving approach and use of technological advancement are recommended in addition to the typical time-motion study. Various steps and sub steps suggested which needs to be implemented suiting the applicability and feasibility of the case. Theoretical contribution of this study is addition in the existing body of knowledge by developing modified SMED for reducing ART. Moreover, outcome of this study is expected to help hospitals in reducing ART by applying proposed modified SMED eventually leading to save life of many patients.

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